Primary prevention of lower limb musculoskeletal injuries

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Participation in sport and physical activity has a positive impact on both physical and emotional health across all age groups[1-3]. Both elite and amateur sport provide an environment in which physical fitness can be improved, along with psychological and social benefits[4]. However, with increased participation comes an inherent risk of injury, particularly to the lower limb[5,6]. The most common anatomical sites of injury are the knee, thigh and ankle[7-9]. Hamstring injuries and anterior cruciate ligament tears represent a significant proportion of these injuries resulting in prolonged periods of absence from sport[10] , with associated potential long-term health implications[5].

The most at-risk demographic are adolescents and young adults, with some injuries demonstrating clear sex differences. While female athletes are at higher risk of ACL injuries compared to males, male athletes are more likely to sustain hamstring injuries[11]. These differences may reflect a complex interaction of biomechanical, hormonal and sociocultural factors, including gendered environments[12,13]. Recovery from injury is complex, beyond physical rehabilitation alone, and can profoundly impact social and psychological development[14]. Notably, injury is one of the most cited reasons for adolescent athlete drop-out from sporting participation[9]. While injuries in elite athletes frequently attract considerable media attention, the burden of injuries is greatest at grassroots level. For every injury in a professional athlete, there are considerable more injuries in amateur and grass roots athletes. Therefore, emphasis on injury prevention is not only essential, but paramount in safe-guarding long-term athlete health and development.

Injury prevention interventions are multicomponent training modalities designed to reduce the risk of musculoskeletal injury. The most well-established approaches focus on improving neuromuscular control, optimising lower limb biomechanics, and enhancing functional performance through components such as balance, strength and power. There is evidence that in football, the sport with the greatest global participation[15], these 10-20 minute interventions reduce the risk of lower limb musculoskeletal injury[16], and enhance performance[17,18].

Injury burden

Lower extremity musculoskeletal injuries encompass 64 – 85% of all injuries sustained in sport across different levels and age groups[8,9,19]. In football, hamstring muscle/tendon injuries are the most common, with knee injuries resulting the longest duration of absence from sport[7]. Hamstring injuries are responsible for the greatest amount of time lost to participation in sports, with evidence of an increase in incidence over recent years[20]. They are also the most common recurrent injury in elite football[8,21], with a 12-41% risk of ipsilateral injury recurrence[22-24]. In addition, there is evidence that the second injury is usually more significant than the first[25], with an inverse relationship between recurrence risk and playing level[22]. An overview of common lower limb sports injuries are visualised in Table 1.

Anatomical region of injury	% of all football injuries	
Thigh	26	Hamstrings = 37%
		Adductors = 23%
		Quadriceps = 19%
		Gastrocnemius = 13%
		Others = 8%
Ankle	16	
Knee	15	
Hip/Groin	13	
Head/Neck/Face	4	
Other (including upper extremity and trunk)	26	

Table 1: Overview of injuries in football (soccer) separated by anatomical location, data from Gurau *et al.*[7]

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In the UK, there are 52,000 ACL injuries per annum, with a twelve-fold increase in rate of reconstructions over the last two decades[26]. This increase in incidence is reflected in the paediatric and adolescent population[27], a trend attributed to increased participation in youth female sport, as well as improved injury diagnostics. Although ACL reconstruction with a lengthy rehabilitation process is an effective management strategy in restoring knee stability, function and facilitating a return to sport in 55-85% of cases[28,29], there is significant proportion who do not achieve this goal. Despite the recognition of this increasing injury burden, effective injury prevention strategies are yet to be implemented nationwide.

Risk factors

Sports that require pivoting, cutting, high-intensity sprints, jumping and contact all result in increased biomechanical forces and thus may increase injury susceptibility[30]. Whilst dynamic models can be applied to identify and incorporate the multifactorial nature of injury risk factors[31], they can be broadly categorised into modifiable and non-modifiable domains (Table 3). Modifiable risk factors include, but are not limited to, poor technique, lower-quality movement patterns, decreased muscle control, flexibility, and overuse/fatigue[9,24,31]. In contrast, non-modifiable risk factors include age, sex, anatomy and pre-existing injury history[30,31]. Whilst these cannot be altered, identification of athletes at an increased risk of injury can facilitate individual or group-specific preventative strategies. Adolescents, females and athletes with prior musculoskeletal injury have an inherently increased risk of lower limb injuries. Furthermore, the concept of a 'gendered environmental approach' emphasises systematic inequality that exists for females in their pre-sport, training, competition and treatment environments[12]. An example of this is the disparity in involvement in weight training between men and women[32], driven by the gendered expectation that weight training is perceived as a masculine activity[12]. This structure, whilst originally designed for the context of ACL injuries, provides a framework with which injury risk reduction can be targeted for female athletes, identifying potential demographic-specific challenges[33]. >>

Modifiable risk factors	Non-modifiable risk factors
Muscle strength	Previous injury profile
Postural stability	Age
Footwear	Sex
Aerobic fitness	Stage of menstrual cycle
Muscle tightness and range of movement	Generalised joint laxity

Table 2: Examples of risk factors for musculoskeletal injury.

Injury prevention interventions

An injury prevention intervention is typically a set of exercises specifically designed to reduce injury risk during sport. The most widely recognised injury prevention interventions are multicomponent training modalities focussed on the improvement of neuromuscular control, biomechanics, functional performance, balance, strength and power. Such interventions include FIFA 11+[34] and Activate[35]. FIFA11+ is a 20-minute set of 15 structured exercises which can be incorporated into warm-ups, designed for adolescent and adult football (soccer) players[34]. Activate is a 20-minute whole-body integrated warm up protocol, targeted at youth and adolescent rugby players[35]. Examples of interventions can be found in Table 3. Systematic reviews and meta-analyses have shown that FIFA11+ injury prevention interventions reduce the risk of knee joint injuries by 25%[36], and total football lower limb injuries 39%[37]. Specific to hamstring injury, FIFA11+ has been shown to decrease injury incidence by 63%[16]. At the time of writing, there is no single, widely accepted, optimal 'one-size-fits-all' injury prevention intervention due to unique, sport-specific demands and diverse sporting demographics.

Image courtesy of www.poweruptoplay.org

An injury prevention intervention (Knee Control Program, KCP) was created and applied nationwide for football (soccer) players in Sweden between 2005 and 2015[38]. Using a Swedish Football Association mandated single accident insurance to capture all significant knee injuries, there was a significant reduction in the number of cruciate ligament injuries of 6% and 13% in males and females respectively[38]. This multidisciplinary approach provides evidence for the efficacy of multidisciplinary input with all stakeholders being engaged appropriately.

Injury prevention in practice: examples and challenges

While great strides have been made specifically regarding risk reduction for isolated injuries, the generation of multiple injury-specific prevention strategies may not be practical, especially in implementation for recreational and amateur athletes. The main barriers to widespread application of these interventions are compliance and funding. This has been evidenced in the implementation of Activate in the UK. Whilst total injury risk was reduced by 67%, when the intervention was used three or more times per week[39], a key barrier to widespread uptake was compliance, with only one of sixteen teams using the protocol in its entirety across a whole season. This is particularly pertinent when considering the dose-response relationship that these interventions exhibit for the athlete in injury risk reduction[41]. Data supports that the core principles translate to a benefit across a multitude of injuries.

Emphasis on injury prevention carries inherent negative connotation for an athlete. The aim cannot be solely on injury avoidance but shifted to facilitating an increase in participation and performance optimisation. Therefore, a unified approach to optimal preparation and availability for participation is warranted.

Future priorities

There is an urgent need to establish injury surveillance infrastructure in the United Kingdom, especially for youth and adolescent athletes. Sampling an injury reporting database or using a survey-based approach would permit consistent data collection, providing epidemiological insight and enabling the assessment of efficacy of injury prevention interventions. The national implementation of injury prevention interventions is complex and should emphasise partner collaboration and policy integration with a clear message across the diverse sporting environments. Future interventions for high-risk groups should be prioritised, and adapted based on risk stratification, particularly for adolescent females and those with history of injury. Finally, central to successful implementation is to understand the barriers and facilitators to real-word application of these interventions, vital for long-term sustainability.

Conclusion

Lower limb musculoskeletal injuries represent a significant yet reducible burden in sport at all levels. Effective injury prevention is achievable through evidence-based, easily implemented interventions that address both physiological and sociocultural risk factors. With appropriate infrastructure, education, and policy support, injury rates can be reduced, long-term athlete health can be improved, and sporting participation enhanced for all. ■

Injury prevention intervention*	Target demographic	Overview
FIFA 11+[33]	Male and female football (soccer)	15 structured exercises lasting 20 minutes with emphasis on core stabilisation, eccentric thigh muscle training, proprioceptive training, dynamic stabilisation, and plyometric exercises, all performed with proper postural alignment.
Activate[39]	Male and female rugby	A 20–25 minute, age specific warm-up with emphasis on balance, resistance and plyometric exercises, with four phases of progression throughout a season.
PEP[40]	Male and female football (soccer)	A 15–20-minute warm-up with emphasis on stretching, strengthening, plyometrics, and sport-specific agility training.

Table 3: Examples of common injury prevention interventions with their respective components. FIFA; Federation Internationale de Football Association. PEP; Prevent Injury and Enhance Performance.

References

References can be found online at www.boa.ac.uk/publications/JTO.