

# Accuracy and Reliability of Examiners' Observations of Pre-Practice Warm-Up and FIFA 11+ Injury Prevention Program Exercises

James R. Slauterbeck, MD; Pamela M. Vacek, PhD; Rebecca Choquette, ATC; Tessa Kettelkamp, ATC; Autumn Reilly, MD; Brandon Lentine, MD; Bruce D. Beynnon, PhD

Department of Orthopaedics & Rehabilitation, University of Vermont Larner College of Medicine, Burlington, Vermont

**Corresponding Author** James R. Slauterbeck, MD. Department of Orthopaedics & Rehabilitation, The University of Vermont Larner College of Medicine, 95 Carrigan Drive Stafford Hall, Burlington, VT 05405 (email: james.slauterbeck@med.uvm.edu).

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## ABSTRACT

**Background:** The Fédération Internationale de Football Association (FIFA) 11+ is an injury prevention program that decreases the incidence of lower extremity injuries. The purpose of the current study was to understand what specific exercises prevented injury from occurring. We thus developed and tested a form to identify these exercises. We hypothesize that trained examiners could accurately and reliably use this form to identify and record individual exercises performed during pre-participation warm-up.

**Methods:** A repeated-measures study design was used in this investigation. After observing five pre-practice warm-up videos obtained from multiple high schools, 11 examiners observed and recorded performed exercises at two different times. The videos included four soccer teams and one American football team. Accuracy, interexaminer reliability, and intraexaminer reliability were assessed. Sensitivity, specificity, accuracy, and percent agreement with a FIFA 11+ expert were measured for each exercise component.

**Results:** The intraclass correlation coefficients between examiners and individually ranged from 0.22 to 1.00 and 0.58 to 1.00, respectively. Reliability was lowest for exercises with similar movements. The percent agreement across all examiners for individual exercises ranged from 20% to 100%. Additionally, the percent agreement between each examiner and the "gold standard" examiner was high (range, 69.6% to 90.4%). For exercises with similar movements, accuracy and reliability were considerably improved (97%) when combined into one category.

**Conclusion:** We determined that trained examiners with different backgrounds and experience can make accurate and reliable observations of most exercises observed in warm-up programs. Using the proposed form, researchers can accurately record exercises and perform quality and fidelity assessments of warm-up exercise routines.

**Keywords:** Anterior Cruciate Ligament, Anterior Cruciate Ligament Injuries, Validation Studies, Randomized Controlled Trial

## INTRODUCTION

Lower extremity injuries are common in high school athletes,<sup>1</sup> with an estimated 800,000 injuries occurring per year. Treatment is expensive, and there is a possibility of long-term health effects.<sup>2</sup> For example, providing medical care for high school varsity sports in North Carolina was estimated to be nearly \$10 million in medical costs, \$45 million in capital costs, and \$145 million in comprehensive costs.<sup>2</sup> Additionally, the long-term health effects of serious lower extremity sport injuries are concerning because of the high risk of developing posttraumatic early-onset osteoarthritis after a severe knee injury.<sup>3,4</sup>

Results of a recent meta-analysis confirmed that anterior cruciate ligament (ACL) injury prevention programs can decrease lower extremity injuries by 37% and ACL injuries by 51%.<sup>5-16</sup> One of the more popular programs is the the Fédération Internationale de Football Association (FIFA) 11+ injury prevention program, which is used as a replacement for a pre-practice warm-up and consists of strengthening, conditioning, and dynamic stretching exercises.<sup>5,9,14,17</sup> Specifically, the FIFA 11+ program has been shown to decrease lower extremity injuries by up to 72% in soccer athletes aged 13 to 25 years.<sup>6,9,14,15,18,19</sup> We are unaware of any warm-up exercises that lead to both decreased injury and increased performance.

Before we understand how specific exercises reduce the occurrence of injury, we must be able to accurately and reproducibly identify specific exercises performed by teams in the field. Currently, no measurement tool can be used to accurately characterize the exercises performed by athletes during injury prevention routines. Therefore, the goal of this investigation was to develop and evaluate an exercise form that can be used by 1) individuals with various backgrounds and experiences and 2) high school sports teams that participate in different pre-participation warm-up programs. This data collection tool will be used in a prospective study to determine the quality and fidelity of exercises performed in a warm-up program. We hypothesized that trained examiners could accurately and reliably use the exercise form to identify and record individual exercises performed during a pre-participation warm-up.

## METHODS

### *Experimental Approach*

The project received approval from our University Committee on Human Research (CHRMS #15-580), and the athletes and their parents provided informed consent before participation. In this investigation, we used a repeated-measures study design. Eleven examiners observed five videos of pre-practice warm-ups. These videos were obtained from high schools and showed recorded exercises at two different times. Accuracy, interexaminer reliability, and intraexaminer reliability were assessed.

### *Procedures*

A former Division I National Collegiate Athletic Association (NCAA), head-university, athletic trainer (RC) observed 130 pre-participation high school workout sessions. Additionally, the trainer recorded the exercises performed. A group of sports medicine surgeons, epidemiologists, and athletic trainers reviewed the exercise descriptions. They then created an exercise form to characterize 30 individual exercises during a typical pre-practice warm-up (Appendix 1). Additionally, all the exercises in the FIFA 11+ warm-up were added to the form. The exercises were divided into categories that described the type of activity completed such as running, dynamic mobility training, dynamic stretching, static stretching, strengthening, plyometric training, agility and balance training, and sports-specific exercising components. These exercise categories were subdivided into additional descriptive component exercises.

Eleven different examiners observed five videos of pre-practice warm-ups. The videos included complete uninterrupted footage of live practice sessions that were obtained from local high schools. The pre-participation warm-up programs included teams that used a FIFA 11+ warm-up or their standard warm-up routine, which included four soccer teams (ie, two junior varsity boys, one varsity boys, and one varsity girls) and one football team (ie, junior varsity and varsity combined). On a data sheet, the examiners recorded the specific exercises performed at two time points (14 to 21 days apart).

A total of 11 examiners participated in this study: one certified athletic trainer, four athletic training students, three medical students, and three post-baccalaureate pre-medical students. Each examiner was trained by an expert (RC) to recognize and record the warm-up routine. The expert evaluator was a former Division I NCAA, head university, athletic trainer with more than 25 years of experience with implementing the FIFA 11+ and other warm-up programs. The training for the examiners included about 6 h of direct observation and training at local high school sites. Training continued until the examiners mastered documenting the observed exercises with the exercise form.

The examiners then characterized the high school team's pre-practice warm-up for the entire fall 2016 season. They received ongoing feedback from the expert athletic trainer before participating in the accuracy and reliability study. The sessions were shown through video presentation. This was because we thought that having 11 examiners and an expert examiner all standing on the sidelines of a practice session would bias the quality and effort of the performance of the exercises. The players and teams were all used to having video analysis of their practices; therefore, the intrusion at practice and potential bias were negligible.

The examiners were asked to attend two 1-hour testing sessions. During each session, the examiner observed six videos of pre-participation team exercises

that were obtained from six high school teams, each lasting about 10 min. The examiners were not told that they were going to evaluate the same videos at the second session. At each session, they were provided with the same instructions and were required to immediately complete an exercise form for each video they observed (Appendix 1).

### **Statistical Analysis**

Examiner reliability of the observations were evaluated using a repeated-measures study design and computing intraclass correlations coefficients (ICC). ICC were calculated between the 11 examiners and individually. Accuracy was assessed by comparing the observations of 10 examiners to that of one expert athletic trainer, which was considered the “gold standard.” Sensitivity, specificity, and percent agreement were computed across examiners for each exercise component.

## **RESULTS**

### **Reliability Results**

Of the 27 FIFA 11+ and 64 non-FIFA exercise components included in the form, there were 37 observed in the warm-up videos at least once. These exercises and ICC (individually and between examiners) are shown in Table 1. Of 110 observations, there were 46 (41.8%) that included at least one component of the FIFA 11+ program; however, only six FIFA 11+ running components were observed. Individual examiners were consistent about whether a warm-up included a FIFA 11+ exercise or not (ICC = 0.87). However, there was less agreement between examiners (ICC = 0.69).

The reliability associated with identification of the six FIFA 11+ running components was varied (Table 1). Agreement was high of individual examiners (ICC = 1.00) and between examiners (ICC = 0.80-0.87) for “circling partner,” “shoulder contact,” and “quick forward and backward running” exercises. Agreement of individual examiners was also high for “straight ahead running” (ICC = 0.85); however, agreement between examiners was low (ICC = 0.31). For “hip in” and “hip out” exercises, agreement of individual examiners and between examiners were low (ICC = 0.47 and 0.28, respectively).

The reliability regarding observations of non-FIFA 11+ running exercises also varied considerably. The lowest agreements were observed for the “straight ahead” exercise and the “increase pace” exercise (ICC of individual examiners = 0.64 and 0.67, ICC between examiners = 0.22 and 0.33, respectively). There was moderate agreement of individual examiners for non-FIFA dynamic mobility components; however, for most of these exercises there was low agreement between examiners (ICC < 0.50). Only the exercise “leg swings: back with forward touch” had a higher reliability between examiners (ICC = 0.72). A number of exercises with non-FIFA dynamic stretching were recorded with high reliability in individual examiners and between examiners. However, there was a low reliability between examiners for “heel on ground forward lean-hold” (ICC = 0.25), “heel on ground forward lean-scoop

ground” (ICC = 0.44), “front lunge with UB rotation” (ICC = 0.57), and “side lunge - hold” (ICC = 0.50).

To determine if the low reliability between examiners for both the FIFA 11+ and non-FIFA “straight ahead” running components was attributable to disagreement about whether the exercise should be classified as a component of FIFA 11+, the responses were combined. This did not improve agreement between examiners (ICC = 0.24), which indicated that identification of the exercise, not its classification as a FIFA 11+ component, was responsible for the low reliability. In contrast, combining the FIFA 11+ “hip out” running component with the non-FIFA “hip out” dynamic mobility component substantially improved reliability of individual examiners (ICC = 1.00) and between examiners (ICC = 0.69). Similar reliability results were obtained for individual examiners and between examiners when the corresponding “hip in” exercises were combined (ICC = 0.92 and 0.70, respectively).

Additionally, improvements in reliability were obtained when similar non-FIFA warm-up exercises were combined. For example, when combining “leg swings” with “back or diagonal” and “back with forward touch,” there was improved reliability of individual examiners (ICC = 0.94) and between examiners (ICC = 0.94). Similarly, when the dynamic mobility exercise “side lunge - side to side” was combined with the dynamic stretch exercise “side lunge - hold,” the ICC of individual examiners and between examiners was 0.97 and 0.86, respectively.

### **Accuracy Results**

Table 2 compares the examiners’ and expert examiner’s accuracy of observations regarding exercises included in the reliability analysis. Sensitivity ranged from 22.5% for non-FIFA dynamic stretching (ie, “heel on the ground forward lean-hold”) to 100% for the non-FIFA dynamic stretching exercises (ie, “knee to chest” and “heel to butt”). For most exercise components, specificity was higher than sensitivity.

However, two exercises had particularly low specificity: the dynamic mobility exercise “leg swings: front/back” (68%) and the dynamic stretching exercise “heel on ground forward lean - scoop ground” (62.5%). Based on the expert examiner, the exercise “leg swings front/back” was not performed in any of the videos but the similar exercise “leg swings: front or front diagonal” was performed in all videos. The exercise “leg swings: front or front diagonal” was observed with only 65% sensitivity; however, the sensitivity improved to 97.0% when the two exercises were combined. This increase in sensitivity indicated that the examiners had difficulty distinguishing between the two exercises. Similarly, the low specificity for the stretching exercise “heel on ground forward lean - scoop ground” appears to be because of its similarity to “heel on ground forward lean - hold,” which had very low sensitivity (22.5%). When these two exercises were combined, sensitivity improved to 96.7% and specificity to 100%.

**Table 1.** Observation of exercise components: frequency and estimated reliability in individual examiners and between examiners

Component	Frequency (n)	%	ICC individual examiners	ICC between examiners
<b>FIFA 11+ Part 1 running components</b>				
Straight ahead	23	20.9	0.85	0.31
Hip out	22	20.0	0.47	0.28
Hip in	22	20.0	0.47	0.28
Circling partner	40	36.4	1.00	0.87
Shoulder contact	40	36.4	1.00	0.87
Quick forwards and backwards	18	16.4	1.00	0.80
<b>Non-FIFA 11+ running components</b>				
Jogging	70	63.6	0.73	0.66
Jogging straight ahead	23	20.9	0.64	0.22
Jogging backwards	20	18.2	0.90	0.81
Side shuffle	21	19.1	0.77	0.77
Karaoke	17	15.5	0.94	0.75
Increased pace	58	52.7	0.67	0.33
Change of direction: front/back	5	4.5	--	--
Change of direction: side/side	3	2.7	--	--
Sports specific/progression of running: sprinting	6	5.5	--	--
<b>Non-FIFA dynamic mobility exercises</b>				
High knee	109	99.1	--	--
Butt kicks	108	98.2	--	--
Leg swings: front/back	32	29.1	0.68	0.30
Leg swings: front/front diagonal	75	68.2	0.65	0.26
Leg swings: back/back diagonal	9	8.2		
Leg swings: back with front touch	33	30.0	0.74	0.72
Hip in	60	54.5	0.67	0.44
Hip out	60	54.5	0.74	0.48
Hip internal rotation	6	5.5	--	--
Hip external rotation	9	8.2	--	--
Power karaoke	4	3.6	--	--
Side lunge: side to side	22	20.0	0.58	0.34
<b>Non-FIFA dynamic stretching</b>				
Knee to chest	44	40.0	1.00	1.00
Heel to butt	24	21.8	0.92	0.92
Heel to butt, front touch	2	1.8	--	--
Heel on ground, forward lean, hold	25	22.7	0.47	0.25
Heel on ground, forward lean, scoop	41	37.3	0.69	0.44
Hip external rotation/glut hold	20	18.2	0.90	0.90
Front lunge, hold	68	61.8	0.80	0.77
Front lunge with upper body rotation	15	13.6	0.57	0.57
Back lunge, hold	1	0.9	--	--
Side lunge, hold	49	44.5	0.71	0.50

FIFA, Fédération Internationale de Football Association; ICC, intraclass correlation coefficients; --, not applicable.

**Table 2.** Accuracy of the 11 examiners' observations compared to those of the "gold standard" examiner

Component	Performed		Not performed		Total (n = 100)
	n	Sensitivity	n	Specificity	% correct
<b>FIFA 11+ Part 1 running components</b>					
Straight ahead	20	60.0	80	88.8	83.0
Hip out	40	37.5	60	93.3	71.0
Hip in	40	37.5	60	93.3	71.0
Circling partner	40	90.0	60	100.0	96.0
Shoulder contact	40	90.0	60	100.0	96.0
Quick forwards and backwards	20	80.0	80	100.0	96.0
<b>Non-FIFA 11+ running components</b>					
Jogging	60	93.3	40	80.0	88.0
Jogging straight ahead	40	32.5	60	90.0	67.0
Jogging backwards	20	85.0	80	98.8	96.0
Side shuffle	20	85.0	80	97.5	95.0
Karaoke	20	75.0	80	100.0	95.0
Increased pace	80	62.5	20	100.0	70.0
<b>Non-FIFA - dynamic mobility exercises</b>					
Leg swings: front and back	0	--	100	68.0	68.0
Leg swings: front/front diagonal	100	65.0	0	--	65.0
Leg swings: back with front touch	20	90.0	80	83.8	85.0
Hip in	60	78.3	40	80.0	79.0
Hip out	60	80.0	40	82.5	81.0
Side lunge: side to side	20	60.0	80	90.0	84.0
<b>Non-FIFA - dynamic stretching</b>					
Knee to chest	40	100.0	60	100.0	100.0
Heel to butt	20	100.0	80	97.5	98.0
Heel on ground, forward lean, hold	40	22.5	60	81.7	58.0
Heel on ground, forward lean, scoop	20	50.0	80	62.5	60.0
Hip external rotation/glut, hold	20	90.0	80	100.0	98.0
Front lunge, hold	60	95.0	40	90.0	93.0
Front lunge with upper body rotation	20	65.0	80	98.8	92.0
Side lunge, hold	40	82.5	60	80.0	81.0

FIFA, Fédération Internationale de Football Association; --, not applicable.

## DISCUSSION

To our knowledge, this is the first study to determine a form's accuracy and reliability at characterizing pre-practice exercises with the intention of preventing injury in high school athletic teams. Most exercises observed were non-FIFA 11+. Of the FIFA 11+ exercises, we only performed and identified part 1 and not parts 2 or 3. Although examiners' observations varied, the accuracy and reliability improved considerably when the exercise categories were combined into common groups. There were several factors that affected reliability and accuracy, and these should therefore be addressed for future studies.

Observations of FIFA 11+ running components were more reliable in individual examiners than between examiners and varied considerably across specific exercises. Reliability was low in individual examiners and between examiners for the exercises "hip in running" and "hip out running." Additionally, reliability was low between examiners for "run straight ahead." Varying

considerably, observations of non-FIFA 11+ exercise components were more reliable in individual examiners than between examiners. The exercises "running straight ahead," "increasing pace," "placing heel on ground forward lean and hold," "placing heel on ground forward lean and scoop ground," and performing "front lunge" and "side lunge" had low reliability between examiners. Most other exercise components had high reliability individually and between examiners.

The lower reliability of examiners' observations of similar exercises can be partly attributed to variation in the athletes' performance of the movements. As the similarity between two exercises increases (eg, hip in vs hip out running), individual athletes might be performing different exercises. This lack of uniformity may have affected the examiners' ability to determine which group exercise to report. When similar exercises with low ICC were grouped together, the observations became more reliable. For example, combining the exercises "hip in and out" with "leg swings back and

diagonal” and “leg swings back and forward with touch” improved ICC individually and between examiners. Another example is combining “side lunge - side to side” with “side lunge - hold.”

Similar to reliability, the accuracy of observations varied across individual exercise components. Exercise observations of non-FIFA dynamic stretching had the greatest variation, with sensitivity ranging from 22% to 100%. Specificity was higher than sensitivity for most of the comparisons, which indicated that examiners were more likely to miss exercises that were performed than to identify ones that were not performed. When similar exercises were combined (eg, “leg swings” and “heel on ground”), the sensitivity and specificity improved from low to above 95%.

The current study has strengths and limitations. The strengths of this investigation were the diversity of the examiners’ educational backgrounds, the inclusion of an expert athletic trainer, and the review of both FIFA and non-FIFA 11+ warm-up exercises performed by high school students who have increased risk of lower extremity injuries. A potential limitation was that instead of teaching the FIFA and non-FIFA warm-up programs to the high school teams, we simply observed the exercises performed. Subsequently, this factor may have made it more difficult for the examiners to identify specific exercises. However, it did have the advantage of simulating the conditions that examiners encounter at typical high school sports programs that are self-trained on FIFA 11+ or perform their own warm-up routine. Furthermore, the form we developed included all exercise components in the FIFA 11+ injury prevention program and was designed to collect information on the focus, cueing, technique, and completeness of each exercise performed. Such detailed information is necessary for evaluating the efficacy of FIFA 11+ and identifying the component exercises most highly associated with injury reduction. Notably, we could not evaluate the accuracy and reliability of the examiners in reporting this information. This is because this study only used the FIFA 11+ running components performed during team warm-ups.

We determined that examiners with different educational backgrounds can make accurate and reproducible observations of warm-ups that include FIFA 11+ running components and other exercises. When observing similar exercises, reliability and accuracy can be improved if exercises are grouped together. To begin to understand how individual exercises decrease risk of injury, it is crucial that examiners can first accurately and reproducibly characterize the individual exercises being completed. Ultimately, this form can be used to study the fidelity and quality of the FIFA 11+ program. Additionally, it can be used to determine which exercises might be related to decreased rates of injury.

## REFERENCES

1. Fernandez WG, Yard EE, Comstock RD. Epidemiology of lower extremity injuries among U.S. high school athletes. *Acad Emerg Med.* 2007;14(7):641-645.
2. Knowles SB, Marshall SW, Miller T, et al. Cost of injuries from a prospective cohort study of North Carolina high school athletes. *Inj Prev.* 2007;13(6):416-421.
3. Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. *Am J Sports Med.* 2007;35(10):1756-1769.
4. Myklebust G, Bahr R. Return to play guidelines after anterior cruciate ligament surgery. *Br J Sports Med.* 2005;39(3):127-131.
5. Donnell-Fink LA, Klara K, Collins JE, et al. Effectiveness of knee injury and anterior cruciate ligament tear prevention programs: a meta-analysis. *PLoS One.* 2015;10(12):e0144063. doi:10.1371/journal.pone.0144063.
6. Grooms DR, Palmer T, Onate JA, Myer GD, Grindstaff T. Soccer-specific warm-up and lower extremity injury rates in collegiate male soccer players. *J Athl Train.* 2013;48(6):782-789. doi:10.4085/1062-6050-48.4.08
7. Heidt RS Jr, Sweeterman LM, Carlonas RL, Traub JA, Tekulve FX. Avoidance of soccer injuries with preseason conditioning. *Am J Sports Med.* 2000;28(5):659-662.
8. Junge A, Rösch D, Peterson L, Graf-Baumann T, Dvorak J. Prevention of soccer injuries: a prospective intervention study in youth amateur players. *Am J Sports Med.* 2002;30(5):652-659.
9. Longo UG, Loppini M, Berton A, Marinozzi A, Maffulli N, Denaro V. The FIFA 11+ program is effective in preventing injuries in elite male basketball players: a cluster randomized controlled trial. *Am J Sports Med.* 2012;40(5):996-1005. doi:10.1177/0363546512438761.
10. Malliou P, Amoutzas K, Theodosiou A, et al. Proprioceptive training for learning downhill skiing. *Percept Mot Skills.* 2004;99(1):149-154.
11. Myklebust G, Engebretsen L, Braekken IH, Skjølberg A, Olsen OE, Bahr R. Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. *Clin J Sport Med.* 2003;13(2):71-78.
12. Olsen OE, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. *BMJ.* 2005;330(7489):449.
13. Pasanen K, Parkkari J, Pasanen M, et al. Neuromuscular training and the risk of leg injuries in female floorball players: cluster randomised controlled study. *BMJ.* 2008;337:a295. doi:10.1136/bmj.a295.
14. Silvers-Granelli H, Mandelbaum B, Adeniji O, et al. Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player. *Am J Sports Med.* 2015;43(11):2628-2637. doi:10.1177/0363546515602009.
15. Soligard T, Myklebust G, Steffen K, et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. *BMJ.* 2008;337:a2469. doi:10.1136/bmj.a2469.

16. Wedderkopp N, Kaltoft M, Lundgaard B, Rosendahl M, Froberg K. Prevention of injuries in young female players in European team handball: a prospective intervention study. *Scand J Med Sci Sports*. 1999;9(1):41-47.
17. Barengo NC, Meneses-Echávez JF, Ramírez-Vélez R, Cohen DD, Tovar G, Bautista JE. The impact of the FIFA 11+ training program on injury prevention in football players: a systematic review. *Int J Environ Res Public Health*. 2014;11(11):1986-2000. doi: 10.3390/ijerph11111986.
18. Hammes D, Aus der Fünften K, Kaiser S, Frisen E, Bizzini M, Meyer T. Injury prevention in male veteran football players: a randomised controlled trial using "FIFA 11+". *J Sports Sci*. 2015;33(9):873-881. doi: 10.1080/02640414.2014.975736.
19. Steffen K, Emery CA, Romiti M, et al. High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial. *Br J Sports Med*. 2013;47(12):794-802. doi: 10.1136/bjsports-2012-091886.

**Appendix 1**  
**Observation of Team Warm-Up Form**  
**University of Vermont FIFA 11+ Injury Prevention Study**

Date of Observation: \_\_\_\_\_ School: \_\_\_\_\_  
 Sport: Soccer / Football Team: Freshman / JV / Varsity Sex: \_\_\_\_\_Boys \_\_\_\_\_Girls  
 Data Collector: \_\_\_\_\_ Total Duration of Warm-Up: \_\_\_\_\_  
 Were components of the FIFA 11+ program used as a warm-up? \_\_\_\_\_Yes \_\_\_\_\_No  
 Was the FIFA 11+ program followed in order from start to finish? \_\_\_\_\_Yes \_\_\_\_\_No  
 Was the field set up for FIFA 11+? \_\_\_\_\_Yes \_\_\_\_\_No  
 Were there modifications in distance, cones, repetitions, exercises etc? \_\_\_\_\_Yes \_\_\_\_\_No

**Components of FIFA 11+ Exercises Observed**

**Part 1 Running:** (8 min) Time spent on Part 1 running exercises: \_\_\_\_\_

	Focus	Cueing	Technique	% Completed
_____ Straight ahead	_____	_____	_____	yes /no /partial
_____ Hip Out	_____	_____	_____	yes /no /partial
_____ Hip In	_____	_____	_____	yes /no /partial
_____ Circling partner	_____	_____	_____	yes /no /partial
_____ Shoulder contact	_____	_____	_____	yes /no /partial
_____ Quick forwards and backwards	_____	_____	_____	yes /no /partial

**Part 2 Strength / Plyometrics / Balance:** (10 min) Time spent on Part 2 \_\_\_\_\_

	Focus	Cueing	Technique	% Completed
The bench				
_____ Static	_____	_____	_____	yes /no /partial
_____ Alternate legs	_____	_____	_____	yes /no /partial
_____ One leg lift and hold	_____	_____	_____	yes /no /partial
Sideways bench				
_____ Static	_____	_____	_____	yes /no /partial
_____ Raise & lower hips	_____	_____	_____	yes /no /partial
_____ With leg lift	_____	_____	_____	yes /no /partial
Hamstrings				
_____ Beginner	_____	_____	_____	yes /no /partial
_____ Intermediate	_____	_____	_____	yes /no /partial
_____ Advanced	_____	_____	_____	yes /no /partial
Single leg stance				
_____ Hold the ball	_____	_____	_____	yes /no /partial
_____ Throwing ball partner	_____	_____	_____	yes /no /partial
_____ Test your partner	_____	_____	_____	yes /no /partial
Squats	Focus	Cueing	Technique	% Completed
_____ With toe raise	_____	_____	_____	yes /no /partial
_____ Walking lunges	_____	_____	_____	yes /no /partial
_____ One-leg squats	_____	_____	_____	yes /no /partial
Jumping				
_____ Vertical jumps	_____	_____	_____	yes /no /partial
_____ Lateral jumps	_____	_____	_____	yes /no /partial
_____ Box jumps	_____	_____	_____	yes /no /partial

**Part 3 Running:** (2 min) Time spent on Part 3 running exercises: \_\_\_\_\_

	Focus	Cueing	Technique	% Completed
_____ Across the field/court	_____	_____	_____	yes /no /partial
_____ Bounding	_____	_____	_____	yes /no /partial
_____ Plant & cut	_____	_____	_____	yes /no /partial

**Components of NON-FIFA 11+ Warm-Up Observed**

**Part 1 Running Components:**

Time spent on running components: \_\_\_\_\_  
 \_\_\_\_\_ Jogging: \_\_\_\_\_ Time \_\_\_\_\_ Straight ahead \_\_\_\_\_ Backwards \_\_\_\_\_ Side shuffles \_\_\_\_\_ Karaoke  
 \_\_\_\_\_ Vertical jump with jogging \_\_\_\_\_ Increase pace \_\_\_\_\_  
 Change of direction: \_\_\_\_\_ Front/back \_\_\_\_\_ Side/side \_\_\_\_\_ Diagonals

**Dynamic mobility:** Time spent on dynamic mobility/stretch: \_\_\_\_\_ Walking \_\_\_\_\_ Jogging \_\_\_\_\_

\_\_\_\_\_ High knees \_\_\_\_\_  
 \_\_\_\_\_ Butt kicks \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: front/back \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: front or front diagonal \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: back or back diagonal \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: back with forward touch \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: add/abd \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: add \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: abd \_\_\_\_\_  
 \_\_\_\_\_ Leg swings: diagonals \_\_\_\_\_  
 \_\_\_\_\_ Hip in \_\_\_\_\_ Hip out \_\_\_\_\_  
 \_\_\_\_\_ Hip int rot \_\_\_\_\_ Hip ext rot \_\_\_\_\_  
 \_\_\_\_\_ Power karaoke \_\_\_\_\_  
 \_\_\_\_\_ Side lunge- side to side \_\_\_\_\_  
 \_\_\_\_\_ Ankles \_\_\_\_\_

**Dynamic stretch:**

\_\_\_\_\_ Knee to chest \_\_\_\_\_  
 \_\_\_\_\_ Heel to butt \_\_\_\_\_  
 \_\_\_\_\_ Heel to butt, bend to touch toes \_\_\_\_\_  
 \_\_\_\_\_ Heel on ground forward lean- hold \_\_\_\_\_  
 \_\_\_\_\_ Heel on ground forward lean- scoop ground \_\_\_\_\_  
 \_\_\_\_\_ Ext Rot- glut- hold \_\_\_\_\_  
 \_\_\_\_\_ Front lunge- hold \_\_\_\_\_ Front lunge with UB rot \_\_\_\_\_  
 \_\_\_\_\_ Side lunge- hold \_\_\_\_\_  
 \_\_\_\_\_ Static stretch: Time spent on static stretch: \_\_\_\_\_ Seated \_\_\_\_\_ Standing \_\_\_\_\_  
 \_\_\_\_\_ "Stretch on your own"

**Part 2 Strength/Plyometrics/Balance Components:**

**Strength:** Time: \_\_\_\_\_

\_\_\_\_\_ Sit ups \_\_\_\_\_ Squats- double leg \_\_\_\_\_  
 \_\_\_\_\_ Push ups \_\_\_\_\_ Squats- single leg \_\_\_\_\_  
 \_\_\_\_\_ Front plank \_\_\_\_\_ Squats- with toe raise \_\_\_\_\_  
 \_\_\_\_\_ Side planks \_\_\_\_\_ Lunges \_\_\_\_\_  
 \_\_\_\_\_ Bridging \_\_\_\_\_ Hamstrings- (partner holds) \_\_\_\_\_  
 \_\_\_\_\_ Jumping jacks \_\_\_\_\_

**Plyometrics:** Time: \_\_\_\_\_

\_\_\_\_\_ Single leg \_\_\_\_\_ Double leg \_\_\_\_\_ Combined (SL-DL or DL-SL) \_\_\_\_\_

**Agility/balance:** Time: \_\_\_\_\_

Agility/balance static: \_\_\_\_\_ Single leg \_\_\_\_\_ Double leg \_\_\_\_\_  
 Agility/balance dynamic: \_\_\_\_\_ Single leg \_\_\_\_\_ Double leg \_\_\_\_\_ Combined (SL-DL or DL-SL) \_\_\_\_\_

**Part 3 Sports specific and Progression of Running Components:** Time: \_\_\_\_\_

\_\_\_\_\_ Running/sprinting across the field/court \_\_\_\_\_  
 \_\_\_\_\_ Bounding \_\_\_\_\_  
 \_\_\_\_\_ Plant & Cut \_\_\_\_\_  
 \_\_\_\_\_ Other Sports Specific Warm-Up \_\_\_\_\_ Time: \_\_\_\_\_  
 \_\_\_\_\_ No Team Warm-Up Done \_\_\_\_\_

**General questions/observations:**

Who was leading the warm-up? \_\_\_\_\_ coach \_\_\_\_\_ captain \_\_\_\_\_ no-one \_\_\_\_\_ other \_\_\_\_\_  
 Was the warm-up done as: \_\_\_\_\_ a team \_\_\_\_\_ individuals (on own) \_\_\_\_\_ by position \_\_\_\_\_  
 Was the team generally focused through out the warm-up? Yes / No / Partial \_\_\_\_\_  
 Was there Cueing of form/technique done throughout warm-up? Yes / No / Partial \_\_\_\_\_  
 Was there correct form/technique done throughout warm-up? Yes / No / Partial \_\_\_\_\_  
 Did the warm-up run continuously? Yes / No / Partial \_\_\_\_\_  
 Did the warm-up have significant stop/stand time? Yes / No / Partial \_\_\_\_\_  
 Time of total warm-up: \_\_\_\_\_