

REVIEW PAPER

Injury Prevention Strategies in Football: A Systematic Review

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Abstract

Football is perhaps the most physically-demanding sport in the world, as players are obliged to play a high number of games in one season, with recovery breaks being short and mostly insufficient. As a consequence, injury rates are high among players, and their participation in the games is adversely affected, which, in turn, adds a tremendous financial and psychological burden for players and clubs alike at all levels (amateur, semi-professional, elite). This study reviews the most effective contemporary injury prevention strategies in football and the scientific evidence behind them. It also aims to determine the benefits and the applicability of these strategies in youth, men, and women at all performance levels. The standard systematic review methodology was modified and adapted for this review, and electronic search tools were used to locate the papers needed. A total of 44 studies were analysed. We have isolated five injury prevention strategies developed by researchers as the most effective to reduce the number of injuries and even to enhance performance to a certain degree: FIFA 11+, foam-rolling techniques, strength training for injury prevention, pre-activation routines, and core training. We evaluated these in relation to their scientific substrate and to their applicability in the training programmes introduced by sports scientists as well as strength and conditioning coaches on the pitch. In conclusion, our present systematic review revealed these five main injury prevention strategies as the most effective and popular ones at present.

Keywords: *injury prevention, methods, soccer, strength and conditioning*

Introduction

Football is perhaps the most popular sport on earth, with many people taking part either as amateurs or professionals. At the same time, football has one of the highest rates of injury events, in both amateur and professional championships (Junge, & Dvorak, 2004). Due to this phenomenon, players are not healthy and able to attend training sessions or games; as a result, football clubs lose injured players from their squad, which can affect their performance. Many studies around the world claim that serious injuries affect not only players but also the finances of football clubs. Studies from England (Woods, Hawkins, Hulse, & Hodson, 2002), Switzerland (Junge et al., 2011) and Netherlands (Lettellast Model, 2008) demonstrate the substantial financial cost that football clubs have to face regarding their players' injuries. Thus, regarding injury incidents in football, the problem

is twofold: a) players do not remain healthy and b) football clubs have to spend a considerable amount of money for their rehabilitation (Hickey, Shield, Williams, & Opar, 2014; Pritchett, 1981).

Injury prevention strategies are some of the most efficient tools for every strength and conditioning (S&C) coach when he wants to protect his players from upcoming injuries and help them be healthy and available for every game throughout the season. The purpose of this paper review is to present the effectiveness of five different injury prevention methods as part of the training session and how these methods can help S&C coaches to protect their players from injury events.

Individual injury prevention methods

FIFA 11+

Before the 1980s, no injury prevention programs had been in-



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troduced in football until Jan Ekstrand presented some opinions about injury prevention (Ekstrand, Gillquist, & Liljedahl, 1983). Two decades later, sports scientists and F-MARC published the first studies that demonstrated the effectiveness of the implementation of basic injury prevention strategies. A new programme was introduced by the FIFA Medical and Assessment Research Centre (F-MARC), which was called “11” and involved ten sets of exercises, which were designed to reduce the most common injury incidents in soccer (i.e., ankle and knee sprains/hamstring and groin strains) (Junge, Rosch, & Peterson, 2002). The exercises used for this warm-up program were focused on eccentric hamstring strength, balance, dynamic stabilization and core stability. The effectiveness of that programme became obvious and recently led a number of global medical sport organizations to collaborate and develop a new injury prevention program called “11+”.

“Fifa 11+” is a complete warm-up program developed by F-MARC in collaboration with the Oslo Sports Trauma Research Centre and the Santa Monica Orthopaedic and Sports Medicine Research Foundation. The goal of this program is to increase the strength levels of the athlete and decrease the injury rates in

both amateur and professional football players (Bizzini, Junge, & Dvorak, 2013).

This program has been evaluated and proved to be efficient regarding injury prevention, in all types of sport participants (amateur, semi-professional, professional) both male and female (Soligard, Myklebust, & Steffen, 2008; Steffen, Myklebust, Olsen, Holme, & Bahr, 2008; Owøye, Akinbo, Tella, & Olawale, 2014). This program is usually used as a warm-up routine and consists of three different phases. Phase One is the “running phase”, Phase Two deals with “strength, plyometrics and balance” including three levels of difficulty (beginner-intermediate-advanced), and Phase Three involves high-intensity runs and agility exercises. Regarding organization, this injury prevention program requires a minimum of equipment, it is time-efficient as it replaces the regular warm-up and helps players to remain injury-free. Table 1 summarizes the benefits of using the “11+” as a warm-up program according to the scientific literature. It must be emphasized that in those studies, subjects of all kinds were involved regarding age and gender. In the majority of studies, the program was applied twice a week.

Table 1. Summary of Some Studies and their Results, after the Implementation of “11+” as a Warm-up Routine

Results	Percentage	Subjects	Study
Fewer overall injuries	-46%	N=396 NCAA Div. I,II Mens	Granelli et al. 2015
	-41%	African Junior Laos League	Owøye et al. 2014
Fewer injuries during training	-37%	N=1892 female players aged 13-17	Soligard et al. 2008
Fewer injuries during games	-29%		
Reduced injury risk	-72%	N=226 Canadian youth football players	Steffen et al. 2013
Improvement in static and dynamic balance	+10.9% (eyes opened) +12.4% (eyes closed)	N=36 U21 soccer players	Daneshjoo et al. 2012
Improvement in the conventional strength ratio	+8%	N=36 Male professional soccer Players	Daneshjoo et al. 2012
Improvement of the fast/slow speed ratio	+8%		

Foam Rolling

During a football season, many players face crucial muscle injuries due to the insufficient recovery time available between games and between high-intensity training sessions. Many players are obliged to train or play games despite reporting feelings of muscular pain (Owen, Wong, Dellal, & Daren, 2013). These pains are a result of disruption of the muscle structure, which leads to prolonged impairment of muscle function and delays onset muscle soreness (DOMS) (Byrne, Twist, & Eston, 2004). The intensity of DOMS increases the first 24 hours post-exercise and peaks between 48-72 hours afterwards. If there is no proper rehabilitation after training and between training sessions or games, damage regarding muscle functions and joint mechanisms may ensue (Rowlands, Eston, & Tilzey, 2001). It has been suggested that DOMS results in adverse effects on sprint, jump height, power, abilities that are crucial during a football game (Byrne et al., 2004). In addition, DOMS can result in decreased joint proprioception, overestimation of force production, decreased range of joint motion and decreased strength and power measurements (Saxton et al., 1995; Brown, Child, Day, & Donnelly, 1997; Behm, & Chaouachi, 2011). Some other authors suggest that there are even more detrimental effects regarding players' performance, such as alteration in agonistic and antagonistic strength ratios, changes in recruitment patterns and, finally, increased risk of

injury (Smith, 1992; Orchard, Marsden, Lord, & Garlick, 1997; Cheung, Hume, & Maxwell, 2003). Considering all the dangers arising from DOMS, foam rolling routines aim to help athletes avoid injuries.

Foam rolling is a form of massage that physiotherapists and S&C coaches can use as a tactic to aid in the recovery of athletes. The purpose of its use is to alleviate DOMS and treat or prevent soft tissue restrictions. Athletes use their body mass on a foam roller to release the tension that exists on the soft tissue. During foam rolling, there are both direct and swiping pressures on the muscle; consequently, the soft tissue of the muscle is lengthening (Pearcey et al., 2015). It has been proved that foam rolling can be used as part of the warm-up, before the stretching stage or as a post-exercise recovery strategy (Zainuddin, Newton, Sacco, & Nosaka, 2005; Pearcey et al., 2015; Macdonald, Button, Drinkwater, & Behm, 2014).

It has also been proved that the use of foam rollers as a pre or post-exercise routine improves an athlete's performance in many ways both directly and indirectly. The benefits from the implementation of a foam-rolling routine before or after training in athletes are: Alleviates DOMS; Reduces DOMS; Corrects muscle imbalances, Promotes soft tissue extensibility; Improves neuromuscular efficiency; Relieves joint stress (Macdonald et al., 2014; Pearcey et al., 2015; Owen, 2016; Rey et al., 2019; Drinkwater, Latella, Wilshire, Bird, & Skein, 2019).

Strength training for hamstrings

Hamstring injuries are the most common type of injury during soccer games (Ekstrand et al., 2006). Owen et al. (2013) supported Zakas, Mandroukas, Vamvakoudis, and Christoulas (1995) viewpoint that hamstrings play a crucial role during running and stability exercises. These types of exercise are inherently and consistently involved in intermittent (stop and start) team sports, such as football, which include many explosive actions, direction changes, and decelerations.

It has been suggested from the scientific literature that hamstring injury rates can decline after the implementation

of a systematic and consecutive program, which focuses on increasing hamstring strength (Small, McNaughton, Greig, & Lovell, 2009; Petersen, Thorborg, Nielsen, Budtz-Jorgensen, & Holmich, 2011; Van Der Host et al., 2015). Table 2 presents such a program, suggested in 2011 by Petersen et al., which aims to prevent hamstring injuries in soccer players. It is crucial to note that the load is increased when the subject can withstand the fall for a more extended period. If the subject can stand the whole range of motion (ROM) for twelve repetitions, the load can be increased by accelerating the starting phase of the motion or by pushing the back of the shoulders.

Table 2. The Protocol of Eccentric Strength Training Applied (Petersen et al., 2011)

Week	Sessions per week	Number of sets	Number of repetitions per set
1	1	2	5
2	2	2	6
3			6-8
4	3		8-10
5-10			12-10-8

Nevertheless, it should be mentioned that over the previous decade other sport scientists suggested that hamstrings' strength training should be more of a holistic approach, than a purely eccentric strength training routine. According to this suggestion, hamstring strength training programmes should include hip- and knee-dominant exercises with regards to elite-level football (Bahr, Thorborg, & Ekstrand, 2015; Oakley, Jennings, & Bishop, 2018).

This opinion is based on the eccentric function of hamstring muscles during the late swing phase of running, at which they resist hip extension and decelerate knee extension (Higashihara et al., 2015). These exercises include single leg bridge (SLB), single-leg deadlift (SLDL), leg curls, deadlift, hip thrusts, glute bridge, Romanian deadlift (RDL), and lunges. Table 3 presents the most efficient hip dominant and knees dominant exercises.

Table 3. Knee-dominant and hip-dominant exercises for hamstring injury prevention (Mendez et al., 2016; Bourne et al., 2017)

Target short head of biceps femoris muscle	Target long head of biceps femoris muscle
Single leg deadlift	Nordic hamstring exercises
Hip extension	Flywheel leg chair
Romanian deadlift	Side leg lunge
Supine bridge	

The combination of both knee and hip-dominant exercises targets all heads of the hamstrings; thus, this kind of approach seems more efficient. As can be seen, some exercises target more the long head of biceps femoris (BF), where most injuries happen), and other exercises target the short head of BF, semitendinosus and semimembranosus muscles. A combined injury prevention program that involves those exercises seems to be much more efficient with regard to hamstring injury prevention.

Strength Endurance Training

According to sports scientists, the implementation of a strength-endurance training program has many benefits for injury prevention in soccer players. It has been suggested that

this kind of training helps soccer players to prepare their tendons, ligaments, and muscle tissue for high-intensity training (Swinnen, 2016). Another benefit of this type of training routine is its low intensity, which allows athletes to use different movement variations during training; this results in a better balance between what sports scientists call "opposite movement patterns" and fewer injuries (Swinnen, 2016). Finally, the form of this kind of training increases short work capacity as well as strength levels of the connective tissue, which results in an improvement of the players' ability to recover faster, avoid long-lasting fatigue, and remain healthy (Bomba, & Haff, 2009). Table 4 presents Brawn Swinnen's suggestions regarding the program design of this kind of training.

Table 4. Strength Endurance Training Planning Suggestions (Swinnen, 2016)

Organization:	Circuit
Intensity:	50–70% of RM
Total volume (sets in total) : 5–15 sets	5–15 sets
Volume:	2–3 sets/exercise
Rest	60–90 secs
Exercise selection:	Variety of movement patterns, Exercise complexes

Legend: RM - repetition maximum

Pre activation routines and core stability

Pre activation routines are mostly regular routines that aim to engage the body's nervous system and activate the muscles that will be used during training sessions or games. According to the scientific literature, these routines aim to increase joint stability, to improve the ability to generate optimal muscle firing patterns and finally to improve postural control and side-to-side imbalances in the lower body area (Caraffa, Cerulli, Proietti, Aisa, & Rizzo, 1996; Soderman et al., 2000; Heitkamp, Horstmann, Mayer, Weller, & Dickhuth, 2001). Additionally, it has been proved that these programs decrease ankle sprains and ACL injuries as well as hamstring injuries (Mandelbaum et al., 2005). It has been suggested that the implementation of these programs improves stability, technical skills, and movement control (Riva, Bianchi, Rocca, & Mamo, 2016). The exercises used for this purpose are usually single-leg stability activities, dynamic joint stability exercises, plyometric exercises, agility drills and sport-specific exercises (Risberg, Mørk, Jensen, & Holm, 2001; Mandelbaum et al., 2005; Hewett, & Myer, 2011).

Regarding core stability training this can help players to remain injury-free in an indirect way, as a strong core minimizes joint loads in all types of activities (Hibbs, Thompson, & French, 2008) not to mention the help it offers them in deal-

ing with the physical contact that football requires (tackles, set-pieces). In addition, a strong and stable core is crucial in providing a foundation for the movement of the upper and lower extremities to support loads and to protect the spinal cord and nerve roots.

Football is perhaps the most popular sport around the world, played by millions of people and watched by many more. The fact that a great number of people watch it has transformed it into a high demand sport throughout the last decades, as athletes have now more competitions and, as a result of this, more games to play during one football season. This increase in the number of games led players to more injuries and created for the S&C coaches the need to design injury prevention programs that will help them reduce this phenomenon.

Injury prevention strategies can involve warm-up protocols (FIFA 11+), myofascial release methods (foam rolling), strength training programs (strength training for hamstrings and strength endurance training) and finally neuromuscular proprioceptive intervention programs. It has been suggested that all those interventions before or (sometimes) after training, can help football players to avoid injuries and remain healthy and fit. Thus it is prevalent that S&C coaches need to apply those strategies to their daily, weekly and yearly periodization.

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Conflict of Interest

The authors declare that there are no conflicts of interest

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