

Efficacy of the FIFA 11+ Injury Prevention Program in the Collegiate Male Soccer Player

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Background: The Fédération Internationale de Football Association (FIFA) 11+ program has been shown to be an effective injury prevention program in the female soccer cohort, but there is a paucity of research to demonstrate its efficacy in the male population.

Hypothesis: To examine the efficacy of the FIFA 11+ program in men's collegiate United States National Collegiate Athletic Association (NCAA) Division I and Division II soccer.

Study Design: Randomized controlled trial; Level of evidence, 1.

Methods: Before the commencement of the fall 2012 season, every NCAA Division I and Division II men's collegiate soccer team (N = 396) was solicited to participate in this research study. Human ethics review board approval was obtained through Quorum Review IRB. Sixty-five teams were randomized: 34 to the control group (CG; 850 players) and 31 to the intervention group (IG; 675 players). Four teams in the IG did not complete the study, reducing the number for analysis to 61. The FIFA 11+ injury prevention program served as the intervention and was utilized weekly. Athlete-exposures (AEs), compliance, and injury data were recorded using a secure Internet-based system.

Results: In the CG, 665 injuries (mean ± SD, 19.56 ± 11.01) were reported for 34 teams, which corresponded to an incidence rate (IR) of 15.04 injuries per 1000 AEs. In the IG, 285 injuries (mean ± SD, 10.56 ± 3.64) were reported for 27 teams, which corresponded to an IR of 8.09 injuries per 1000 AEs. Total days missed because of injury were significantly higher for the CG (mean ± SD, 13.20 ± 26.6 days) than for the IG (mean ± SD, 10.08 ± 14.68 days) ($P = .007$). There was no difference for time loss due to injury based on field type ($P = .341$).

Conclusion: The FIFA 11+ significantly reduced injury rates by 46.1% and decreased time loss to injury by 28.6% in the competitive male collegiate soccer player (rate ratio, 0.54 [95% CI, 0.49-0.59]; $P < .0001$) (number needed to treat = 2.64).

Keywords: injury prevention; epidemiology; neuromuscular training; FIFA 11+

Soccer (football) is the most widely played sport among both men and women, with approximately 300 million registered players globally.^{10,20,25} The growth of the sport in the United States (US) has been unprecedented. It is currently the third most popularly played sport, with over 13 million Americans participating at the youth and adult levels.⁵⁷ Major League Soccer (MLS) is currently in its 20th season and has grown to 20 professional teams within the US and in Canada since its inception, with further expansion on the horizon.⁴² In addition, there are approximately 412,000 high school male and 23,000 collegiate male soccer players participating in US National

Collegiate Athletic Association (NCAA) soccer.⁴⁶ The number of participants is increasing annually, imparting a multitude of positive effects with respect to emotional and physical wellness and health, and is influential in decreasing the onset of illness and systemic disease. However, the risks associated with soccer participation have been well documented.^{**} In the past 2 decades, numerous attempts have been made to gain a fuller understanding about the mechanism of these injuries and how researchers can reduce the incidence of such injuries.^{††}

Soccer-related injuries are not uncommon. There have been numerous research studies published elucidating the incidence and prevalence of soccer-related injuries in

both male and female players; recreational, amateur, and professional players; and youth and adult players.^{11,12,21,28,32,37,48} Researchers have also focused on variations in the injury rate occurring on artificial turf versus grass and during tournament play versus regular-season play.^{7,22,24,36,48} However, there is a growing body of evidence validating the notion that injury prevention programs have the inherent ability to decrease the incidence of soccer-related injuries and the time loss associated with such injuries.^{31,49,52-55} In the past 2 decades, many injury prevention efforts were focused solely on female athletes, namely, on anterior cruciate ligament (ACL) injury prevention.^{24,29,30,33,40} Recent publications have focused on the injury mechanisms related to male soccer players, but most of the injury prevention interventions have focused on women and girls.^{2,3,23,37,39,50}

The rate of injuries in soccer depends on several factors: age, level of competition, position on the field, environmental setting, location of injury, time of injury, and sex. These injuries most commonly involve the lower extremities and typically consist of mild to moderate sprains, strains, or contusions.^{27,36,56} In studies analyzing the injury rates of professional male soccer athletes, researchers have found an overall injury rate ranging from 6.2 to 13.2 injuries per 1000 athlete-exposures (AEs).^{7,22,43} In a collegiate analysis of male soccer injuries, the game injury rate was 21.92 per 1000 AEs in Division I and 20.43 per 1000 AEs in Division II; the practice injury rate was 4.60 per 1000 AEs in Division I and 4.40 per 1000 AEs in Division II.¹

The Fédération Internationale de Football Association (FIFA) and its Medical Assessment and Research Centre (F-MARC) developed injury prevention programs such as the "11" and the "FIFA 11+" in an effort to improve strength and reduce the incidence of all injuries incurred as a result of soccer participation.^{10,52,55} These programs have been evaluated in both sexes; in recreational, amateur, and semiprofessional soccer; and in court-based sports (basketball in the study by Longo et al³⁸).^{31,49,52,55,58} To address the compliance issue and perhaps some of the inadequacies of the therapeutic exercises initially selected for the "11" protocol, an international group of researchers reconvened and restructured the "11" program and developed a dynamic warm-up program that addressed the major deficiencies that were deemed to be ubiquitous to soccer athletes, renamed as the "FIFA 11+" program. The program effectively reduced soccer-related injuries in multiple studies and has been shown to optimally, from a physiological

perspective, prepare the athlete for competition.^{9,31,35,49,58} The program has also demonstrated the ability to improve muscular strength that may be deemed integral to injury prevention.^{18,45,50}

The aim of this research study was to describe the use of the FIFA 11+ program in competitive male soccer athletes in the collegiate setting. We hypothesized that the teams who participated in the FIFA 11+ intervention program would have a lower rate of injuries and incur a reduction in time loss due to injury in comparison to the control group.

METHODS

Study Design and Recruitment

A prospective, cluster randomized controlled trial was conducted in NCAA Division I and Division II men's soccer teams. Every athletic director, head soccer coach, and head athletic trainer from each institution with a men's college Division I or II soccer program (N = 396) was contacted via a formal letter, an email that reiterated the written letter, and a direct telephone call. The letter and email included a hyperlink for video clips that featured former and current prominent US soccer players and a coach who discussed the nature and importance of injury prevention in the sport of soccer (<http://vimeo.com/25708967> and <http://vimeo.com/25708960>). The inclusion criteria included current student athletes who were participating in an NCAA Division I or Division II member institution and, to avoid participant contamination, who had not participated in an injury prevention program in the past 4 competitive seasons. Sixty-five institutions consented to participate; participants from each institution ranged in age from 18 to 25 years. Human ethics internal review board approval was obtained through Quorum Review IRB. Before randomization, player consent was obtained, and a document of coaching comprehension was signed by each institution to ensure that there was a thorough understanding of the expectations of study participation. The randomization of each club was conducted utilizing a random number generator once every enrolled team had been identified. Upon randomization of the enrolled institutions, the intervention group (IG) received an instructional FIFA 11+ DVD, an injury prevention manual, and explanatory placards describing the FIFA 11+ intervention at length (www.f-marc.com/11plus). The control group (CG) received the identical study materials as the IG at the end of the data collection process.

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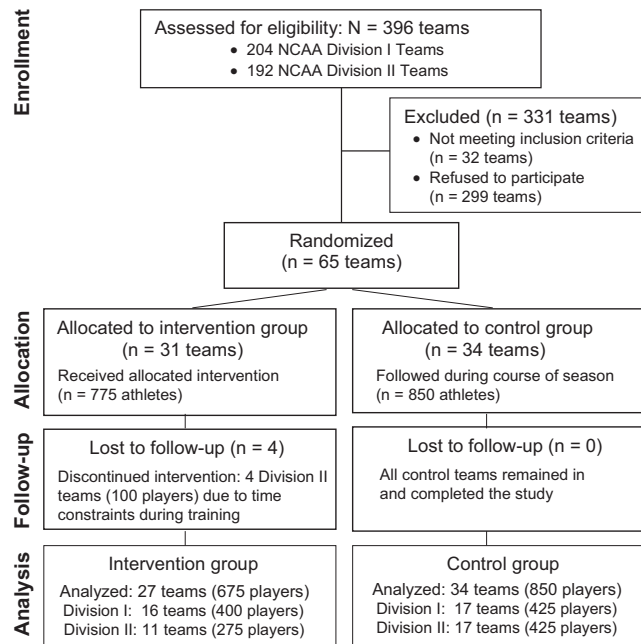


Figure 1. Description of National Collegiate Athletic Association team randomization and study flow.

An Internet-based injury surveillance system (HealtheAthlete) was utilized by every enrolled institution. Every AE, incurred injury, utilization of the FIFA 11+ program, and compliance data were entered weekly by the team's certified athletic trainer (ATC) and verified by the research staff. Sixty-one institutions completed the study during the fall 2012 season (August-December): 34 control institutions (n = 850 athletes) and 27 intervention institutions (n = 675 athletes) (Figure 1). Demographic information, including age, position played, and leg dominance, was also collected. Upon the completion of the season, the injury data entry was confirmed by each ATC and batched with his or her individual institution's data collection system for accuracy and thoroughness. During the course of the season, the individual compliance of the program was monitored by the research team weekly. In the event that compliance within the IG was deemed less than optimal, a member of the research team contacted the team to encourage improvements in compliance.

Intervention Program

The FIFA 11+ is an injury prevention program designed as an alternative warm-up program to address lower extremity injuries incurred in the sport of soccer for athletes older than 14 years.¹⁰ It is a 20-minute program that is utilized on the field without any additional or onerous equipment necessary, and it consists of 15 exercises divided into 3 separate components: running exercises (8 minutes) that encompass cutting, change of direction, decelerating, and proper landing techniques; strength, plyometric, and balance exercises (10 minutes) that focus on core strength,

eccentric control, and proprioception; and lastly, running exercises (2 minutes) to conclude the warm-up and prepare the athlete for athletic participation. There are 3 levels for each specific exercise (levels 1-3) that increase the difficulty for each respective exercise. This allows for both individual and team progression throughout the course of the competitive season²⁶ (<http://f-marc.com/11plus/home/>) (see Appendix 1, available in the online version of this article at <http://ajsm.sagepub.com/supplemental>). In this specific study, the FIFA 11+ program served as the intervention program over the course of 1 competitive collegiate soccer season. The warm-up was suggested to be utilized 3 times per week for the duration of the season. In comparison, typical soccer warm-up programs are quite heterogeneous and typically encompass running exercises, static and/or dynamic stretching, movements involving change of direction, and short passing. They typically average from 5 to 45 minutes in duration. The average warm-up program does not typically emphasize qualitative movement.^{9,10}

Exposure, Injury Data Entry, and Compliance

Upon consenting to participate in the study, each team provided a roster to be entered into the HealtheAthlete injury surveillance system. The surveillance system was a web-based system that was a data-secured, Health Insurance Portability and Accountability Act (HIPAA)-compliant site that utilized the Verisign secure second-factor logon feature. The injury and exposure data for each player on the roster were entered by the team's ATC. All injuries were entered weekly by the ATC and were verified and crosshatched with his or her institutional injury surveillance system at the end of the competitive season. The ATC indicated on which days the FIFA 11+ program was completed and which athletes participated in the training. The NCAA calendar was entered for each respective club to delineate the full soccer schedule, which commenced in August 2012 and ended in December 2012 (contingent upon the success of the institution in the NCAA playoff tournament). No unique identifiers that would reveal the identity of the team or the athlete were visible to any of the research staff.

The operational definition for an AE was participation in any team practice or game during preseason or in-season. We decided to use AEs over hours of playing time secondary to the NCAA substitution rules.⁴⁷ An injury was defined as any physical complaint sustained by a player that resulted from a football match or football training, irrespective of the need for medical attention or time loss from football. An injury resulting in a player receiving medical attention was referred to as a "medical attention" injury and an injury that resulted in a player being unable to take full part in future football training or match play as a "time-loss" injury.²⁷

Statistical and Data Analyses

All statistical analyses were conducted utilizing SPSS for Windows version 22. Descriptive and inferential tests

TABLE 1
Player and Injury Characteristics for the Control and Intervention Groups^a

	Control Group (n = 34 Teams)	Intervention Group (n = 27 Teams)
No. of players	850	675
Division I	425 (17 teams)	400 (16 teams)
Division II	425 (17 teams)	275 (11 teams)
Age, mean \pm SD, y	20.68 \pm 1.46	20.40 \pm 1.66
No. of AEs		
Total	44,212	35,226
Games	13,624	10,935
Practices	30,588	24,291
Injuries by position, n (%)		
Defender	204 (30.68)	92 (32.28)
Forward	132 (19.85)	67 (23.51)
Midfielder	256 (38.50)	101 (35.44)
Goalkeeper	73 (10.98)	25 (8.77)
Total injuries, n (mean \pm SD)	665 (19.56 \pm 11.01 ^b)	285 (10.56 \pm 3.64 ^b)
Division I injuries, n (% of total)	355 (53.4)	198 (69.5)
Mean \pm SD	22.19 \pm 12.0	9.9 \pm 3.11
Division II injuries, n (% of total)	310 (46.6)	87 (30.5)
Mean \pm SD	17.22 \pm 10.03	12.43 \pm 4.61
Game injuries, n (%)	392 (58.9)	185 (64.9)
Mean \pm SD	11.53 \pm 5.84 ^b	6.85 \pm 3.17 ^b
Practice injuries, n (%)	273 (41.1)	100 (35.1)
Mean \pm SD	8.03 \pm 6.24 ^b	3.70 \pm 2.13 ^b
IR per 1000 AEs		
Total	15.04	8.09
Games	28.77	16.92
Practices	8.93	4.01
Days lost to injury n (mean \pm SD)	8790 (13.20 \pm 26.6 ^b); SE = 1.09	2944 (10.08 \pm 14.68 ^b); SE = 0.96
Time loss, n (% of injuries)		
No time loss	201 (30.2)	104 (36.5)
1-3 d	126 (18.9)	31 (10.9)
4-7 d	94 (14.1)	43 (15.1)
8-29 d	164 (24.7)	81 (28.4)
\geq 30 d	80 (12.0)	26 (9.1)

^aAE, athlete-exposure; IR, incidence rate.

^b $P < .001$.

were used to compare the CG and IG, including t tests, χ^2 tests, and generalized linear regression models, with a logit link function and Poisson distribution for count data. Two generalized linear regression models (Biostatistics Core Facility, University of Delaware) were used to test if there was a significant difference in the number of days missed because of injuries between the IG and CG and, secondly, to test if the number of days missed because of injuries was different for athletes who had used the FIFA 11+ on the day of the injury. All injuries that occurred throughout the fall 2012 soccer season were analyzed by location, duration, and turf type (grass vs artificial turf).

RESULTS

The CG consisted of 850 athletes (56%) in 34 teams (56%) who had 44,212 (56%) AEs (games: 13,624; practices: 30,588). The IG consisted of 675 athletes (44%) in 27 teams

(44%) who had 35,226 (44%) AEs (games: 10,935; practices: 24,291). The CG had a significantly higher number of injuries per team (mean \pm SD, 19.56 \pm 11.01) compared with that of the IG (mean \pm SD, 10.56 \pm 3.64) ($t(59) = 4.07$; $P < .001$; Cohen $d = 1.16$). The number of participants who needed to be exposed to the intervention to reduce 1 injury in the IG (number needed to treat [NNT]) was 3. The mean utilization of the FIFA 11+ in the IG was 32.78 \pm 12.13 doses over the course of the season. There was no significant difference between the age of the injured athletes (IG: 20.40 \pm 1.66 years; CG: 20.68 \pm 1.46 years), nor was there a difference in the number of injured athletes based on player position (Table 1).

When the data were stratified by division of play (I or II) and for game and practice, the Division I CG had a significantly higher number of game injuries (n = 200 [56.3%]; mean \pm SD, 12.5 \pm 5.51; incidence rate [IR], 29.36) compared with Division I IG game injuries (n = 122 [61.6%]; mean \pm SD, 6.13 \pm 2.47; IR, 18.83) ($P = .000038$) (see

TABLE 2
Total Injury Counts for the Control and Intervention Groups^a

Area	Control Group (n = 850)			Intervention Group (n = 675)			Rate Ratio (95% CI)	NNT
	No. of Injuries	IR per 1000 AEs	% of Total Injuries	No. of Injuries	IR per 1000 AEs	% of Total Injuries		
Ankle	115	2.601	17.3	59	1.675	20.7	0.65 (0.48-0.87)	21
Knee	102	2.307	15.3	34	0.965	11.9	0.42 (0.29-0.61)	14
Head	61	1.380	9.1	31	0.880	10.9	0.64 (0.4203-0.9743)	39
Hamstring	55	1.244	8.3	16	0.454	5.6	0.37 (0.21-0.63)	24
Foot	49	1.108	7.4	22	0.625	7.7	0.57 (0.35-0.93)	40
Groin	48	1.086	7.2	23	0.653	8.1	0.60 (0.37-0.98)	45
Hip	45	1.018	6.8	16	0.454	5.6	0.45 (0.26-0.79)	34
Quadriceps	44	0.995	6.6	25	0.710	8.8	0.72 (0.44-1.16)	68
Leg	39	0.882	5.9	25	0.710	8.8	0.08 (0.49-1.32)	113
Shoulder	30	0.679	4.5	6	0.170	2.1	0.25 (0.1054-0.6016)	38
Spine	30	0.679	4.5	9	0.255	3.2	0.38 (0.18-0.79)	46
Hand	10	0.226	1.5	6	0.170	2.1	0.76 (0.28-2.07)	348
Torso	10	0.226	1.5	9	0.255	3.2	1.13 (0.46-2.77)	638
Elbow	9	0.204	1.4	2	0.057	0.7	0.25 (0.05-1.15)	114
Wrist	7	0.158	1.1	0	0.000	0.0	0.01 (0.001-0.017)	121
Neck	6	0.136	0.9	1	0.028	0.4	0.21 (0.025-1.73)	179
Chest	3	0.068	0.5	0	0.000	0.0	0.004 (0.0026-0.01)	283
Arm	1	0.023	0.2	1	0.028	0.4	1.26 (1.179-20.1)	3279
Forearm	1	0.023	0.2	0	0.000	0.0	1.25 (0.078-20.1)	3279
Total	665		100.0	285		100.00		

^aAE, athlete-exposure; IR, incidence rate; NNT, number needed to treat.

Appendix 2, available online). There was a similar outcome for Division I and Division II practices. There was a significant difference between the Division I CG practice injuries (n = 155 [43.7%]; mean ± SD, 9.69 ± 7.6; IR, 10.13) compared with Division I IG practice injuries (n = 76 [38.4%]; mean ± SD, 3.44 ± 1.86; IR, 5.146) ($P = .0027$). There was also a significant difference between the Division II CG practice injuries (n = 118 [38.1%]; mean ± SD, 6.56 ± 4.42; IR, 7.72) compared with Division II IG practice injuries (n = 24 [27.6%]; mean ± SD, 3.14 ± 1.57; IR, 2.36) ($P = .0457$). There was no significant difference found between the CG and IG in Division II game injuries (see Appendix 2).

The injury rates were significantly lower in the IG when stratified for type of injury as well (Table 2 and Figure 2). The highest number of reported injuries in both the CG and IG were ankle injuries. The CG reported 115 ankle injuries, accounting for 17.3% of the total CG injuries (IR, 2.601), compared with 59 ankle injuries in the IG (20.7% of total injuries; IR, 1.675; rate ratio [RR], 0.65 [95% CI, 0.48-0.87]). Knee-related injuries were the second highest reported injury for both groups. The CG reported 102 total knee injuries (15.3%; IR, 2.307) compared with 34 in the IG (11.9% of total injuries; IR, 0.965; RR, 0.42 [95% CI, 0.29-0.61]; NNT = 14). When the data were stratified for type of knee injury, there were 16 ACL injuries reported in the CG (2.4%; IR, 0.362) and 3 ACL injuries in the IG (1.1%; IR, 0.085), accounting for a 4.25-fold reduction in the likelihood of incurring an ACL injury (RR, 0.236 [95% CI, 0.193-0.93]; NNT = 70; $P < .001$). A similar trend was seen with respect to acute hamstring

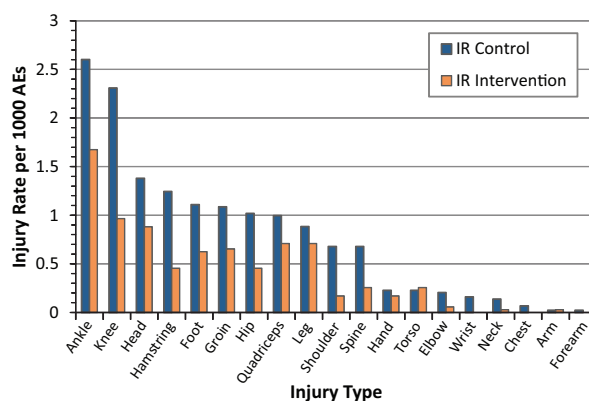


Figure 2. Injury rate per 1000 athlete-exposures (AEs) classified by type and stratified by group.

injuries. There were 55 hamstring injuries reported in the CG (8.3%; IR, 1.244) compared with 16 in the IG (5.6%; IR, 0.454), accounting for a 2.74-fold reduction in the likelihood of incurring a hamstring injury (RR, 0.37 [95% CI, 0.21-0.63]; NNT = 24; $P < .001$).

A Poisson regression was used to compare the total number of days missed between groups, IG versus CG, and for field types (grass vs turf) because the number of days missed is a count variable and normality was violated for both groups. The overall model was significant (likelihood ratio [LR] $\chi^2(2) = 263.06$; $P < .001$). There was a significantly higher number of days missed in the

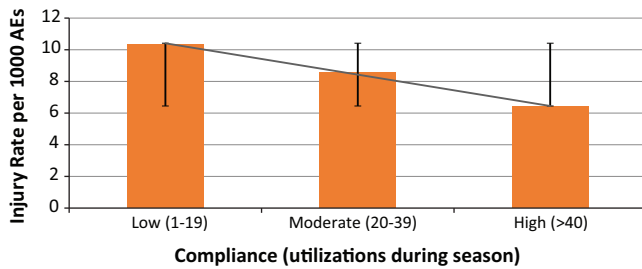


Figure 3. Injury rates in relationship to compliance with the FIFA 11+ program. AE, athlete-exposure.

CG (mean \pm SD, 13.20 \pm 26.6 days) than in the IG (mean \pm SD, 10.08 \pm 14.68 days) (Wald $\chi^2(2) = 7.35$; $b = 0.34$; SE = 0.12; $P = .007$); for each day missed in the IG, 1.4 days were missed in the CG (odds ratio [OR], 1.40). The total number of days missed because of injuries was 8790 in the CG compared with 2944 in the IG. There was no difference in either group for days missed based on field type (Wald $\chi^2(2) = 0.91$; $b = 0.13$; SE = 0.14; OR, 1.15; $P = .341$).

A second Poisson regression was used for those who were in the IG to compare the number of days missed if the injury occurred on a day when the intervention was used. The model was significant (LR $\chi^2(2) = 6.02$; $P < .049$). There was a significantly higher number of days missed when the intervention was not used on the day of injury (mean \pm SD, 10.65 \pm 15.35 days) than when it was used (mean \pm SD, 6.56 \pm 10.44 days) (Wald $\chi^2(1) = 4.26$; $b = 4.08$; SE = 1.98; $P = .039$). There was no difference in the number of days missed in the IG based on field type (Wald $\chi^2(1) = 0.90$; $b = 2.10$; SE = 2.21; $P = .343$).

Compliance

Compliance of the intervention was analyzed and stratified by utilization consistency. Compliance was determined to be low (LC: 1-19 doses/season), moderate (MC: 20-39 doses/season), or high (HC: >40 doses/season). The mean (\pm SD) utilization per team was 30.47 \pm 12.16 FIFA 11+ sessions. There were 54 injuries in 4 teams reported in the LC group (mean, 13.5 doses/season [range, 10-19 doses/season]; IR, 10.353 \pm 2.21), 156 injuries in 14 teams in the MC group (mean, 11.14 doses/season [range, 21-39 doses/season]; IR, 8.545 \pm 2.46), and 75 injuries in 9 teams in the HC group (mean, 8.33 doses/season [range, 40-64 doses/season]; IR, 6.39 \pm 2.71). There was a statistically significant difference reached, and an inverse relationship between the utilization compliance of the FIFA 11+ and the injury rate was identified ($P = .034$). The greater the team compliance to the program, the lower the injury rate within that respective cohort (Figure 3).

DISCUSSION

The FIFA 11+ was designed as a concise and comprehensive warm-up program to address lower extremity injuries

associated with the sport of soccer. In this study, the principal finding in this randomized controlled trial was that, by virtue of utilizing the FIFA 11+, there was an overall reduction of injuries in the IG by 46.1%, demonstrating the decreased likelihood of an athlete in the IG being injured (RR, 0.54 [95% CI, 0.49-0.59]; $P < .0001$; NNT = 2.64). This is consistent with other studies that have elucidated the efficacy of the 11+ in similar populations.^{31,49,52,55} There was a statistically significant reduction in injuries with respect to individual injuries (IR, 15.04/1000 AEs [CG] vs 8.09/1000 AEs [IG]; $P < .001$) and in relation to injuries per team (mean injuries/team: 19.56 [CG] vs 10.56 [IG]; $P < .001$). This reinforces the findings of other authors, elucidating the protective benefit of the FIFA 11+ program for both men and women.

When the data were analyzed for division of play (Division I or II), there were significant reductions in the IG for Division I game (IR, 29.36 [CG] vs 18.83 [IG]; $P = .000038$) and practice injuries (IR, 10.13 [CG] vs 5.146 [IG]; $P = .0027$) and Division II practice injuries. There was no statistical difference in Division II game injuries, but a trend for injury reduction in this cohort was apparent ($P = .3762$) (see Appendix 2). This injury distribution with respect to level of play and game versus practice injury is consistent with the existing literature.^{1,21,23,31}

The FIFA 11+ program was first tested in female soccer players in Norway. Soligard et al⁵² conducted a cluster randomized controlled trial in 125 female youth soccer clubs in Norway (aged 13-17 years): 65 teams in the IG (n = 1055) and 60 teams in the CG (n = 837) followed the protocol for 1 season (8 months). During the season, 264 players had relevant injuries: 121 players in the IG and 143 in the CG (RR, 0.71 [95% CI, 0.49-1.03]). In the IG, there was a significantly lower risk of injuries overall (RR, 0.68 [95% CI, 0.48-0.98]), overuse injuries (RR, 0.47 [95% CI, 0.26-0.85]), and severe injuries (RR, 0.55 [95% CI, 0.36-0.83]). This indicates that a structured warm-up program can prevent injuries in young female soccer players.

In a small cohort study conducted of men's collegiate soccer in the US, Grooms et al³¹ utilized the FIFA 11+ intervention for 1 Division III soccer team (N = 41; aged 18-25 years). The first season served as the referent season, and the second season served as the intervention assessment. The injury rate in the referent season was 8.1 injuries per 1000 AEs with 291 days lost and 2.2 injuries per 1000 AEs and 52 days lost in the intervention assessment season. The intervention assessment season demonstrated reductions in the relative risk of lower extremity injuries of 72% (RR, 0.28 [95% CI, 0.09-0.85]) and time lost to lower extremity injuries ($P < .01$). Despite the small sample size, there was a statistically significant reduction in the injury rate and time lost to injury. The researchers noted excellent compliance and adherence to the program and benefited from direct oversight from an ATC at every exposure.

A recent study investigated the efficacy of the FIFA 11+ in a male soccer cohort in the African Laos Junior League. Owoye et al⁴⁹ utilized the FIFA 11+ intervention in a cluster randomized trial in 20 teams (N = 416 players:

intervention = 212 players, control = 204 players) over the course of 6 months. In total, 130 injuries were recorded, affecting 104 (25%) of the 416 players. The FIFA 11+ program significantly reduced the overall rate of injuries in the intervention group by 41% (RR, 0.59 [95% CI, 0.40-0.86]; $P = .006$) and all lower extremity injuries by 48% (RR, 0.52 [95% CI, 0.34-0.82]; $P = .004$). However, the rate of injury reduction based on secondary outcomes mostly did not reach the level of statistical significance.

The FIFA 11+ program has been shown to be an efficient means of achieving optimal physiological readiness for sport.^{9,35} The program has also been shown to increase muscle activation in the rectus abdominis, gluteus medius, and gluteus minimus immediately after completing the program, corroborating its effect on core activation.⁴⁵ Daneshjoo et al¹⁸ analyzed the effect of the FIFA 11+ on knee strength in male competitive soccer players. Quadriceps and hamstring strength was assessed after 24 sessions of utilizing the FIFA 11+ program in U-21 male soccer players ($N = 36$); concentric quadriceps peak torque increased by 27.7% at 300 deg/s in the dominant leg ($P < .05$), and concentric hamstring peak torque increased by 22%, 21.4%, and 22.1% at 60, 180, and 300 deg/s, respectively, in the dominant leg and by 22.3% and 15.7% at 60 and 180 deg/s, respectively, in the nondominant leg compared with the control group.

The results in the aforementioned articles suggest that consistent utilization of a neuromuscular training program, such as the FIFA 11+, may impart a protective benefit to the soccer athlete by achieving an optimal state of physiological preparedness for soccer competition and sufficient biomechanical training to offset the risk of injuries associated with soccer participation.

Evolution of the Program

Steffen et al⁵⁵ attempted to reduce the incidence of ACL injuries by using a set of exercises known as “The 11.” It was a cluster randomized controlled trial to test the efficacy of the “11” on the injury risk in female soccer players (IA, 59 teams; $n = 1091$) compared with a control group (CA, 54 teams; $n = 1001$). A total of 396 players (20%) sustained 483 injuries. There was no difference in the overall injury rate between the IA (3.6 injuries/1000 athlete-hours [95% CI, 3.2-4.1]) and CA (3.7 injuries/1000 athlete-hours [95% CI, 3.2-4.1]; RR, 1.0 [95% CI, 0.8-1.2]; $P = .94$), nor was there a difference in the IR for type of injury. The training program was utilized during 60% of the soccer training sessions in the first half of the season, but only 14 of 58 intervention teams completed more than 20 prevention training sessions throughout the course of the season. The researchers noted no effect of the injury prevention program on the injury rate perhaps because of the exercises not being specific enough to address the biomechanical deficiencies present in this population. Furthermore, the low compliance rates among the intervention teams could have negatively affected the prevention benefit. However, a study analyzing the efficacy of “The 11” in adult male amateur players ($N = 23$ teams; 11

intervention teams [223 players] and 12 control teams [233 players]) showed a significant difference in the incidence of knee injuries but not in overall injuries (9.6 injuries/1000 athlete-hours [95% CI, 8.4-11.0] for the intervention and 9.7 injuries/1000 athlete-hours [95% CI, 8.5-11.1] for the control), despite having good compliance (73% compliance rate for teams and 71% for players).⁵⁸ “The 11” program was subsequently revamped into “The 11+” to address the inadequacies in the former program’s components.

Compliance

A variable worthy of discussion, which may positively or negatively affect the efficacy of a neuromuscular injury prevention intervention, is the role of compliance. It has been demonstrated that compliance is inversely correlated with the injury rate; the more regularly the neuromuscular training programs are implemented, the lower the reported injury rate.⁵² High adherence to injury prevention programs, specifically the FIFA 11+, resulted in lower injury rates in a Canadian youth female soccer cohort (incidence rate ratio, 0.28 [95% CI, 0.10-0.79]).⁵³ In contrast, when compliance and adherence to a program are diminished, the propensity of the prevention program to be effective is limited as well.⁵⁵ In this current study, there was an inverse relationship between the injury rate and compliance; as compliance increased, injury rates subsequently decreased with statistical significance ($P = .034$) (Figure 3). It is critical to effectively communicate the importance of the regularly scheduled implementation of programs such as the FIFA 11+ to fully impart their benefits to the soccer community at large.

Program Dissemination

The NCAA FIFA 11+ program was delivered without direct contact to the ATC at each respective institution because of the wide geographic expanse of the randomized groups. The researchers relied solely on video, DVD, and printed materials to ensure proper implementation of the program with a proper biomechanical technique. The fact that the ATC was the point person for FIFA 11+ delivery as well as injury collection is a strength of the study, as ATCs are highly qualified and well-educated members of the multidisciplinary medical team. The subject of program delivery has been the source of debate in the literature.^{10,29,51,52,54,55} Steffen et al⁵³ examined the effect of different delivery methods on compliance and injury rates in youth soccer. Teams that had supervision and had access to a coach-focused workshop demonstrated greater adherence to the FIFA 11+ program compared with the control teams, who only had access to the educational website (85.6% and 81.3%, respectively; control, 73.5%). Players with high adherence to the FIFA 11+ program had a 57% lower injury risk, but this was not statistically significant. This research demonstrates that despite financial and geographic limitations associated with the multicultural and global appeal of the sport of soccer, the factor

that remains critical to optimal injury prevention outcomes is imploring coaching and training staff to regularly utilize such programs on a weekly basis.

Another factor to consider with implementation is the timing of the intervention during the course of training. The PEP program and the FIFA 11+, among others, have been designed as dynamic warm-up programs to be utilized before training.^{10,40,52} The rationale behind this method of delivery is to increase compliance, as warm-ups are consistently utilized in the sport of soccer, and to neuromuscularly prepare the athlete for training in a nonfatigued state. When a neuromuscular training program is delivered, it should be performed with a proper biomechanical technique. If the exercises are performed in a fatigued state, or with a poor or inconsistent biomechanical technique, a pathokinematic motor pattern may be neuromuscularly reinforced. A study that utilized an injury prevention program after training, in a fatigued state, and devoid of a strength element was largely unsuccessful in reducing the rate of ACL injuries across 3 sports.⁵¹

Limitations

There are several factors to consider with respect to the methodological limitations of the study. The study was only conducted over the course of a single NCAA competitive season (August-December 2012). The average Division I and II teams have 18 and 18 games and 51 and 52 practices, respectively, throughout the course of the season.^{1,19} Because of the truncated nature of the collegiate season, it is often challenging to impart the full neuromuscular benefit of such a program because of the short duration of the season compared with domestic professional and European leagues (9- to 10-month season). In addition, training for the study was accomplished remotely via a website (www.f-marc.com/11plus), an educational video clip (Vimeo), an instructional DVD, a manual, and a PDF poster detailing the elements and progression of the FIFA 11+. There was no direct contact or training with each individual institution or the team ATC because of the wide geographical expanse of the study population. However, the ATC was responsible for initiating each session at his or her respective institution and for entering the injury data in a medical database. The ATC served as a highly qualified medical professional who vastly improved the quality of the data entered into the HealthAthlete secure system.¹⁹ In a recent study, various FIFA 11+ implementation strategies were investigated in a cluster randomized controlled trial. The study compared (1) unsupervised, website-directed FIFA 11+ implementation with a comprehensive coach-focused workshop (2) with and (3) without regular supervision by a physical therapist. The researchers found that teams in the comprehensive and regular interventions demonstrated greater compliance, which was not statistically significant. Players with higher compliance to the program showed lower injury rates, which were not shown to be statistically significant either.⁵⁴ However, this may speak to the overall effectiveness and generalizability of the program. In this current study, we

found a statistically significant difference between compliance groups in relation to the injury rate. Even in the LC IG teams ($n = 4$; range, 10-19 doses), the athletes demonstrated an injury rate significantly lower than that of the CG teams (IR, 10.353 ± 2.21 [LC], 8.545 ± 2.46 [MC], 6.39 ± 2.71 [HC] vs 15.04 ± 11.01 [control]; $P = .034$). In continents with extensive geographic expanse, such as North and South America, Africa, and Australia, researchers may often depend on the electronic dissemination of medical information and program implementation. Although the authors contend that direct contact with coaches and players is optimal, electronic educational dissemination has been shown to be effective and cost efficient. In spite of the anonymous delivery system utilized in this study, the program was initiated during the preseason portion of the season and continued throughout the duration of the season with significant reductions in injuries and time loss due to injury. The authors contend, from a public health perspective, that the ease and generalizability of the program and the ability to deliver and disseminate the injury prevention message meaningfully and effectively over a vast geographic area are strengths of the program.

Future Directions

There have been several research studies that have illuminated the protective benefit of utilizing the FIFA 11+ prevention program as a viable alternative to an existing warm-up protocol. There have been notable reductions in injury rates in both male and female soccer players, and time loss due to injury had been significantly reduced by virtue of utilizing the FIFA 11+ program. To fully understand the biomechanical changes imparted by the FIFA 11+ through the kinematic chain, a thorough biomechanical motion analysis before and after utilization among men and women in various age groups and levels of competition would be warranted and is being conducted at the present time.

CONCLUSION

The FIFA 11+ was shown to reduce injury rates and time loss due to injury in the competitive male collegiate soccer player in a statistically significant manner. The more consistently the program was utilized, the greater the injury prevention benefit imparted to the athlete. The benefits of sport participation are numerous and far outweigh the risks associated with such. However, the likelihood of incurring an injury by virtue of participating in soccer should not be underestimated. As clinicians, it is integral to our collective ethos to recognize the risks associated with sport and to profess the merits of prevention protocols that have been presented in the peer-reviewed literature. This information may successfully reduce the incidence of sport-related injuries in a meaningful way. As researchers, we will continue to set our sights higher to improve the quality and efficacy of the prevention programs available

to the athletic community. We recognize and embrace the need for program compliance and further randomized controlled trials to elucidate the epidemiology, mechanism of injury(s), and ultimate reduction and prevention of sport-related injuries.

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