IMPLEMENTING INJURY PREVENTION

THE ROCKY ROAD FROM RCT TO REAL-WORLD INJURY REDUCTION

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During the last 30 years we have witnessed significant progress in the field of football injury prevention. Large-scale randomised controlled trials (RCTs) have shown that exercise-based prevention programmes can substantially reduce the incidence of football injuries. But while it is commonly assumed that the positive results of these RCTs will automatically lead to real-world injury rate reductions, long-term analyses indicate that the rate of some football injuries, including hamstring and anterior cruciate ligament (ACL) injuries, are actually on the rise[1,2]. One of the reasons for this paradox is that many teams don't perform evidence-based injury prevention programmes as prescribed, decide not to use them or have no knowledge of the programmes. Bridging this gap between RCT evidence and everyday injury prevention practices in clubs represents one of the biggest future opportunities for football medicine. This article focuses on implementing injury prevention (that is, putting programmes into practice), including the research progress made so far and the challenging road ahead.

In 1983, Ekstrand et al[3] published the first RCT on an injury prevention strategy in football, involving 180 amateur male players. In this landmark study, a multi-factorial programme including a structured warm-up and cool-down, education, taping and controlled rehabilitation led to a staggering 75% reduction in injury rates in the intervention group. Subsequent research progress was initially slow, but isolated studies in the 1980s and 1990s employing preventive balance exercises, reported promising reductions in the rate of ankle and knee injuries[4,5]. Since 2000, the volume of published research on injury prevention, particularly exercise-based programmes, has grown rapidly. Key examples of such programmes are the Nordic Hamstring exercise, the FIFA 11+ and the Knee Control programme.

The ability of these prevention programmes to substantially reduce the rate of football injuries has been clearly proven in large RCTs. The Nordic Hamstring programme reduced new hamstring injuries by 59% and recurrent hamstring injuries by 86% in a study on male Danish players from the top five divisions[6]. Knee Control, an exercise programme including strength, core stability and jumping/landing exercises (Figure 1), reduced the rate of anterior cruciate ligament (ACL) injuries by 64% in a trial involving more than 4500 adolescent female players[7]. The FIFA 11+[8] – a 20-minute warm-up programme combining running, strength, core stability and plyometric exercises (Figure 2) – reduced

Figure 1: Swedish female youth players performing the Knee Control programme. Photo courtesy of Emma Busk Winquist.

Figure 2: Brazilian national team players performing the FIFA 11+. Photo courtesy of C. von Grebel, Zürich.

overall injury rates in amateur female (by 32%)[9], amateur male (41%)[10] and collegiate male football teams (46%)[11].

While the scale of injury reductions found in these RCTs is certainly cause for optimism, these studies also showed that the positive effect of these programmes is dependent on players and teams complying with the prescribed number of injury prevention sessions. Amateur adolescent female players with high compliance to the Knee Control programme had an 88% reduction in the ACL injury rate, a 90% reduced rate of severe knee injuries and 72% reduction in the rate of acute knee injuries, whereas the ACL injury rate in the low compliance group did not differ to the control group[12]. In the case of the FIFA 11+, amateur female teams with high compliance suffered significantly fewer overall injuries (-72%), compared to those teams with moderate compliance. Similarly, male collegiate teams completing a high number of FIFA 11+ sessions had a significantly lower injury rate compared to teams that were less compliant[11]. It has also been shown that compliance levels can decline significantly across a season[12].

Low compliance is just one of many barriers that evidence-based injury prevention programmes can face along the road from an RCT to broad-scale reproduction under less controlled conditions. Other significant threats include

teams choosing not to use the programme or having no knowledge of the programmes in the first place. For example, although 88% of top European teams were familiar with the Nordic Hamstring exercise, only 11% of teams performed it fully and 6% performed it partially[13]. This is despite hamstring injuries being the most common injury type among professional players and the strong evidence supporting the Nordic Hamstring exercise[6]. The authors concluded that use of the programme was far too low to expect any impact on the rate of hamstring injury[13].

This shows that establishing the effect of an injury prevention programme in an RCT, while extremely important, represents just one step along the road to real-world injury prevention. A programme that successfully reduces injuries in the intervention group of an RCT, can still fail to achieve any large-scale and sustained impact beyond the teams involved in the study. Even the most potent programme will have limited impact if teams don't know about it, decide not to use it, don't perform it properly or don't keep using it[14]. The significant challenges involved in spreading the word on evidence-based injury prevention (dissemination) and actually putting a programme into practice (implementation) are gaining increased attention in the sports medicine field. The key steps along the path from a successful RCT to large-scale, real-world injury reductions are neatly outlined in the Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) framework (Table 1[15]), which was developed to improve the transfer of evidence-based programmes into practice.

Applying RE-AIM to the example of preventing hamstring injuries, the Nordic Hamstring exercise has good reach among professional teams (88% know about it)[13] and also scores highly for effectiveness (59% reduction in new injuries in an RCT)[6]. However, adoption of the exercise by these teams is very low (17%) and even fewer teams use it as originally prescribed (11%)[13]. Hence, the real-world impact of the exercise in this population of teams is limited. The RE-AIM framework can also be applied to recent research findings from the Knee Control programme, for which a 3-year follow up to the original RCT has been published[16]. Table 2 shows how an injury prevention programme, proven highly effective in an RCT[7], can lose much of its impact along the road to real-world practice. Although the reach and adoption of Knee Control among coaches was high, implementation was low, with many coaches modifying the programme or only using it sporadically[16]. Similar trends have been reported in other football settings. For example, among high school football and basketball coaches in Oregon, half of all coaches were aware of injury prevention programmes, but just 21% reported using one and only 9% performed the programme correctly[17].

Barriers to putting an injury prevention programme into practice are not solely related to coaches. In a survey of head medical officers from 33 top-level European teams, coach compliance to injury prevention measures was reported to be generally high[18]. However, player compliance was highly variable across teams, with only four teams reporting full compliance from all players and 17 teams reporting either 'low' or 'no adherence' in up to half of their players. Nonetheless, 97% percent of the teams rated player compliance as either 'essential' or 'very important' to preventing injuries in professional football teams[18]. Barriers have also been reported at higher levels of the football system, including national football organisations. The FIFA 11+ has been promoted in more than 80 countries (including courses, workshops etc.) and at three FIFA Medical Conferences, along with extensive supporting material including a website, a detailed manual, a DVD, a poster and a promotional booklet (all in multiple languages). Despite these efforts, the programme has been endorsed by only 20 (10%) of FIFA's national football organisations[8]. Fortunately, positive examples also exist, with countries such as Germany, Brazil and New Zealand embracing injury prevention initiatives and helping to show what can be done when sufficient political willingness exists[19].

The above findings highlight the many challenges involved in implementing injury prevention programmes and that barriers can exist at multiple levels. Enhancing the real-world impact of these programmes requires an understanding

Table 1

***R**each - People have to know about it*
***E**ffectiveness - The program needs to work*
***A**doption - People have to decide to use it*
***I**mplementation - People have to use it correctly*
***M**aintenance - People need to continue using it*

Table 1: The RE-AIM framework[15]. Table courtesy of Caroline Finch.

Table 2

RE-AIM[15]	*Research findings from the Knee Control programme*	*% ACL injuries prevented*
E	*64% effectiveness in RCT[7]*	*64%*
R	*91% reach[16]*	*58%*
A	*74% adoption[16]*	*43%*
I	*35% implement it properly[16]*	*15%*
M	*82% maintain it[16]*	*12%*

Table 2: The RE-AIM framework applied to the Knee Control programme shows the reduction in impact from RCT to real-world injury prevention.

Table 3

Target level	*Key considerations*	*Key messages*
Policy makers *e.g.* *Club CEOs* *League officials* *National association officials*	*Policy makers are unlikely to be interested in medical data such as injury statistics and injury risk factors, as their focus is more on finances and team success.*	*Injuries are expensive. The costs to a professional club for a player being injured for 1 month can reach 500,000 Euros[27]. In Switzerland, football injuries resulted in 500,000 lost work days and 145 million Swiss francs in national insurance costs in 1 year[28].* *Investing in injury prevention is cost-effective. An injury prevention programme in New Zealand resulted in a NZ$8.2 per invested dollar return after 7 years.* *Teams with fewer injuries are more successful in both their national league and in UEFA competitons[29].*
Programme deliverers *e.g.* *Football coaches* *Fitness staff* *Medical staff*	*Coaches primarily focus on team success and technical/tactical factors. Their perceptions may be influenced by role model coaches.* *Medical staff primarily focus on protecting player health and may refer to the scientific literature[21].* *Fitness staff primarily focus on the physical performance of their players.*	*Lower injury rates are correlated with team success[29].* *Avoiding injury increases player availability for training and matches.* *Injury prevention programmes can be easily incorporated into team training (e.g. warm-up) with minimal time cost.* *Top teams endorse evidence-based injury prevention programmes (Figure 3).* *Large RCTs support the effect of injury prevention programmes[6, 7, 11].* *Performing an injury prevention programme can improve neuromuscular control[30] and dynamic balance[31] while also inducing similar physiological responses to other established warm-up programmes[32].* *Avoiding injury can protect players from both the short- and long-term negative effects of injuries[33].*
Players	*Players want to participate in trainings and matches without restriction. Their perceptions may be influenced by role model players.*	*Injury prevention is important to keep you on the pitch, extend your career and invest in your long-term health.* *Top teams endorse evidence-based injury prevention programmes (Figure 3).*

CEO=Chief Executive Officer, UEFA=Union of European Football Associations, NZ=New Zealand, RCT=Randomised Controlled Trial

Table 3: Key messages for promoting injury prevention programmes at different target levels.

of the reasons behind these barriers. Why do teams choose to adopt or not to adopt an injury prevention programme? And why do teams often perform programmes differently to how they were originally intended? Over the last decade, research has begun to shed light on some of these questions. In a sub-analysis of an RCT on the FIFA 11+ in amateur female teams, the probability of low compliance with the programme was significantly increased if the coach viewed it as too time consuming (87% higher) or was not football-specific (81% higher). Other studies in amateur teams have identified lack of time, low numbers of support staff, less coaching experience and the perceptions that programmes are difficult to perform or offering no relative advantage to their existing practice, as potential reasons for low adoption[17,20].

In male academy football teams, the reasons for the use and modification of specific injury prevention exercises have been investigated[21]. For example, the Nordic Hamstring exercise was used in 9% of injury prevention sessions, with reasons for its use including the strong evidence base and the high incidence of hamstrings injuries. In a further 34% of sessions, staff used alternative hamstring exercises (e.g. deadlift, hip thrust) to align with athletic goals and add progression, variation and individualisation to the programmes. In other prevention sessions, the Nordic Hamstring exercise was excluded, with reasons including the perceived risk of neuromuscular fatigue, Delayed Onset Muscle Soreness (DOMS) and injury. The successful delivery of injury prevention programmes in these academy teams was influenced by factors at different levels, including the player (e.g. motivation and absences), team staff (e.g. planning and communication), club (e.g. acceptance and culture), governing bodies (e.g. game schedules) and the environment (e.g. weather)[22].

THE ROAD AHEAD FOR INJURY PREVENTION IMPLEMENTATION

Applying the RE-AIM framework to football injury prevention research can assist in identifying knowledge gaps and highlighting important directions for future research. In a recent systematic review on the reporting of RE-AIM items in injury preventions trials, a moderate number of papers addressed aspects of programme reach (34%), effectiveness (58%) and implementation (36%), but very few reported information on aspects of adoption (4%) or maintenance (<1%)[23]. Future research must address these gaps.

Reach the target users

Injury prevention strategies need to reach multiple targets including: the players, the programme deliverers (e.g. coaches/team staff members) and policy makers (e.g. club officials/governing bodies). Reach can be improved by embedding injury prevention programmes in coach education, using social media, apps and websites, along with the endorsement of prevention programmes by football organisations and high-profile figures. More than 95% of health practitioners and researchers believe that social media has a role in spreading and obtaining research evidence[24]. Social media is likely to play a significant role in improving the future reach of injury prevention due to its key advantages over other media; it is highly accessible at a low cost and it allows ongoing two-way communication (e.g. between researchers and players/teams). Examples of injury prevention apps include the IOC's Get Set – Train Smarter, SISU Idrottsböcker's Knee Control and Strengthen Your Ankle by VeiligheidNL.

The use of a comprehensive coach workshop improved coaches' understanding of the FIFA 11+ and their perceived ability to carry out the programme among Canadian amateur team coaches[25]. A predecessor of the FIFA 11+ (FIFA 11) was implemented on a national level in Switzerland by integrating the programme into coach education sessions. A 4-year follow-up found that 80% of coaches were aware of the FIFA 11 and 57% performed the programme, in part or full.

Enhance adoption

Knowledge of a programme or even good intentions to use it, do not ensure adoption[26]. Planning and organising how, when and where programmes will be delivered are crucial processes. Potential barriers to adoption can be identified by involving all target levels in the planning phase of injury prevention programmes. Enhancing adoption may require different messages for different target levels, as detailed in Table 3[6,7,11,21,27-33].

Increase effectiveness

Teams often modify programmes to fit their context, without knowing how this impacts programme effectiveness. Accordingly, there is a need for research to identify which aspects of programmes are indispensable for achieving injury reductions. It is also important to establish

Figure 3: Brazilian national women's team players and staff members promoting the FIFA 11+. Photo courtesy of C. von Grebel, Zürich.

Figure 4: Academy players performing balance exercises. Photo: GEPA Pictures/Mathias Mandl.

the minimal required training doses necessary to achieve and maintain positive effects.

Knowing more about exactly which types and doses of exercises are effective can help in tailoring programmes to different contexts (e.g. different competitive levels) and thus increase the chances of teams accepting and using injury prevention programmes. Some teams in amateur settings, with minimal training time and resources, will benefit from a simple, set programme which can be easily performed under all conditions. In contrast, professional teams will be better served by a catalogue of evidence-based exercises, offering multiple exercise progressions and variations, and covering each key area for prevention. This allows teams to adapt the programmes to different training locations, formats and cycles, along with providing adequate variation, progression and individualisation[21,22]. The effect of preventive exercises on performance parameters (e.g. speed, strength, jumping) also requires further research. There is potential to harmonise injury prevention goals (e.g. hamstring strengthening) with performance goals (e.g. increasing horizontal force production for sprinting)[34,35].

Improve compliance

In addition to developing context-specific programmes (Figure 4), compliance can be improved by providing adequate supporting material (manuals, apps, online resources etc.) along with training, feedback and mentoring. However, very little research has evaluated how different delivery methods affect compliance. In an RCT on the FIFA 11+ in amateur female teams, a pre-season coaching workshop led to higher compliance with the FIFA 11+ compared to unsupervised website education, but the addition of on-field supervision of the sessions was of no additional benefit[36]. In an RCT of 220 athletes, two different methods of delivering a programme to prevent recurrent ankle injuries were compared; one group were offered the Strengthen Your Ankle App and the other group received a booklet. At 1-year follow-up, there was no difference between the methods in terms of injury incidence, pain/disability, compliance rates or cost effectiveness[37,38].

Ensure maintenance

Finally, players, staff members and policy makers need support to maintain injury prevention programmes over multiple seasons. This can be particularly challenging, because in many football settings coaches and other staff members come and go, increasing the risk of prevention programmes routines not being maintained across seasons. Key factors are establishing systems and policies at the team, club, league and association level, along with providing ongoing evaluation and support. National insurance companies can potentially also play a role, by offering more attractive policies to players and teams who successfully implement and maintain injury prevention programmes and hence consume fewer healthcare resources. Long-term follow-ups to RCTs[16], along with implementation studies over multiple seasons, are necessary to gain insight into the factors influencing programme maintenance.

PUTTING IT ALL TOGETHER

Taken together, the current evidence highlights the need for a context-specific

Figure 5: Text adapted from[39]: Padua DA, Frank B, Donaldson A, et al. Seven steps for developing and implementing a preventive training program: lessons learned from JUMP-ACL and beyond. Clin Sports Med 2014; 33:615-32.

and multi-level approach to putting injury prevention programmes into practice. While the RE-AIM framework can assist in identifying and evaluating barriers to implementation, there remains the need for an operational plan to put all of this information into action. Padua et al[39] proposed a seven-step approach to designing and implementing injury prevention programmes for a specific real-world setting. These steps are outlined in Figure 5, along with important considerations at each stage. Bizzini et al have also outlined a stepwise approach to implementing the FIFA 11+ in national member associations[19].

CONCLUDING REMARKS

Great progress has been made in injury prevention research over the last 30 years with the development of exercise programmes that can substantially reduce injuries under RCT conditions. We have also started to understand the steps involved in translating positive RCT findings into widespread injury reductions in the real world. By focusing more on successful implementation, the injury prevention programmes of the future will not only impress in RCTs, but equally in real-world practice.

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