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The FIFA 11+ Program Is Effective in Preventing Injuries in Elite Male Basketball Players

A Cluster Randomized Controlled Trial

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Background: Recently, structured training programs for sports injury prevention (''The 11'' and ''The 11+'') have been validated in soccer. The FIFA 11+ program has not been evaluated in basketball.

Hypothesis: The FIFA 11+ program is effective in reducing the rates of injury in male basketball players.

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

Methods: The authors randomized 11 teams of the same club. Seven teams were allocated to the intervention group (80 players; mean [SD] age 13.5 [2.3] years), and 4 teams were allocated to the control group (41 players; mean [SD] age 15.2 [4.6] years). The authors conducted an injury surveillance program during a 9-month season. The primary outcome was any injury to the athletes. The secondary outcome was any injury to the lower extremity (foot, ankle, lower leg, knee, thigh, groin, and hip). They included an analysis of the type of exposure (match or training), injury location in the body, and type of injury (acute or overuse).

Results: During the 9-month season, 23 (19%) of the 121 players included in the study sustained a total of 31 injuries (14 in the intervention group and 17 in the control group). In the intervention group, injury rates per 1000 athlete-exposures were lower than those in the control group, with statistical significance, for overall injuries (0.95 vs 2.16; $P = .0004$), training injuries (0.14 vs 0.76; $P = .007$), lower extremity injuries (0.68 vs 1.4; $P = .022$), acute injuries (0.61 vs 1.91; $P < .0001$), and severe injuries (0 vs 0.51; $P = .004$). The intervention group also had statistically significant lower injury rates for trunk (0.07 vs 0.51; $P = .013$), leg (0 vs 0.38; $P = .007$), and hip and groin (0 vs 0.25; $P = .023$) compared with the control group. There was no statistically significant difference in match injuries, knee injuries, ankle injuries, and overuse injuries between 2 groups. The most frequent acute injury diagnoses were ligament sprains (0.41 and 0.38 in the intervention and control groups, respectively; $P < .006$) and contractures (0.76 and 0.07 in the control and intervention groups, respectively; $P < .003$).

Conclusion: The FIFA 11+ warm-up program is effective in reducing the rates of injuries in elite male basketball players.

Keywords: athlete; sports; injury prevention; FIFA; basketball

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Basketball is one of the most popular team sports in the world. Despite the numerous health benefits, participation in a physically demanding sport such as basketball can result in increased risk of injury.[8,36] Injuries can counter the beneficial effects of sports participation if an athlete is unable to continue to participate because of residual effects of injury.[28,30,31,34,37,38] Moreover, economic issues arise, linked to sponsors and media coverage, when an athlete is injured.[27,35,38,39]

The ankle/foot (39.7%), knee (14.7%), head/face/neck (13.6%), arm/hand (9.6%), and hip/thigh/upper leg (8.4%) are most commonly injured sites in basketball.[8] The most frequent injury diagnoses are ligament sprains (44.0%),

muscle/tendon strains (17.7%), contusions (8.6%), fractures (8.5%), and concussions (7.0%).[8]

There is a need for programs to prevent injuries in athletes. However, unfortunately to our knowledge, no injury prevention programs have been developed in basketball. Few studies have investigated the effect of injury prevention programs on altering proposed lower extremity injury risk factors.[25,26] The injury prevention program "The 11," developed with the support of the Fédération Internationale de Football Association (FIFA), aims to reduce the effect of intrinsic injury risk factors in soccer, and it has been validated in that sport.[47,48] A successive modified version of "The 11" ("The 11+") has been also shown to be effective in preventing injuries in young female soccer players.[46] The FIFA 11+ provided more than a 40% reduction of the risk of injury. Several factors can be related to the risk of injury during sport. Therefore, different exercises or factors might have been responsible for the efficacy of the FIFA 11+ to prevent injuries. The program was found to be not effective in preventing the following injuries: ankle, anterior thigh, posterior thigh (hamstring), hip/groin, sprains, strains, fractures, and anterior lower leg pain (periostitis). On the other hand, the program was effective in preventing knee injuries, lower extremity injuries, overall injuries, severe injuries, and overuse injuries, such as lower extremity tendon pain and low back pain. According to data about mechanism of injury in soccer,[5,41] basketball,[24] handball,[43] rugby,[29] and alpine skiing,[7] the success of the program could be related to running exercises with increasing difficulty to obtain proper knee control and core stability during cutting and landing; exercises to improve dynamic and static balance, neuromuscular control, and proprioception, particularly of the knee and the hip; and exercises increasing hamstring muscle strength to prevent injuries to the anterior cruciate ligament.[41]

To our knowledge, the "FIFA 11+" program has not been evaluated in basketball. We therefore conducted a cluster randomized controlled trial to examine the effect of the FIFA 11+ on rates of injuries in elite male basketball players.

MATERIALS AND METHODS

We randomized 11 teams of the same club to the intervention or control group. To minimize contamination bias within teams, we used a cluster randomized design, in which teams (1 team = 1 cluster) were randomized. Randomization was done independently by drawing lots. The statistician who conducted the randomization did not take part in the study.

All teams of the same club participating in Male Under 12 Basketball League, Male Under 13 Basketball League, Male Under 15 Basketball League, Male Under 17 Basketball League, Male Under 19 Basketball League, and Basketball Third League were enrolled to participate in the study during one 9-month season (August 2009 to April 2010). To be included in the study, teams had to carry out at least 1 training session a week in addition to match play. In both groups, teams practiced a training program 3 to 4 times a week during the season.

All teams were recruited in June and July 2009. The purpose and the design of the study were explained to teams' coaches by telephone. After consent was obtained, a letter including a detailed description of the study and an enrollment return form were sent out to the coaches, who also informed the players. Player participation was voluntary, and the athletes enrolled in the study were elite, highly competitive male basketball players.

We informed teams allocated to the intervention group that they would receive a program of warm-up exercises used to prevent injuries and enhance performance. We asked the teams in the control group to warm up as usual during the season and informed them that, if the intervention program prevented injuries, they would receive the same program as the intervention group in the subsequent season.

Intervention

The program of warm-up exercises was obtained from the FIFA website (www.fifa.com/aboutfifa/developing/medical/the11/index.html). The warm-up program was developed in previous investigations by an expert group convened by FIFA, with representatives from the Oslo Sports Trauma Research Center, the Santa Monica Orthopaedic and Sports Medicine Research Foundation, and the FIFA Medical Assessment and Research Centre.[46]

The program consisted of 3 different parts (Table 1). The first part was running exercises at slow speed combined with active stretching and controlled contacts with a partner. The running course included 6 to 10 pairs of cones (depending on the number of players). The second part consisted of a different set of exercises, including strength, balance, jumping exercises, and Nordic hamstring exercises. The final part was speed running combined with basketball-specific movements with sudden changes in direction.[46]

At the start of the preseason, August to September 2009, we invited the coaches and team captains from all teams of the intervention group to a 1-day instructional course in which the warm-up program was explained. The coaches were familiarized with the program during the seminar by receiving theoretical and practical training in the program and instruction to teach the exercises to team members. In addition, all the coaches and each player received a poster explaining every exercise downloaded from the FIFA website. The complete exercise program was used as the warm-up routine for each training session during the season, and the running exercises in the program were used as part of the warm-up routine for every match.

When introducing the program to the teams, our main focus was to improve awareness and neuromuscular control during standing, running, planting, cutting, jumping, and landing.[46] We encouraged the players to concentrate on the correct execution of their movements and put emphasis on core stability, hip control, and proper knee alignment to avoid excessive knee valgus during both static and dynamic movements. We asked the coaches and the players to watch each other closely and give feedback during training. Once players were familiar with the exercises, the program took about 20 minutes to complete.

TABLE 1
Warm-up Exercise Program Administered to Basketball Players

Exercise	Repetitions
I. Running exercises, 8 minutes (along the major diameter of the basketball court, about 28 meters)	
Running, straight ahead	10
Running, hip out	2
Running, hip in	2
Running, circling	2
Running and jumping	2
Running, quick run	2
II. Strength, plyometrics, balance, 15 minutes	
Bending with both legs	10 × 3
Nordic hamstring lower	10 × 3
Single-leg balance	
Level 1: holding ball	2 (each leg)
Level 2: throwing ball with partner	3 (each leg)
Level 3: testing partner	3 (each leg)
Squats	
Level 1: with heels raised	2 × 30 seconds
Level 2: walking lunges	2 × 30 seconds
Level 3: 1-leg squats	2 × 10 (each leg)
Jumping	
Level 1: vertical jumps	3 × 15 seconds
Level 2: lateral jumps	3 times along the major diameter of the basketball court
Level 3: box jumps	3 times along the major diameter of the basketball court
III. Running exercises, 1 minute and 40 seconds (along the major diameter of the basketball field, about 28 meters)	
Running over pitch	3
Bounding run	3
Running and cutting	3

During the season, coaches were contacted by the researchers at least twice a month by e-mail and telephone to increase their compliance to the program. In this way, coaches could have questions answered about the warm-up program and/or injury and exposure data collection.

Outcome Measures

The primary outcome was any injury to the athletes. We also collected the type of exposure (match or training), location in the body, and type of injury (acute or overuse). The secondary outcomes were any injury to the lower extremity (foot, ankle, lower leg, knee, thigh, groin, and hip). We included in the analysis all injuries recorded after the intervention teams had completed the first prevention training session to compare the risk of injury between the intervention and the control groups. We conducted the study during the normal 9-month season of competitive basketball in Italy.

Exposure and Injury Collection

The coaches compiled daily injury reports, containing information about location and type of injuries and details of players' participation in each training session and match[14] (Appendix 1, available in the online version of this article at http://ajs.sagepub.com/supplemental/). In addition, the intervention team coaches specified whether the warm-up exercise program was carried out in the training session. Reports were submitted weekly by e-mail or fax to the research center. At the research center, injuries were recorded by 1 experienced specialist in orthopaedic sports medicine and 2 orthopaedic trainees who were blinded to group allocation. They performed injury registration by applying injury classification supported by international consensus (Appendix 2, available online).[15] The players affected by minimal or mild injuries were examined by the team physician and local physical therapist. When moderate or severe injuries occurred, players were examined by the team physician, but if there was any doubt about the diagnosis, the player was referred to our sport medicine center for further management, including imaging studies and/or injection and/or surgery.

Statistical Methods

We conducted all statistical analyses with SPSS for Windows (version 13.0; SPSS, Inc, an IBM Company, Chicago, Illinois). All data were analyzed on an intention-to-treat basis. Pearson's χ^2 test "exact" based on Monte Carlo simulation was used to assess the efficacy of intervention on the primary and secondary outcomes.[45] Odds ratios and 95% confidence intervals were also calculated. Cox regression was used to perform the survival and hazard function curves for all the variables, which were found to be

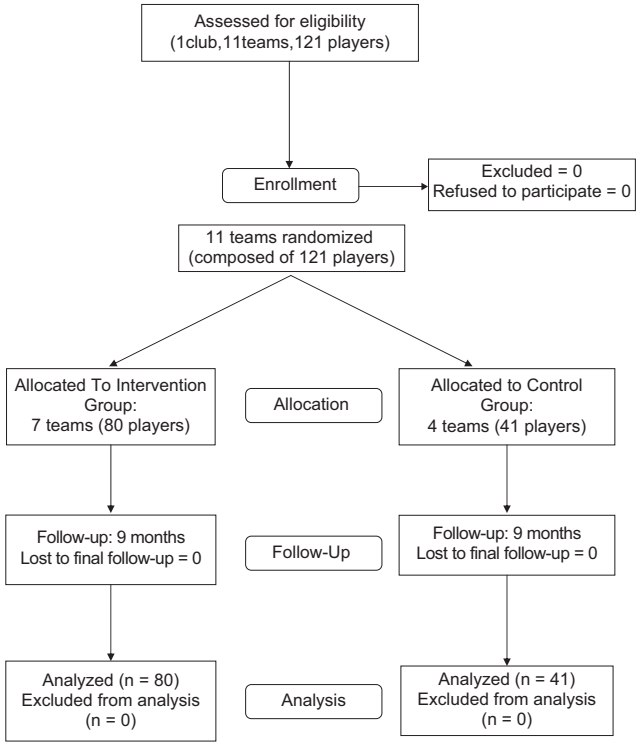

Figure 1. Flow of team clusters and players throughout the study.

statistically significant. The estimated injury rate was calculated as follows: [(number of events during a specified period)/(total athlete-exposures at risk during a specified period)] × 1000.[23] The exposure time was calculated as (1) participation hours and (2) athlete-exposure. The participation hours were calculated for each group as the sum of the number of exposure hours of each player (match exposure time, training exposure time, total exposure time = match + training hours). The athlete-exposure was calculated for each group as the number of athletes participating in each game or training session (1 athlete participating in 1 game or 1 training session). Mean values of participation hours and athlete-exposure were compared between the 2 groups using the *t* test. A *P* value <.05 was considered significant.

Sample Size

We planned choosing the number of participants to enroll in the study according to the number of basketball players playing in the team club in which the study was conducted. The FIFA 11+ had already been shown to be effective in reducing the injury rate in elite soccer players.[46] Therefore, as a similar effect was expected also in basketball, the team club allowed us to allocate double the number of athletes to the intervention group. Therefore, we allocated 7 teams (80 players) to the intervention group and 4 teams (41 players) to the control group (Figure 1).[9,22]

RESULTS

Demographics of participants of the control and intervention groups are reported in Table 2. The dropout rate was 0 in both groups.

Exposure and Injury Characteristics

Athletes in the intervention group played 23,640 hours of basketball (2040 hours during matches and 21,600 hours during training). Athletes in the control group played 12,648 hours of basketball (984 hours during matches and 11,664 hours of practice) (Table 3).

During the 9-month season, 23 (19%) of the 121 players included in the study sustained a total of 31 injuries (14 in the intervention group and 17 in the control group). We identified 24 acute injuries, which occurred more commonly in the intervention group (n = 9; 0.61/1000 athlete-exposures) than in the control group (n = 15; 1.91/1000 athlete-exposures) ($P < .0001$). We also reported 7 overuse injuries with similar rates between the intervention and control groups (0.34 vs 0.25; $P = 1.00$).

Efficacy of Injury Prevention Program

Significantly lower injury rates were found for overall injuries (0.95 vs 2.16; $P = .0004$), training injuries (0.14 vs 0.76; $P = .007$), lower extremity injuries (0.68 vs 1.4; $P = .022$), acute injuries (0.61 vs 1.91; $P < .0001$), and severe injuries (0 vs 0.51; $P = .004$) in the intervention group. The intervention group also had statistically significant lower injury rates for trunk (0.07 vs 0.51; $P = .013$), leg (0 vs 0.38; $P = .007$), and hip and groin (0 vs 0.25; $P = .023$) compared with the control group. There was no statistically significant difference in match injuries, knee injuries, ankle injuries, and overuse injuries between the 2 groups (Appendix 3, available online, and Table 4). Survival and hazard curves in the 2 groups were calculated for overall injuries (Figure 2), lower extremity injuries (Figure 3), and acute injuries (Figure 4).

An assessment of the type of acute and overuse injuries for both groups was performed (Table 5). The most frequent acute injury diagnoses were ligament sprains (0.41 and 0.38 in the intervention and control groups, respectively; $P < .006$) and contractures (0.76 and 0.07 in the control and intervention groups, respectively; $P < .003$). Muscle contracture (or twitching) consists of involuntary, persistent, and painful contraction of 1 or more skeletal muscles. The hypertonicity of the muscular tissue is not associated with any rupture of muscle fibers.[19]

The most frequent overuse injury diagnosis was tendinopathy (0.20 and 0.13 in the intervention and control groups, respectively; $P = .65$). The distribution of injury severity in both groups of basketball players was also evaluated (Table 6). In each group, moderate injuries represented the most frequent type of injury (0.88 and 1.4 in the intervention and control groups, respectively; $P = .085$). However, severe injuries were recorded only in the control group.

TABLE 2
Demographitcs of Participants of the Control and Intervention Groups[a]

	Intervention Group (n = 80)	Control Group (n = 41)	*P* Value
Age, y	13.5 ± 2.3 (11-21)	15.2 ± 4.6 (13-24)	.006[b]
Height, cm	170.5 ± 12.4 (148-203)	182.8 ± 10 (153-206)	.0002[b]
Body weight, kg	63 ± 16.2 (32-103)	72.2 ± 10.9 (41-105)	.008[b]

[a]Data presented as mean ± standard deviation (range). *P* values were calculated with *t* test based on mean values.
[b]Statistically significant difference between groups.

TABLE 3
Details of Time-Exposure[a]

Time-Exposure	Intervention Group (n = 80)	Control Group (n = 41)	*P* Value
Match exposure, h	2040 (25.5 ± 5.8)	984 (24 ± 3.2)	.10
Training exposure, h	21,600 (270 ± 31.4)	11,664 (284.5 ± 53.3)	.06
Total exposure, h	23,640 (295.5 ± 32.1)	12,648 (308.5 ± 53.3)	.10
Match athlete-exposure, h	3060 (38.2 ± 8.8)	1548 (37.8 ± 11.2)	.79
Training athlete-exposure, h	11,700 (146.2 ± 16.9)	6318 (154.1 ± 28.9)	.06
Total athlete-exposure, h	14,760 (184.5 ± 19.3)	7866 (191.8 ± 31.08)	.11

[a]Data presented as No. (mean ± standard deviation). *P* values for participation hours and athlete-exposure were calculated with the *t* test based on mean values.

TABLE 4
Number of Injuries in Intervention and Control Groups During 1 Season[a]

	Intervention Group (n = 80)			Control Group (n = 41)					
Injuries	Number of Injuries	% in Relation to the Number of Players	Injury Rate (per 1000 AE)	Number of Injuries	% in Relation to the Number of Players	Injury Rate (per 1000 AE)	Odds Ratio	95% CI	*P* Value
All injuries	14	17.5	0.95	17	41.4	2.16	0.316	0.165-0.603	.0004[b]
Match injuries	12	15	0.81	11	26.8	1.4	0.477	0.236-0.965	.056
Training injuries	2	2.5	0.14	6	14.6	0.76	0.175	0.049-0.626	.007[b]
Lower extremity injuries	10	12.5	0.68	11	26.8	1.4	0.404	0.194-0.839	.022[b]
Hip/groin	0	0	0	2	4.8	0.25	—	—	.023[b]
Thigh	1	1.2	0.07	0	0	0	—	—	.316
Knee injuries	5	6.2	0.34	2	4.8	0.25	1.213	0.358-4.110	1.000
Leg	0	0	0	3	7.3	0.38	—	—	.007[b]
Ankle injuries	3	3.7	0.20	2	4.8	0.25	0.792	0.206-3.039	1.000
Trunk	1	1.2	0.07	4	9.7	0.51	0.091	0.011-0.724	.013[b]
Acute injuries	9	11.2	0.61	15	36.5	1.91	0.210	0.100-0.444	<.0001[b]
Overuse injuries	5	6.2	0.34	2	4.8	0.25	1.213	0.358-4.110	1.000
Severe injuries	0	0	0	4	9.7	0.51	—	—	.004[b]

[a]AE, athlete-exposures; CI, confidence interval. *P* values were calculated with Pearson's χ^2 test based on injury rates.
[b]Statistically significant difference between groups.

Compliance With the Exercise Program

Both in the intervention and control groups, teams performed a training session 6 times a week during the first month. In the intervention group, teams performed a complete execution of the warm-up exercise program during each session. During the following months of the season, they performed 3 to 4 training sessions a week, practicing the warm-up exercise program at least twice a week. There was 100% compliance with the warm-up exercise program. In the control group, the routine warm-up exercise program was practiced 3 to 4 times a week during all months of the season.

Sample Size

We performed a post hoc power analysis on our results. In our study, we found a 68% reduction in the number of injured players. With these results, our study has a power of 0.90 with an unequal randomization of a 2:1 ratio (80:41) to detect a significant difference at a 5% significance level.

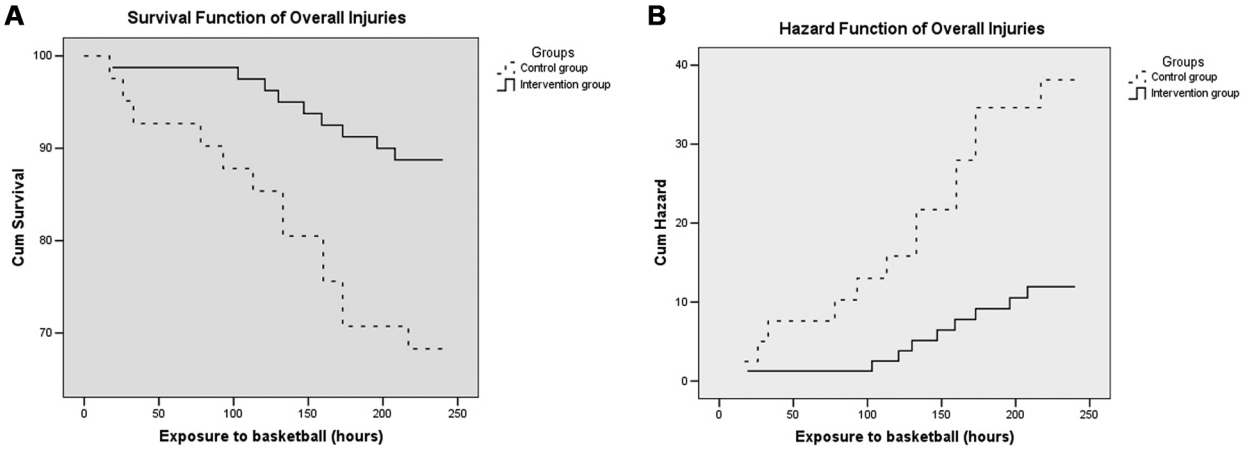

Figure 2. (A) Survival function and (B) hazard function of overall injuries.

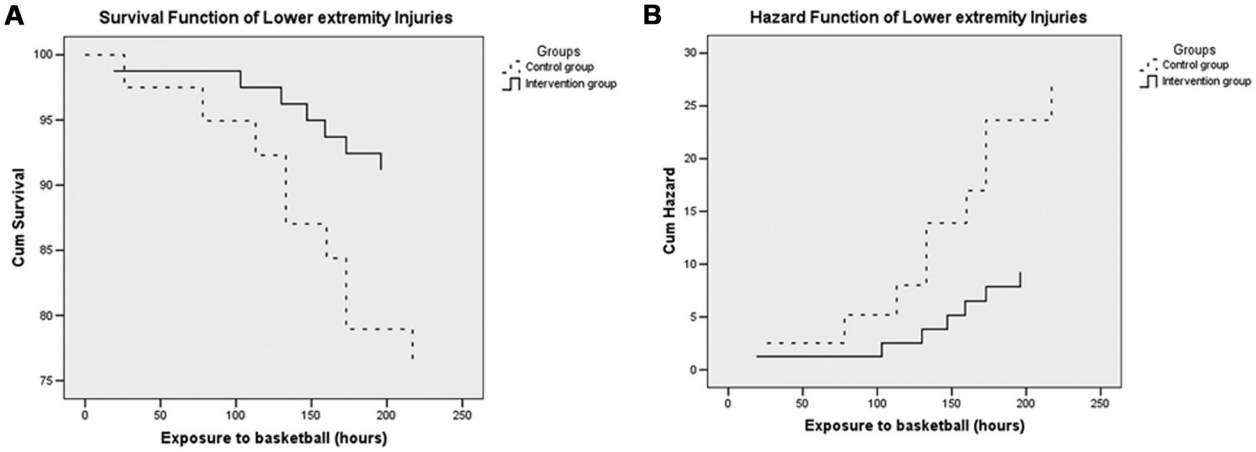

Figure 3. (A) Survival function and (B) hazard function of lower extremity injuries.

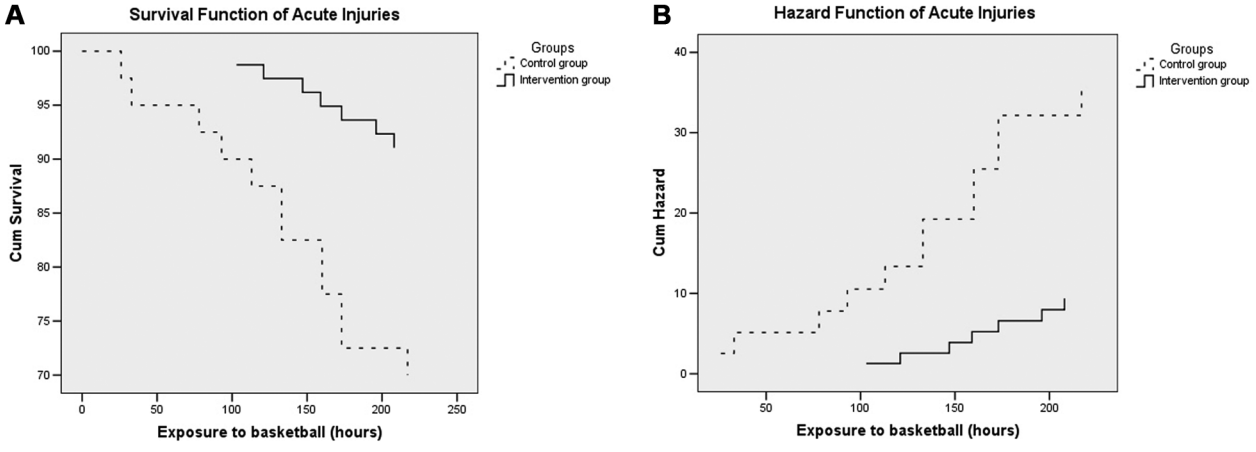

Figure 4. (A) Survival function and (B) hazard function of acute injuries.

TABLE 5
Most Common Type of Acute and Overuse Injuries in Basketball Players During 1 Season

	Intervention Group (n = 80)			Control Group (n = 41)					
	Number of Injuries of a Body Part	% in Relation to the Overall Number of Injuries	Injury Rate (per 1000 AE)	Number of Injuries of a Body Part	% in Relation to the Overall Number of Injuries	Injury Rate (per 1000 AE)	Odds Ratio	95% CI	*P* Value
Acute injuries									
Sprains	6	66.7	0.41	3	20.0	0.38	8.121	4.268-15.453	<.006[b]
Contractures	1	11.1	0.07	6	40.0	0.76	0.185	0.088-0.390	<.003[b]
Strains	1	11.1	0.07	1	6.6	0.13	1.642	0.609-4.425	.565
Contusions	1	11.1	0.07	1	6.6	0.13	1.642	0.609-4.425	.565
Fractures	0	0	0	2	13.4	0.25	—	—	.023[b]
Other	0	0	0	2	13.4	0.25	—	—	.023[b]
All injuries	9	100.0	0.61	15	100.0	1.91	0.210	0.100-0.444	<.0001[b]
Overuse injuries									
Tendinopathy	3	60.0	0.20	1	50.0	0.13	1.5	0.857-2.626	.65
Low back pain	1	20.0	0.07	1	50.0	0.13	0.350	0.133-0.468	.56
Other	1	20.0	0.07	0	0	0	—	—	<.316
All injuries	5	100.0	0.34	2	100.0	0.25	1.213	0.358-4.110	1.000

[a]AE, athlete-exposures; CI, confidence interval. *P* values were calculated with Pearson's χ^2 test based on injury rates.
[b]Statistically significant difference between groups.

TABLE 6
Severity of Injuries in Basketball Players During 1 Season[a]

	Intervention Group (n = 80)			Control Group (n = 41)					
Injuries	Number of Injuries	% in Relation to the Number of Players	Injury Rate (per 1000 AE)	Number of Injuries	% in Relation to the Number of Players	Injury Rate (per 1000 AE)	Odds Ratio	95% CI	*P* Value
Minimal injuries	0	0	0	0	0	0	—	—	—
Mild injuries	1	1.3	0.07	2	4.8	0.25	0.192	0.022-1.673	.214
Moderate injuries	13	16.3	0.88	11	26.8	1.4	0.515	0.257-1.030	.085
Severe injuries	0	0	0	4	9.7	0.51	—	—	.004[b]

[a]AE, athlete-exposures; CI, confidence interval. *P* values were calculated with Pearson's χ^2 test based on injury rates.
[b]Statistically significant difference between groups.

DISCUSSION

We evaluated the efficacy of the FIFA 11+ program on rates of injuries in elite male basketball players. The effect of the FIFA 11+ program has been studied previously in young female soccer players in a randomized controlled trial, providing good results.[46] To our knowledge, this is the first randomized controlled trial to evaluate the effectiveness of this specific program to prevent injuries in basketball. We found that the FIFA 11+ warm-up program is effective in reducing the injury rate in elite male basketball players. In the intervention group, we found injury rates (per 1000 athlete-exposures) statistically significantly lower when compared with those in the control group for overall injuries (0.95 vs 2.16) and lower extremity injuries (0.68 vs 1.4). The intervention group had also a statistically significantly lower risk of trunk, leg, and hip and groin injuries as compared with the control group.

The comparison of ankle and knee injury rates of the 2 groups did not show a statistically significant difference. However, because females are at higher baseline risk of knee injury (such as anterior cruciate ligament rupture), the baseline injury rates in this study using male athletes may be too low to determine statistically significant differences between the 2 groups when considering relatively rare injuries. Moreover, we found a statistically significant difference in the incidence of more serious injuries in the control group, such as meniscal tears and distal peroneal fractures, with loss of sport participation greater than 28 days. Thus, 11+ seems to reduce the risk of developing severe injuries of the knee and ankle.

Our findings support previous studies identifying ligament sprains and contractures as the most frequent acute injury diagnoses.[1,3,4,8,11,12] Ligament sprains were the most frequent acute injuries in the intervention group (67%), whereas contractures followed by ligament sprains were the most frequent in the control group (40% and 20%, respectively). Regarding injury severity, in our sample, moderate injuries represented the most frequent type of injury. However, severe injuries were recorded only in

the control group (4 vs 0 events), with a statistically significant difference between the 2 groups. We also performed survival and hazard curves for overall injuries (Figure 2), lower extremity injuries (Figure 3), and acute injuries (Figure 4) in the 2 groups. Survival curves showed a decrease in event-free survival with increasing exposure to basketball. The control group curves decreased more than did the intervention group curves because more injuries were reported in the first group. On the other hand, hazard curves showed increased risk of developing an injury with increasing exposure to basketball. The control group curves increased more than did the intervention group curves, showing a higher risk in the first group. Our data confirm the effectiveness of the FIFA 11+ program to prevent injuries, as reported in previous studies.[46] The 11+ program was designed to prevent not only knee injury but also lower extremity injuries, overall injuries, severe injuries, and overuse injuries, such as lower extremity tendon pain and low back pain. In our study, we found that the 11+ program appears to reduce the risk of trunk, leg, and hip/groin injuries; lower extremity injuries; overall injuries; and severe injuries in elite male basketball players. Moreover, our percentage of the reduction in the number of injured players (68%, overall injury rates from 1.78-0.61) was greater than the reduction obtained by Soligard et al[46] (approximately 40%).

The 11+ program did not seem to lower the ankle and knee injury rates in our population of athletes. It may be possible that, as the program was conceived for implementation in soccer, it may not be as effective in basketball, where jumping, twisting, and hopping occur much more frequently than in soccer and in more restricted spaces. It is possible that dedicated programs would have resulted in a more evident effect. Nevertheless, we point out that, although the rate of injury in the knee and ankle was not reduced, the severity of such injuries was reduced, as shown in Table 6. In this respect, therefore, the 11+ program was successful.

Strengths of the study are its cluster randomized nature and the fact that the statistician who conducted the randomization did not take part in the study. The trial took place in all categories of a professional basketball club of the third division of the Italian Basketball League and enrolled 11 teams, comprising 121 athletes. Although inclusion of players from only 1 club can be considered a limitation, this allowed us to obtain 100% compliance and 0% dropout. None of the players or the coaches declined to participate, and all the athletes were randomized. Moreover, no statistically significant difference in average participation hours and average athlete-exposure between the 2 groups was found. To boost compliance, we also used information material for coaches and players downloaded from the FIFA website and encouraged them to personally look at the FIFA website. Furthermore, the fact that all teams belonged to the same club allowed us to facilitate follow-up visits throughout the season to make sure that the 11+ program was correctly implemented.[49] In a previous study on soccer,[46] after inclusion, the authors had to exclude 13 intervention clubs and 19 control clubs because they did not deliver any data on injury or exposure.

As the FIFA 11+ has already been shown to be effective in reducing the injury rate in elite soccer players,[46] with a similar effect expected in basketball, the potential disappointment of the athletes enrolled in the present study of being randomized to the control group and hence not receiving the warm-up program explains the decision to randomize two-thirds of the athletes to the FIFA 11+ program and one-third to the control group. Unequal randomization, up to a 3:2 ratio, is a realistic alternative, given the need to gain further experience with newer procedures and treatments.[9,22] A 2:1 or 3:2 ratio can be used without significant loss of statistical power.[2,9] Also, as a potential beneficial effect was expected, the team club allowed us a 2:1 ratio randomization.

One of the limitations of our study is that the control groups did not perform a standardized program of warm-up. Each team performed its usual warm-up program in a nonstandardized fashion. Even if this can be regarded as a potential bias, it reflects the common practice in the teams studied. We are fully aware that a stricter program of warm-up for the control group would have added more strength to this work. On the other hand, control teams could have included some of the beneficial training drills and exercises in their practices. Because of this potential contamination, the potential benefit of the 11+ program could actually be underestimated.

Another limitation of this study is that teams were not blinded to the exercise program. Obviously, this introduces a potential bias, but in an elite setting, it is difficult to perform a study without informing coaches and players, and obviously it is almost impossible to blind athletes who train in the same basketball court. Also, it is difficult to ask players of the same team to avoid speaking about a randomized controlled study to their teammates.

Another limitation of this study is that only coaches and captains of intervention teams were instructed in person during an instructional course. All other players were instructed by coaches. Thus, we did not actually observe the individual players performing the intervention program. Although this could introduce bias in the study, it was inevitable in this setting and reflects the pragmatic nature of the present study and of similar studies performed in the setting of elite/professional sport.

Because we undertook cluster randomization, the fact that the control group seems to be older, taller, and heavier is due to chance. We can only speculate that age, height, and weight may have an influence on the results,[32,33] but as a randomization was performed, no definitive conclusions can be drawn on this aspect. This could be the subject of future endeavors.

Another potential limitation of this study involves the survivor effect (that younger athletes who get injured do not continue to play in future seasons). We did not have any dropouts during the 9 months that we followed these athletes; however, we are not able to evaluate any survivor effect because we included only 1 season.

The FIFA 11+ program was recently developed[46] on the basis of "The 11" program to prevent injury and enhance performance,[40] with running activities at the start and the end.[44] The running exercises were included to make

the program more suitable as a warm-up and to teach proper knee control and core stability during cutting and landing. Moreover, the revised exercises included both variety and progression of difficulty.[46]

Several studies focused on core stability, balance, neuromuscular control, hip control, and knee alignment to avoid excessive knee valgus during both static and dynamic movements.[10,16,17,40,42] The FIFA 11+ program aims to improve technique and control during standing, cutting, jumping, running, planting, and landing.[46] On the basis of data from volleyball,[6,18] team handball,[42,44] and soccer,[46] we encouraged players to reduce the impact of landings with increased hip and knee flexion and to land on 2 legs rather than 1 leg.

We used young male basketball players as a model, and we do not know whether the results can be generalized to both sexes, other age groups, or other youth sports. Similar preventive programs, however, were effective in youth team handball players,[44] young female soccer players,[46] young male soccer players,[21] and senior elite soccer players.[5,10] Thus, the available published data and the successful results of the present study encourage us to replicate implementation in large-scale nationwide programs, as already done for Swiss amateur soccer players.[20]

One of the aims of sports injury prevention programs is to develop less vulnerable movement patterns. Therefore, it might be easier to teach these patterns to younger players who have not yet established their basic motion patterns.[13,17] As suggested for soccer,[46] programs to improve strength, awareness, and neuromuscular control of static and dynamic movements should be implemented as soon as children start playing organized basketball.

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