Evidence Summary: Soccer

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The British Columbia Injury Research and Prevention Unit (BCIRPU) was established by the Ministry of Health and the Minister's Injury Prevention Advisory Committee in August 1997. BCIRPU is housed within the Evidence to Innovation research theme at BC Children's Hospital (BCCH) and supported by the Provincial Health Services Authority (PHSA) and the University of British Columbia (UBC). BCIRPU's vision is *to be a leader in the production and transfer of injury prevention knowledge and the integration of evidence-based injury prevention practices into the daily lives of those at risk, those who care for them, and those with a mandate for public health and safety in British Columbia.*

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Evidence Synthesis Tool

SPORT:	Soccer	**Target Group:**	Male and Female Players
Injury Mechanisms:	Common injuries: Ankle injuries, knee injuries, concussions, hamstring injuries and groin injuries Common injury Mechanisms: Contact and non-contact; Running; Overstretched muscles during active/dynamic movements; forced inversion or eversion trauma/movement to the ankle; forced valgus or varus trauma to the knee; direct impact on the body		

Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/Evaluation	Resources
All Injury **Male Elite Youth** • Overall (range) = 2.0 to 19.4 injuries/1000h • Game = 9.5 to 48.7 injuries/1000h • Practice = 3.7 to 11.4 injuries/1000h.[1] **Male Professional Adult** Overall (range) = 2.5 to 9.4 injuries/1000h, Game = 8.7 to 65.9 injuries/1000h, Practice = 1.4 to 5.8 injuries/1000h.[1] **Female Youth and Adult** Game = 12.5-30.3 injuries/1000h, Practice = 1.2-3.8 injuries/1000h.[2] **Most Common Injuries[1,2]** • Thigh/Hamstring injuries • Ankle injuries • Knee injuries • Groin injuries **Concussion** **Male youth** Overall = 0.19 (0.16 to 0.21)	**Modifiable Risk Factors** **Male:** *Ankle Injuries* • **Lower extremity Power Output Score < 30W/kg**: OR = 9.2 (95% CI; 1.13 to 75.09)[1] • **Poorer Balance Scores**: OR = 0.43 (95% CI; 0.21 to 0.89).[1] **Female:** *Ankle Injuries* • **Lower Knee Valgus Angle (in a drop jump)**: OR = 0.64 (95% CI; 0.41 to 1.00).[2] *Hamstring Injuries* • **Greater BMI**: OR=1.51 (5%CI; 1.08 to 2.11).[2] **Non-Modifiable Risk Factors** **Male:** *Hamstring Injury* • **Increasing Age**: HR = 1.1 (95% CI; 1.0 to 1.2).[4] OR = 1.4 (95%CI; 1.2 to 1.4).[5] **Female:**	There is extensive evidence (including level 1 evidence) that exercise-based interventions in the form of neuromuscular training programs are effective in reducing all soccer-related injuries (acute and overuse) across all levels of participation. • An injury risk reduction of 30% to 70% was reported for the 11+ Warm-up Program;[1-4] • 50% to 56% for the Knee Injury Prevention Program (KIPP);[4] • 78% for the HarmoKnee Program;[4] and 19% to 44% for other unnamed NMT programs specific for all injuries, knee (ACL) and ankle injury reduction.[4-7] **Cost-Effectiveness** An healthcare cost reduction of 43% was reported in the NMT group (−$689/1000 player hours) (95% CI; −$1741 to $234) - NMT program similar to the 11+ but with additional use of wobble board -	**Evaluation Frameworks** Literature relating to implementation research for effective interventions such as the 11+ and other NMT programs is still sparse (no systematic review),[1-6] however, only 1 study reported using an implementation framework in the evaluation of an NMT program for knee/ACL prevention.[3] In this study, the RE-AIM SSM was used. **Best Practice** Current literature concludes that: 1. Coaching workshops can effectively increase coach attitudes, perceived behavioral control, and intent to implement an injury prevention program. However, high levels of behavioral determinants do not appear to translate to high levels of implementation compliance.[1,2] 2. Coach-led delivery of the 11+ was equally successful with or without the additional field	**Program Delivery** To run the 11 + programs, a soccer coach would need to be trained either through an organized coach-workshop or self-training using freely available resources online: https://goo.gl/tJDUKN Most NMT programs do not require the use of equipment, e.g. 11+, however, some might require wobble boards or pads for balance training Soccer associations and organizations at the federal, provincial and community levels will need to enact policies that would empower and drive coaches to adopt and use the 11+, especially at the youth and amateur levels of participation.[1,2] This may be aligned with ongoing implementation research evaluating the real-world effectiveness (including healthcare cost) of

concussions/1000AE **Female youth** Overall = 0.27 (0.24 to 0.30) concussions/1000AE	*Knee Injuries* • **Older Age** (>14years): HR = 1.97 (95 % CI; 1.30 to 2.97).[3] • **Knee Complaints at the Start of the Season**: HR = 1.98 (95 % CI; 1.30 to 3.02).[3] • **Familial Disposition of ACL Injury HR** = 1.96 (95 % CI; 1.22 to 3.16).[3] **Male and Female:** *All Injuries* • **Workload**: Load can be both a risk or protective factor in youth soccer. Current evidence is sparse.[6] Few primary studies recently published have been systematically synthesized (on DET) and summarized on report. • **Game Exposure** (vs. Practice): RR = 2.89 (95% CI; 1.69 to 5.21).[7] • **Previous Injury:** OR = 1.23 to 11.6, for all injuries and specific lower extremity injuries (e.g. hamstring, knee, ankle).[2,4,5,7-9]	compared with the control group.[8] Only two studies[8,9] were found to evaluate the cost-effectiveness of NMT programs in aligned RCTs (although cost-effective, one of such program – FIFA 11 (now revised to 11+) did not reduce injuries). There is need for more data on cost-effectiveness, especially relating to the 11+ program.	involvement of a physiotherapist.[3] 3.Implementation/performance was reported to low to moderate for programs evaluated.[4,5] 4. To maximize program effectiveness, coaches will need to ensure quality delivery in their teams - exercise fidelity as prescribed (e.g. proper technique), and adequate adherence to program (2x weekly recommended).[6,7] **Implementation Facilitators[3]** • Focus on performance enhancement • High coaching experience • Pressure from parents • Awareness of data • ACL injuries in people related to individuals **Implementation Barriers[4]** • Ignorance of the program • Already doing similar exercises • Not having enough time • Other priorities (unspecified)	interventions and strategies for improving program delivery and sustenance in the future. Such example includes the two countrywide campaigns in Switzerland and New Zealand.[3,4] A similar approach is currently being used in an ongoing nationwide implementation and evaluation of the 11+ in Canada.[5,6]
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Review of Sport Injury Burden, Risk Factors and Prevention

Soccer

Incidence and Prevalence

The incidence of injuries in soccer players vary across levels of participation, type of exposure, and sex. Table 1 provides information on the incidence of soccer injuries (all injuries) by specific populations (Junge 2015; Pfirrmann et al. 2016). The incidence of injuries is higher in male participants (vs. females) and during games (vs. practice). Further, injury incidence is higher in training in male elite youth (vs. male professional adult), however, the reverse is the case for games (Junge 2015; Pfirrmann et al. 2016).

The prevalence of concussion in youth soccer appears to be low with an incidence of 0.19 (95%CI 0.16 to 0.21) concussions/1000AE and 0.27 (95%CI 0.24 to 0.30) concussions/1000AE in male and female athletes respectively (Pfister et al. 2016); a higher concussion incidence has been consistently reported in females (Junge 2015; Pfister et al. 2016).

Table 1: Incidence of Injuries in Soccer

Type of Exposure	Category of Participation		
	Male Elite Youth (Pfirrmann et al. 2016)	Male Professional Adult (Pfirrmann et al. 2016)	Female Youth and Adult (Junge 2015)
Overall (Range)	2.0 to 19.4 injuries/1000h	2.5 to 9.4 injuries/1000h	
Game (Range)	9.5 to 48.7 injuries/1000h	8.7 to 65.9 injuries/1000h	12.5 to 30.3 injuries/1000h
Practice (Range)	3.7 to 11.4 injuries/1000h	1.4 to 5.8 injuries/1000h	1.2 to 3.8 injuries/1000h

Mechanism of Injury

Overall, about two-thirds of soccer injuries are traumatic in origin; about a third (27% to 33%) are caused by overuse (Bizzini and Dvorak 2015; Pfirrmann et al. 2016). Further, about two thirds of traumatic injuries are caused by player contacts (contact injuries), and 12 to 28 % of all of such injuries are caused by foul play (Bizzini and Dvorak 2015; Junge and Dvorak 2004). Noncontact injuries (e.g. from running, overstretching, twisting, cutting, landing from a jump) account for 26% to 59% of all injuries (Bizzini and Dvorak 2015; Junge and Dvorak 2004).

Location and Type of Injury

In male players, the most common injuries affect the hamstring muscles followed by the ankle, knee and groin (Junge and Dvorak 2004; Pfirrmann et al. 2016). In female players, knee (particularly ACL injuries) and ankle injuries are the most common, followed by thigh/hamstring injuries (Junge 2015; Junge and Dvorak 2004).

The most common injury types are strains, sprains and contusions in both male and female players (Junge 2015; Bizzini and Dvorak 2015; Junge and Dvorak 2004; Pfirrmann et al. 2016).

Limitations in this Report and Current Literature

A major strength of this report is that the reviews synthesized included high quality prospective studies; however, most of these studies are from Europe and North America. Little is currently known about the incidence of injuries in other parts of the world. For instance, only one study was cited from Asia and none from Africa. This may be due to paucity of literature from these regions of the world. One very recent prospective study from this region suggests that the incidence of injuries is a lot higher in Africa (Owoeye et al. 2017).

Another limitation in current literature is the possibility of grossly under-reporting overuse injuries. Recent studies on overuse injury surveillance in various sports, including soccer suggest that current literature underestimates the prevalence of overuse injuries due to the insensitivity in the injury surveillance method that has been used in reporting such injuries so far (methods originally designed for traumatic injuries) (Bahr 2009). The burden of overuse injuries in soccer may be more than what is currently reported.

Risk and Protective Factors

Risk factors for injuries can be divided into modifiable risk factors (factors that can be adjusted or changed) and non-modifiable risk factors (factors that cannot be adjusted but individuals can be identified and targeted for interventions). Current literature has mainly provided information on risk factors for soccer injuries (no information on protective factors were found except for workload). Risk factors have been specifically described for the most common injuries based on body location and are described in Table 2. Previous injury (either as all previous LE or specific LE injury) appears to be the strongest and most consistent risk factor for any new injury (Arnason et al. 2004; van Beijsterveldt, van de Port, et al. 2013; Clausen et al. 2016; Engebretsen et al. 2010; Hägglund, Waldén, and Ekstrand 2006).

Table 2: Risk Factors for Injuries in Soccer

Injury by Location	**Male**		**Female**	
	Modifiable Risk Factors	Non-Modifiable Risk Factors	Modifiable Risk Factors	Non-Modifiable Risk Factors
Ankle Injuries	Lower extremity Power Output	Previous Ankle Injury	Lower Knee Valgus Angle (in a	

	Score (< 30W/kg) OR = 9.2 (95% CI 1.13 to 75.09) (Henry et al. 2016) Poorer Balance Scores OR = 0.43 (95% CI 0.21 to 0.89) (Henry et al. 2016)	OR = 1.23 (95% CI 1.06 to 1.41) (Engebretsen et al. 2010)	drop jump) OR = 0.64 (95% CI 0.41 to 1.00) (Nilstad et al. 2014)	
Hamstring Injuries		Increasing Age HR = 1.1 (95% CI 1.0 to 1.2) (Hägglund, Waldén, and Ekstrand 2006) OR = 1.4 (95%CI 1.2 to 1.4) (Arnason et al. 2004) Previous LE Injury HR = 3.5 (95%CI 1.9 to 6.5) (Hägglund, Waldén, and Ekstrand 2006) Previous Hamstring Injury OR (range) = 2.19 to 11.60 (van Beijsterveldt, van de Port, et al. 2013)	Greater BMI OR = 1.51 (5%CI 1.08 to 2.11) (Nilstad et al. 2014)	
Knee Injuries		Previous LE Injury HR = 3.1 (95%CI 1.3 to 7.6) (Hägglund, Waldén, and Ekstrand 2006)		Older Age (>14years) HR = 1.97 (95%CI 1.30 to 2.97) (Martin Hägglund and Waldén 2016) Knee Complaints at the Start of the Season HR = 1.98 (95%CI 1.30 to 3.02) (Martin Hägglund and Waldén 2016)

				Familial Disposition of ACL Injury HR = 1.96 (95%CI 1.22 to 3.16) (Martin Hägglund and Waldén 2016)
				Previous LE Injury IRR = 3.65 (95%CI 1.73–7.68) (Clausen et al. 2016)

Furthermore, load (a modifiable factor) appears to be both a risk and protective factor in youth and adult soccer. Table 3 presents a breakdown of the relationship between workload in soccer and overall injury risk based on very recent high quality primary studies.

Table 3: Workload as a Risk and Protective Factor for Injuries in Soccer

Male		**Female**	
Risk Factors	Protective Factors	Risk Factors	Protective Factors
Poor Aerobic Fitness Levels OR = 4.50 (95%CI 3.98 to 5.50) (Malone et al. 2016)	In-Season Acute:Chronic Workload Between 1 to 1.25 OR = 0.68 (95%CI 0.08 to 1.66) (Malone et al. 2016)	High Daily Training Load OR = 1.98 (95%CI 1.43 to 2.78) (Watson et al. 2016)	
High Pre-Season Workload OR (Range) = 1.95 to 5.11 (Malone et al. 2016)	Low Amount of Accumulated Load (Different Measures of Load): Overall, RR (Range) = 0.27 to 0.31 (Bowen et al. 2016) Non-Contact, RR = 0.21 to 0.31 (Bowen et al. 2016)	High Prior Day Load OR = 1.38 (95%CI 1.01 to 1.88) (Watson et al. 2016)	
High Amount of Accumulated Load (Different Measures of Load) Overall, RR (Range) = 1.65 to 3.84			

(Bowen et al. 2016) Non-Contact, RR = 2.2 to 5.11 (Bowen et al. 2016)			
High and Very High Acute:Chronic (over 1.41 and 1.76 respectively) Overall, RR (Range) = 2.55 to 4.98 (Bowen et al. 2016)			

Finally, game exposure (vs. practice) [RR = 2.89 (95%CI; 1.69 to 5.21)] predisposes both male and female players to a higher risk of having a new injury (i.e. all injuries) (Emery, Meeuwisse, and Hartmann 2005) and low mood [OR = 0.12 (95%CI; 0.02 to 0.66)] has been identified as a risk factor for all injuries in female youth soccer players (Watson et al. 2016).

Limitations

This report is based on data extraction from primary studies, as there was no review level studies on the topic. However, data were synthesized from primary studies that meet an inclusion threshold based on a critical appraisal.

Generally, it appears that the current literature has not examined risk and protective factors for soccer-related injuries, despite their importance in developing appropriate countermeasures for injury incidence. To date, only a few studies have investigated modifiable risk factors as predictors of injuries in a prospective cohort design. Further, workload has been identified lately as the single most important factor for injury risk; acting either as a direct predictor or as an effect modifier (Gabbett et al. 2014). However, just like other potential risk factors, only a few studies currently exit on this topic and no systematic is currently available.

Opportunities for Prevention: Effective Interventions, Cost-Effectiveness, Implementation and Evaluation

There is extensive evidence (including level 1 evidence) that exercise-based interventions in the form of neuromuscular training programs are effective at reducing all soccer-related injuries (acute and overuse) in male and female amateur and elite youth/young adult players. Specifically, an injury risk reduction of 30% to 70% was reported for the 11+ Warm-up Program formerly known as FIFA 11+ (Al Attar et al. 2016; Barengo et al. 2014; Herman et al. 2012; Thorborg et al. 2017); 50% to 56% for the Knee Injury Prevention Program (KIPP) (Herman et al. 2012); 78% for the HarmoKnee Program (Herman et al. 2012); and 19% to 44% for other unnamed NMT programs specific for all injuries, knee (ACL) and ankle injury reduction (van Beijsterveldt, van der Horst et al. 2013; Grimm et al. 2015; Herman et al. 2012; Grimm et al. 2016).

Cost Effectiveness

A healthcare cost reduction of 43% was reported in an NMT group (−$689/1000 player hours) (95% CI; −$1741 to $234) -NMT program similar to the FIFA 11+ but with additional use of wobble board- compared with a standard of practice control group (Marshall et al. 2016).

Implementation/Evaluation of Interventions

Literature relating to implementation research for effective interventions such as the 11+ and other NMT programs is advancing but no reviews currently exist on the topic (Frank, Register-Mihalik, and Padua 2015; Martin Hägglund et al. 2013; Joy et al. 2013; Junge et al. 2011; Owoeye et al. 2017a, 2017b; Soligard et al. 2010; Steffen et al. 2013). Of all the studies currently available, only one study reported using an implementation framework in the evaluation of an NMT program for knee/ACL prevention (Frank, Register-Mihalik, and Padua 2015). In this study, the RE-AIM SSM was used. Implementation/performance of NMT components range between low and moderate (Joy et al. 2013; Junge et al. 2011).

Best Practices

The following conclusions have been reached based on existing literature:

1. Coaching workshops can effectively increase coach attitudes, perceived behavioral control, and intent to implement an injury prevention program (Owoeye et al. 2017b; Steffen et al. 2013). However, high levels of behavioral determinants do not appear to translate to high levels of implementation compliance (Steffen et al. 2013).

2. Coach-led delivery of the FIFA 11+ was equally successful with or without the additional field involvement of a physiotherapist (Frank, Register-Mihalik, and Padua 2015).

3. To maximize program effectiveness, coaches will need to ensure quality delivery in their teams - exercise fidelity as prescribed (e.g. proper technique), and adequate adherence to program (2x weekly recommended) (Martin Hägglund et al. 2013; Soligard et al. 2010).

Implementation Facilitators reported in current literature (Frank, Register-Mihalik, and Padua 2015) include the following:

- Injury prevention
- Performance enhancement
- High coaching experience
- Pressure from parents
- Awareness of data
- ACL injuries in people related to individuals

Implementation barriers reported in current literature (Joy et al. 2013) include the following:

- Ignorance of the program

- Already doing similar exercises
- Not having enough time
- Other priorities (unspecified)

Directions for Program Delivery

Resources

To run the 11 + programs, a soccer coach would need to be trained either through an organized coach-workshop or self-training using freely available resources online: https://goo.gl/tJDUKN

Most NMT programs do not require the use of equipment, e.g. 11+, however, some might require wobble boards or pads for balance training.

Partnership Supports

Soccer associations and organizations at the federal, provincial and community levels will need to enact policies that would empower and drive coaches to adopt and use the 11+, especially at the youth and amateur levels of participation (Bizzini and Dvorak 2015; Bizzini, Junge, and Dvorak 2013). This may be aligned with ongoing implementation research evaluating the real-world effectiveness (including healthcare cost) of interventions and strategies for improving program delivery and sustenance in the future. Such example includes the two countrywide campaigns in Switzerland and New Zealand (Bizzini, Junge, and Dvorak 2013; Junge et al. 2011). A similar approach is currently being used in an ongoing nationwide implementation and evaluation of the 11+ in Canada (Owoeye et al. 2017a, 2017b).

Limitations in Current Literature

Although the effectiveness of preventive interventions for soccer injuries have been demonstrated through data synthesized from systematic reviews and meta-analysis, little is currently known about the cost of interventions and their implementation. For example, only two studies (Krist et al. 2013; Marshall et al. 2016) were found to evaluate the cost-effectiveness of NMT programs in aligned RCTs, of which one evaluated the FIFA 11 (which did not reduce injuries, albeit cost-effective) – now revised to 11+. There is need for more data on cost-effectiveness and implementation/evaluation of proven injury prevention interventions currently available, especially ones relating to the 11+ program. Moreover, current evidence on prevention strategies in soccer directly relates to amateur and elite youth and young adult, generalizability of results to male professional adult players in which a considerable number of participants exit remains unclear.

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