

## **ACUTE AND CHRONIC EFFECTS OF THE FIFA 11+ ON SEVERAL PHYSICAL PERFORMANCE MEASURES IN ADOLESCENT FOOTBALL PLAYERS**

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### ABSTRACT

The purpose of this study was to analyse the acute and chronic effects of the FIFA 11+ on several physical performance measures. A total of 41 youth amateur men football players completed this study. Participants were allocated into two different sub-studies: a) sub-study 1 (acute effects) and b) sub-study 2 (chronic effects). While in the sub-study 1, participants completed the FIFA 11+ and their regular warm-up routine in a randomized order on separate days; in the sub-study 2, participants performed the FIFA 11+ 3 times a week for 4 weeks or completed their usual warm-up routines (control). In both sub-studies, 10 physical performance measures grouped in 4 blocks (joint range of motion, dynamic postural control, sprinting and jumping) were assessed. The results of both sub-studies reported no meaningful differences between FIFA 11+ and regular warm-up for any physical performance measure analysed. Therefore, the findings of the current study report that the FIFA 11+ might be considered an appropriate warm-up inducing improvements in physical performance comparable with those obtained with other warm-up routines in football players. In addition, the training stimuli provided by the implementation of the FIFA 11+ three times per week for 4 weeks appear to be not enough to elicit chronic positive effects on physical performance measures.

**Key Words:** prevention program, warm-up, soccer, physical performance, sport-related injuries

## **EFFECTOS AGUDOS Y CRÓNICOS DEL PROGRAMA FIFA 11+ SOBRE MEDIDAS DEL RENDIMIENTO FÍSICO EN JUGADORES ADOLESCENTES DE FÚTBOL**

### RESUMEN

El objetivo de este estudio fue analizar los efectos agudos y crónicos del programa FIFA 11+ sobre medidas del rendimiento físico. Un total de 41 jugadores jóvenes de fútbol completaron este estudio. Los participantes fueron distribuidos en dos sub-estudios diferentes: a) sub-estudio 1 (efectos agudos) y b) sub-estudio 2 (efectos crónicos). Mientras que en el sub-estudio 1, los participantes completaron el programa FIFA 11+ y su habitual rutina de calentamiento de forma aleatoria en días distintos; en el sub-estudio 2, los participantes realizaron el programa FIFA 11+ 3 veces a la semana durante 4 semanas o completaron su habitual rutina de calentamiento (control). En ambos sub-estudios, 10 medidas del rendimiento físico agrupadas en 4 bloques (rango de movimiento articular, control dinámico postural, sprint y salto) fueron evaluadas. Los resultados de ambos sub-estudios informan de la ausencia de diferencias relevantes entre el programa FIFA 11+ y la rutina de calentamiento habitual para cada una de las medidas de rendimiento físico analizadas. Por lo tanto, los hallazgos del presente estudio informan de que el programa FIFA 11+ podría ser considerado un calentamiento adecuado que induce mejoras en el rendimiento físico comparables con las producidas por otras rutinas de calentamiento en jugadores de fútbol. Además, el estímulo de entrenamiento proporcionado por la implementación del programa FIFA 11+ tres veces a la

semana durante 4 semanas parece no ser suficiente para provocar efectos crónicos positivos sobre medidas del rendimiento físico.

**Palabras clave:** programa de prevención, calentamiento, fútbol, rendimiento físico, lesiones relacionadas con el fútbol

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## INTRODUCTION

The FIFA 11+ is a structured warm-up program designed by the FIFA Medical Assessment and Research Centre (F-MARC) in collaboration with others Sport Medicine Institutions (i.e. Oslo Sports Trauma Research Centre and Santa Monica Orthopaedic and Sports Medicine Research Foundation) following evidence-based and best practise criteria with the aim to prevent and reduce the number and severity of football-related injuries, particularly in amateur players (Bizzini, Junge, & Dvorak, 2011).

In the recent years, some countrywide campaigns have been developed with the purpose of implementing this warm-up program in the everyday football training routines (especially in youth players and at amateur levels) (Bizzini, Junge, & Dvorak, 2013; Fuller, Junge, Dorasami, DeCelles, & Dvorak, 2011; Junge et al., 2011). The rationale behind these campaigns is based on the following two arguments. On the one hand, the first argument is based on the fact that there is some evidence available demonstrating that the FIFA 11+ is effective in reducing lower extremity injury rates in both male (Owoeye, Akinbo, Tella, & Olawale, 2014; Silvers, Mandelbaum, Bizzini, & Dvorak, 2014) and female (Soligard et al., 2008; Steffen et al., 2013) football players. Thus, Soligard et al. (2008) and Steffen et al. (2013), in two randomised controlled trials (RCT), found a significant reduction (up to 50%) of injuries in female players aged 13–18 when the FIFA 11+ exercises were performed at least twice a week. With respect to the male players, Owoeye et al. (2014) found a significantly lower (approximately 40%) incidence of injuries in young Nigerian male players (aged 14–19), and Silvers et al. (2014) reported similar results in American male NCAA Division I-II players (aged 18–25) when performing the program regularly (2-3 days per week). On the other hand, the second argument is based on the fact that the FIFA 11+ is a comprehensive warm-up program consisting of 15 exercises (including running, specific dynamic movement as well as sprinting, agility and plyometric exercises) that only takes 15-20 minutes to be completed (depending on the athletes' experience with the exercises) and requires no additional or specific equipment (for example balance boards) other than a football ball (Rössler et al., 2014). These two latter-mentioned characteristics (short duration and no addition equipment is required) in conjunction with the fact that this program is described in detail through different audio-visual resources (technical manual, videos, posters and cards) that can be accessed freely through the FIFA website ([www.f-marc.com/11plus/sitio-web](http://www.f-marc.com/11plus/sitio-web)); led that the FIFA 11+ may be considered simple and viable to be performed in almost every amateur football contexts.

However, before considering the FIFA 11+ as appropriate warm-up program to be performed prior to formal training and competition, it must demonstrate that it is able to elicit positive acute (post-exercise) affects on the

major physical performance measures (e.g.: sprint time, jumping height, dynamic balance and range of motion [ROM]). Furthermore, if the use of the FIFA 11+ is to be promoted to the detriment of the traditional warm-up programs currently performed by most amateur football teams, the magnitude of its hypothetical positive effects on physical performance measures should be at least similar to those reported by the latter mentioned warm-up programs (Amiri-Khorasani, Osman, & Yusof, 2011; Brown, Hughes, & Tong, 2008; Fletcher & Monte-Colombo, 2010; Gelen, 2010; Little & Williams, 2006; Till & Cooke, 2009; Zois, Bishop, Ball, & Aughey, 2011). Surprisingly, to the best of our knowledge only Bizzini et al. (2013) have analysed the acute effects of the FIFA 11+ on various physical performance measures, showing improvements in 20 m sprint time, jumping height and agility comparable with those obtained with other dynamic warm-up routines reported in the literature.

On the other hand, the knowledge of chronic (training) positive effects elicited by the FIFA 11+ on the physical performance could be used as other strong reason to encourage coaches to implement this injury prevention program in their everyday football training routines. Although some studies have explored the chronic effects of this warm-up program on some measures of physical performance (lower extremity [Daneshjoo, Mokhtar, Rahnama, & Yusof, 2012; Steffen et al., 2013] and core [Impellizzeri et al., 2013] balance, sprinting and jumping ability [Daneshjoo, Mokhtar, Rahnama, & Yusof, 2013; Impellizzeri et al., 2013], the results reported are conflicting and hence not conclusive. In addition, none of the aforementioned studies have used adolescents players as sample despite being the target population of this program.

Therefore, the purpose of this study was twofold: to analyse a) the acute and b) the chronic effects of the FIFA 11+ on several physical performance measures (10 and 20m sprint time, jumping height, dynamic balance and joint ROM) in youth amateur football players.

## METHOD

### *Participants*

A total of 45 youth male amateur football players took part in the current study. Participants were recruited from 2 different football teams that were engaged in the Official Amateur Championships of the Spanish Football Federation (first regional juvenile league). The participants met 3 inclusion/exclusion criteria: 1) had no history of impairments to the knee, thigh, hip, or lower back in the 6 month prior to the study; 2) all participants were free of delayed onset muscle soreness (DOMS) at any testing session; and 3) participated on 3 supervised training sessions per week (1.5-2 hours per session). In addition, participants were excluded from the data analysis if they a)

missed more than 2 consecutive or 3 non-consecutive training sessions (chronic sub-study) and/or b) one testing session (acute and chronic sub-studies).

Before any participation, experimental procedures and potential risks were verbally and written explained fully to the participants, and written informed consent was obtained from players, their parent/guardian and coaches. The Institutional Research Ethics committee conformed to the recommendations of the Declaration of Helsinki approved the study protocol prior data collection.

Finally, 41 men (age:  $16.4 \pm 1.3$  y; body mass:  $70.7 \pm 2.9$  kg; stature:  $172.9 \pm 7.1$  cm; years playing football:  $6.4 \pm 2.7$  y) classified as amateur football players completed this study. Four men were excluded from the study because they missed one testing session ( $n = 1$ ) or more than three non-consecutive training sessions ( $n = 3$ ).

### *Procedure*

The current study was conducted during the competitive phase of the first national juvenile league (second term [from February to April]).

This study was divided into two different sub-studies in order to address the two purposes previously mentioned: a) sub-study 1 - acute effects - and b) sub-study 2 - chronic effects -.

The sub-study 1 (acute effects) was carried out using exclusively all the players belonging to one team ( $n = 20$ ) while the sub-study 2 (chronic effects) was carried out using exclusively all the players belonging to the other team ( $n = 21$ ). Although the use of all players of each of the two teams as a sample to address both purposes would have been desirable, the coaches of both teams refused this option arguing time restriction (i.e.: "*this experimental design would require too much training sessions lost*").

The independent and dependent variables were the same for both sub-studies (acute and chronic effects). Thus, the independent variables were the two different intervention (warm ups) routines (FIFA 11+ and regular or traditional [control] warm-ups). The dependent variables included 10 physical performance measures grouped in 4 blocks (range of motion [hip, knee and ankle joints], dynamic postural control, sprint time [10m and 20m] and jumping height).

*Sub- study 1: acute effects.* A randomized, crossover and counterbalanced order study design was used to address the first purpose of this study (i.e. to analyse the acute effects of the FIFA 11+ on several physical performance measures) (figure 1).

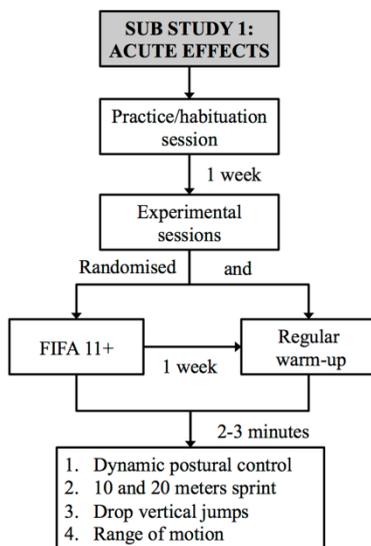


FIGURE 1: Schematic representation of the sub-study 1 (acute effects) design.

In this sense, participants were tested on three occasions, with a week's rest interval between sessions. Each testing session was carried out 48–72 hours after finishing the previous competitive match (i.e. Tuesday or Wednesday) so that the players could have enough time for recovery. Furthermore, to minimize circadian and other similar effects on performance, each participant carried out all experimental sessions at the same time of day (in the early evening) on his regular training session and outdoor pitch (3G artificial surface).

The first testing sessions was a practice/habituation session to the different testing procedures and warm-up exercises, and the following two testing sessions were the experimental sessions.

During each experimental session, participants began by completing one of the two interventions: the FIFA 11+ or their regular warm-up. The order of interventions was randomised per person using a computer-based software programme ([www.randomiser.org](http://www.randomiser.org)) to avoid carry-over effects. The assessment of the physical performance measures was carried out 2–3 minutes (post-test) after the entire warm-up program was completed. The order of the tests was consistent throughout the experimental sessions and was established with the intention of minimizing any possible negative influence among variables (figure 1). Each experimental session was carried out under the strict supervision of two researchers who were blinded to the purpose of the study and to the test results from previous testing sessions.

*Sub-study 2: chronic effects.* A parallel, two-group, pre-post, randomised controlled trial was used to address the second purpose of this study (to

analyse the chronic effects of the FIFA 11+ on several physical performance measures) (figure 2).

A week prior to the application of the FIFA 11+ (intervention phase), the participants' baseline value for each dependent variable was determined. During this testing session, participants began by completing their regular warm-up routine. The assessments of the dependent variables were carried out 3-5 min after the regular warm-up and following the same order as the sub-study 1.

After the pre-test session was completed, participants were randomised into 2 groups, control ( $n = 11$ ) vs. FIFA 11+ ( $n = 10$ ), using a computer-based software programme ([www.randomiser.org](http://www.randomiser.org)). One of the researchers without any contact or knowledge of the players completed allocation and randomisation. Therefore, no allocation concealment mechanisms were necessary.

For the following 4 weeks (intervention phase), the participants completed only one of the 2 intervention programs 3 days a week. As the FIFA 11+ was initially proposed as a training program that should be performed during the pre-exercise warm-up, the participants who were allocated in the intervention groups carried out the FIFA 11+ to the detriment of their traditional or regular warm-up routine. A Master degree student was assigned to the team for administrating FIFA 11+ and for checking the warm-up and assisting the coaches during the normal warm-up (control group).

Two days after the intervention phase, the post intervention assessments were carried out following the same procedure completed during the baseline-testing phase. The testers who conducted the baseline and post intervention assessments were blinded to group assignment.

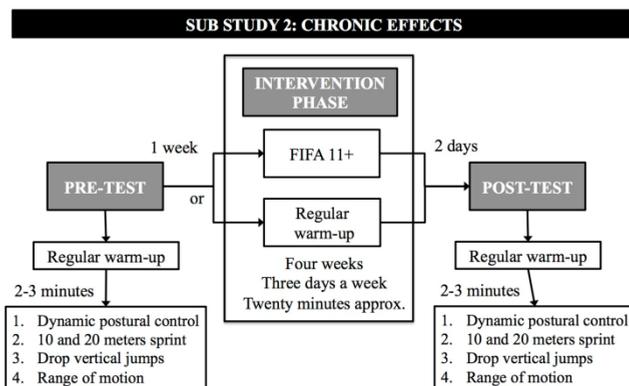


FIGURE 2: Schematic representation of the sub-study 2 (chronic effects) design.

### *Interventions*

*FIFA 11+*. The FIFA 11+ consisted of three parts, the first of which involved running exercises (part 1). The second part covered six exercises, all of which comprised three levels of difficulty and were aimed at improving strength, balance, muscle control and core stability (part 2). The third and final part consisted of advanced running exercises (part 3). For more details see the manual and instructions freely available on the official website ([www.f-marc.com/11plus](http://www.f-marc.com/11plus)). All participants performed the level II of difficulty for each exercise in part 2.

*Regular warm-up (control)*. Coaches were asked to administer their normal warm-up routines trying to match the duration of the FIFA 11+ (20–25 minutes). The normal warm-up slightly differed between teams but included a combination of running exercises (4–6 min at light intensity), static stretching of the major muscle groups (4–6 exercises, 1–2 sets of 15–30 s of stretching per muscle group), and technical exercises with the ball (4–6 min).

### *Physical performance measures*

*Dynamic postural control*. Dynamic postural control was evaluated using the Y-Balance test and following the guidelines proposed by Shaffer et al. (2013). Players were allowed a maximum of 5 trials to obtain 3 successful trials for each reach direction (anterior, posteromedial and posterolateral). Specifically, testing order was completed as dominant anterior, non-dominant anterior, dominant posteromedial, non-dominant posteromedial, dominant posterolateral, and non-dominant posterolateral. The average of the 3 reaches was normalized by dividing by the previously measured leg length to standardize the maximum reach distance ( $(\text{excursion distance}/\text{leg length}) \times 100 = \% \text{ maximum reach distance}$ ) (Gribble, Hertel, & Plisky, 2012). Leg length was defined as the length measured in centimetres from the anterior superior iliac spine to the most distal portion of the medial tibial malleolus. To obtain a global measure of the balance test, data from each direction were averaged for calculating a composite score (Filipa, Byrnes, Paterno, Myer, & Hewett, 2010).

*10 and 20 meters sprint*. Owing to its good reproducibility, linear sprint tests ranging from 10 to 20 m are used as general measures of linear acceleration and speed in football players. Time during a 20-m sprint in a straight line was measured by means of single beam photocell gates placed 1.0 m above the ground level (Time It; Eleiko Sport, Halmstad, Sweden). Each sprint was initiated from an individually chosen standing position, 50 cm behind the photocell gate, which started a digital timer. Each player performed 2 maximal 20-m sprints interspersed with 3 min of passive recovery, and the fastest time achieved was retained.

*Drop vertical jump.* A drop vertical jump (DJ) without arm swing was performed on a contact platform (Ergojump®, Finland) according to Onate, Cortes, Welch, & Van Lunen (2010). Participants stood with feet shoulder-width apart on a 28-cm-high step, 30 cm from the contact platform. They were instructed to lean forward and drop from the step as vertically as possible, in an attempt to standardize landing height. Participants were required to land with one foot on the contact platform, then immediately perform a maximal vertical jump, finally landing back on the contact platform. Participants were asked to keep their hands on their hips to prevent the influence of arm movements on vertical jump performance. Each participant performed at least 5 maximal jumps starting from a standing position, with at least 1 minute of recovery between jumps. Participants were asked to jump as high as possible. The mean jump height of the best three jumps was used for statistical analysis.

*Hip, knee and ankle range of motions.* The passive hip flexion (passive straight leg raise test, knee flexion (Modified Thomas test) and ankle dorsiflexion (weight-bearing lunge with knee extended test) range of motions of the dominant and non-dominant extremities were assessed following the methodology previously described (Cejudo, Sainz de Baranda, Ayala, & Santonja, 2015). Participants were instructed to perform, in a randomised order, 2 maximal trials of each range of motion test for each extremity, and the mean score for each test was used in the subsequent analyses.

### *Statistical analysis*

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, v. 20.0 for Windows; SPSS Inc, Chicago).

Means  $\pm$  standard deviations (SD) were used to describe variables. Data normality and homoscedasticity were confirmed before inferential analysis through Kolmogorov–Smirnov and Levene’s tests, respectively.

Dependent sample t-tests were carried out to assess differences between limbs (dominant versus non-dominant) in dynamic postural control and range of motions measures. In cases where no significant differences were found, the mean value of both limbs was used for the subsequent analyses.

*Sub-study 1: acute effects.* Dependent t-tests were carried out to assess intra-group (inter-sessions) differences for each dependent variable. Effect sizes, which are standardised values that permit the determination of the magnitude of differences between groups or experimental conditions (Cohen, 1988), were also calculated (mean and 95% interval confidence [IC]) for each of the variables in each inter-session comparison using the procedure described by Cohen (1988).

Magnitudes of standardized differences in means were assessed with the scale suggested by Rhea (2004) for recreational athletes: < 0.35 trivial, from

0.35 to 0.8 small, from 0.8 to 1.5 moderate, and  $> 1.5$  large. A difference was reported as unclear when the confidence interval of the standardized difference crossed the 0 value (i.e. null value), independently of if the mean value was higher than  $\pm 0.35$ .

*Sub-study 2: chronic effects.* A 2 (group)  $\times$  2 (time) repeated measures ANOVAs were run to analyse and compare differences between groups (regular warm-up vs. FIFA 11+) for each dependent variable at the pre-test and post-test moments. The experiment-wise type I error rate was set at  $p < 0.05$  and protected by adjusting the critical p values for each ANOVA using a Holms correction. Effect size were also calculated to determine the magnitude of differences between the groups or experimental conditions for each variable using the method previously described by Cohen (1988) for pre-post parallel groups trials. The same qualitative descriptors to interpret the effect size values used in the sub-study 1 were applied.

## RESULTS

Table 1 and 2 show the mean and standard deviation for the physical performance measures analysed between testing moments and separated by experimental conditions (regular warm-up vs. FIFA 11+) for the sub-study 1 and 2 respectively.

The statistical analysis showed no significant differences ( $p > 0.05$ ) in dynamic postural control (anterior, posteromedial and posterolateral directions) and ROMs (hip flexion, knee flexion and ankle dorsiflexion) outcomes between the dominant and non-dominant limbs of the players at neither testing sessions. Consequently, the average score of both limbs for each unilateral variable was used for the subsequent statistical analysis.

TABLE 1

Results of the dependent t-test on the physical performance measures in the sub-study 1 (mean  $\pm$  standard deviation [SD]). The differences between group average values are also reported (mean and 95% interval confidence [IC]).

Physical performance measure	Regular warm-up		FIFA 11+		Difference		
	Mean	SD	Mean	SD	Mean	95%IC	
Dynamic postural control <sup>T</sup>							
▪ Anterior distance	65.2	$\pm 5.5$	63.6	$\pm 9.3$	1.6	-0.3	3.4
▪ Posteromedial distance	102.1	$\pm 9.3$	104.3	$\pm 8.3$	-2.2	-4.9	0.23
▪ Posterolateral distance	96.7	$\pm 7.4$	95.4	$\pm 6.1$	1.3	-0.9	3.7
▪ Composite	95.1	$\pm 6.1$	95.2	$\pm 5.8$	-0.1	-1.26	0.92
Sprint time (s)							
▪ 10 m	1.85	$\pm 0.57$	1.47	$\pm 1.02$	0.38	-0.34	1.12
▪ 20 m	3.43	$\pm 0.31$	3.03	$\pm 1.31$	0.41	-0.28	1.11
Jumping height (cm)	27.1	$\pm 3.1$	24.6	$\pm 2.8$	2.5	-3.0	8.1
Range of motions ( <sup>o</sup> )							
▪ Hip flexion	67.2	$\pm 12.2$	70.4	$\pm 10.5$	-3.2	-7.4	1.1
▪ Knee flexion	125.3	$\pm 13.9$	124.2	$\pm 11.6$	1.1	-3.9	6.2
▪ Ankle dorsiflexion	38.6	$\pm 8.1$	38.4	$\pm 8.2$	0.2	-1.2	1.8

<sup>T</sup>: Normalized to limb length expressed as a percentage; s: seconds; cm: centimetre;

<sup>o</sup>: degrees

TABLE 2

Results of the general linear model for repeated measures on the physical performance measures in the sub-study 2 (mean  $\pm$  standard deviation [SD]). The differences between pre and post-test average values are also reported (mean and 95% interval confidence [IC]).

Physical performance measure	Regular warm-up							FIFA 11+						
	Pre-test		Post-test		Difference			Pre-test		Post-test		Difference		
	Mean	SD	Mean	SD	Mean	95%IC	Mean	SD	Mean	SD	Mean	95%IC		
Dynamic postural control <sup>T</sup>														
▪ Anterior distance	69.7	$\pm 4.9$	65.8	$\pm 5.2$	-3.9	-7.9	0.9	68.1	$\pm 6.9$	67.8	$\pm 6.2$	-0.3	-3.7	3.1
▪ Posteromedial distance	110.4	$\pm 6.1$	109.3	$\pm 6.4$	-1.2	-5.1	2.7	113.7	$\pm 5.3$	115.3	$\pm 2.8$	1.6	-2.5	5.6
▪ Posterolateral distance	106.5	$\pm 5.7$	106.6	$\pm 5.7$	0.1	3.8	3.8	109.9	$\pm 4.6$	109.5	$\pm 4.9$	-0.4	-3.8	2.9
▪ Composite	95.4	$\pm 5.1$	93.2	$\pm 4.9$	-2.2	-5.3	0.9	97.1	$\pm 3.5$	97.3	$\pm 2.7$	0.2	-1.5	1.8
Sprint time (s)														
▪ 10 m	1.81	$\pm 0.29$	1.99	$\pm 0.33$	0.18	-0.05	0.41	1.89	$\pm 0.1$	2.03	$\pm 0.23$	0.14	-0.10	0.25
▪ 20 m	3.27	$\pm 0.16$	3.31	$\pm 0.23$	0.04	-0.09	-0.16	3.27	$\pm 0.15$	3.24	$\pm 0.15$	-0.03	-0.09	0.05
Jumping height (cm)	24.3	$\pm 2.4$	22.1	$\pm 5.5$	-2.2	-7.6	3.8	26.9	$\pm 3.5$	26.6	$\pm 3.5$	-0.4	-4.7	3.9
Range of motions ( <sup>o</sup> )														
▪ Hip flexion	77.5	$\pm 7.9$	76.5	$\pm 7.4$	-0.9	-5.1	3.2	79.1	$\pm 6.1$	77.8	$\pm 6.7$	-1.25	-7.2	4.7
▪ Knee flexion	135.4	$\pm 7.4$	134.1	$\pm 8.3$	0.7	-3.9	5.3	138.6	$\pm 6.9$	137.5	$\pm 7.3$	-1.1	-2.1	-0.2
▪ Ankle dorsiflexion	34.9	$\pm 2.6$	36.5	$\pm 2.5$	1.6	-0.6	3.8	37.2	$\pm 1.9$	39.8	$\pm 3.4$	2.5	1.1	6.1

<sup>T</sup>: Normalized to limb length expressed as a percentage; s: seconds; cm: centimetre; <sup>o</sup>: degrees

### Sub-study 1: acute effects

No statistically significant differences ( $p > 0.05$ ) were found between paired-comparisons (FIFA 11+ vs. regular warm-up) for any physical performance measure analysed. In addition, the standardized differences (effect sizes) for all paired-comparisons were considered as "unclear" (with the exception of the 20m sprint time measure [ $d = 1.2$ ; 95% IC = from 0.21 to 2.2]) because the confidence intervals crossed the null value (figure 3).

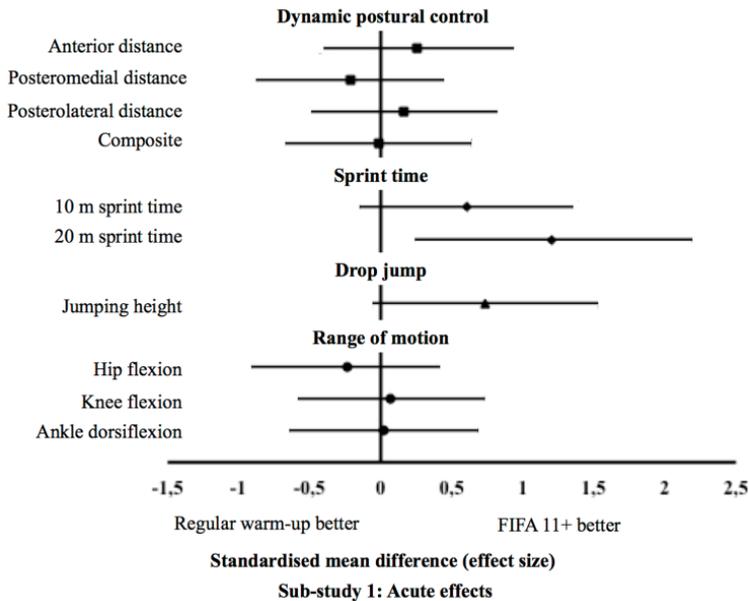


FIGURE 3: Acute net effects (expressed as standardized mean differences [effect size] and 95% interval confidence) of the intervention for the FIFA 11+ and regular warm-up on the physical performance measures analysed.

### Sub-study 2: chronic effects

Similarly to the sub-study 1, neither statistically significant differences ( $p > 0.05$ ) nor clear standardized differences (figure 4) were found between interventions for any physical performance measure.

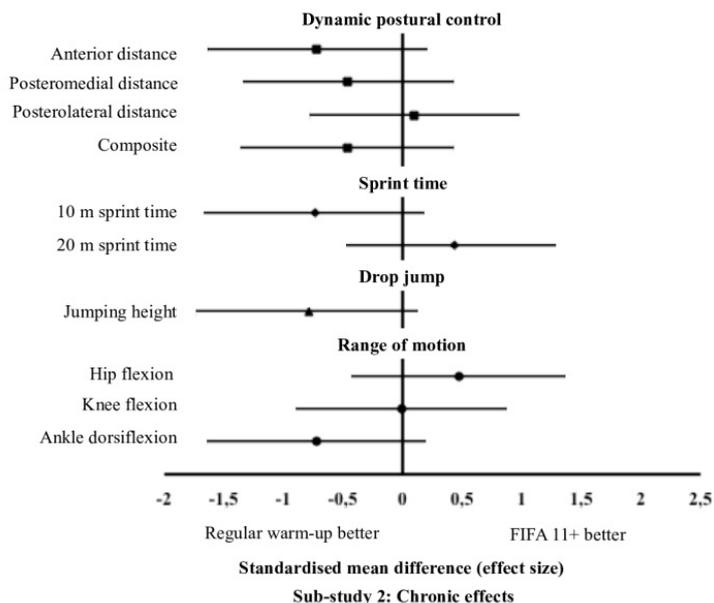


FIGURE 4: Chronic net effects (expressed as standardized mean differences [effect size] and 95% interval confidence) of the intervention for the FIFA 11+ and regular warm-up on the physical performance measures analysed.

## DISCUSSION

The FIFA 11+ is an injury prevention program for football (especially for youth amateur players), which has been proposed as a warm-up routine. While its effectiveness in preventing injuries has been proven (Owoeye et al., 2014; Silvers et al., 2014; Soligard et al., 2008; Steffen et al., 2013; van Beijsterveldt et al., 2012), there is not enough evidence that support that the FIFA 11+ may be considered as a “good” warm-up that would be able to elicit improvement in the following performance (Bizzini et al., 2013). In addition, the knowledge of chronic effects elicited by this warm-up program on the physical performance can help in identifying the potential mechanisms behind the reported reduction in injury incidence (Impellizzeri et al., 2013). Therefore, the purposes of the current study were to analyse a) the acute and b) the chronic effects of the FIFA 11+ on several physical performance measures (sprint time, jumping height, dynamic balance and joint ROM) in youth amateur football players.

### *Sub-study 1: acute effects*

The results of the current study reported that the acute (post-exercise) effects elicited by the FIFA 11+ on the four different groups of physical performance measures (sprint time, jumping height, dynamic balance and joint ROM) in the youth players recruited were similar (figure 3) to those found by

the traditional football-related warm-up routine analysed. This finding is consistent with the results reported by the only study (to the authors' knowledge) that has analysed and compared the acute effects of the FIFA 11+ with some standards football-related warm-up routines (Bizzini et al., 2013). Thus, Bizzini et al. (2013), carried out a meta-analysis to compare the effects elicited by the FIFA 11+ (level 3) in a intra-session pre-post test trial with other warm-up routines previously published regarding football players on some physical performance measures (20-m sprint time, agility, vertical jump height, leg stiffness, isometric maximal voluntary contraction, rate of force development, and dynamic postural control) reporting similar magnitude of the effects.

However, it should be noticed that although not substantial and with a practical significance that is unclear, there appears to exist a tendency showing that the FIFA 11+ elicits superior improvements in the 10 ( $\Delta 20\%$ ) and 20 ( $\Delta 10\%$ ) m sprint times and jumping height ( $\Delta 10\%$ ) measures that the regular warm-up (figure 3). Perhaps, a probable explanation for this positive tendency in sprint times and jumping height improvements in favour of the FIFA 11+ may be due to the fact that the regular warm-up routine, in contrast to the FIFA 11+, includes a specific part of static stretching exercises, which may have elicited a negative effect on maximal muscle performance (Behm & Chaouachi, 2011). Thus, it has been found that an acute bout of static stretching similar than that performed during the regular warm-up intervention may reduce muscle activation via peripheral (autogenic inhibition of the Golgi tendon reflex, mechanoreceptor and nociceptor afferent inhibition) and central nervous system (supraspinal fatigue) mechanisms (Avela, Finni, Liikavainio, Niemelä, & Komi, 2004). Another possible explanation for this positive tendency in sprinting times and jumping height in favour of the FIFA 11+ may be based on a better activation of the history-dependent neuromuscular factors such as post-activation potentiation (PAP) and stretch-shortening cycle (SSC), which have been found mainly after isometric or resistance/weight-based exercises completed immediately before the task (Turki et al., 2011; Zois et al., 2011). Thus, the higher stimuli of resistance-based exercises presented in the exercises belonging to the final part of the FIFA 11+ (vertical and countermovement jumps, low squats, lunges and rapid running and change of direction tasks) may have lead to a higher post-activation potentiation in contradiction to the regular warm-up intervention. Nevertheless, until future studies address this issue, the above-mentioned positive tendency should be taken with a high degree of caution.

Therefore, the results of the current study in conjunction with those previously reported by Bizzini et al. (2013) support the implementation of the FIFA 11+ in the everyday football sessions as warm-up routine because it

induces improvements in physical performance at least comparable with those obtained with other warm-up routines in football players.

### *Sub-study 2: chronic effects*

Another important finding of the current study is that the training stimuli provided by the implementation of the FIFA 11+ three times per week for 4 weeks (12 sessions) appear to be not enough to elicit chronic (training) positive effects (in comparison with its paired control group) on the physical performance measures analysed.

This finding appears to be in agreement with the study by Impellizzeri et al. (2013) conducted on adult (age:  $23.7 \pm 3.7$  years) football players, which did not find meaningful improvements in the dynamic postural control, sprint time (10 and 20 m), jumping height (countermovement jump) and agility after performing the FIFA 11+ three times a week for 9 weeks. Contrarily to the results found by Impellizzeri et al. (2013) and the current study, Daneshjoo et al. (2013) reported benefits (compared to standard practises) in jumping height and 20 m sprint time after performing the FIFA 11+ three times a week for 8 weeks. There is not a clear explanation for this discrepancy further than the one attributed to the different population used in each study. In this sense, while Daneshjoo et al. (2013) used professional football players, Impellizzeri et al. (2013) and we looked at amateur football players. It is possible that the professional football players may be more susceptible to improve the neuromuscular performance after implementing the FIFA 11+ into their regular training.

The absence of improvements in the physical performance measures analysed after performing the FIFA 11+ was not expected because this program includes specific groups of exercises a priori designed to enhance all of them. Perhaps, the training stimuli needed to achieve meaningful improvements in physical performance after the implementation of the FIFA 11+ might be higher. Admitting this hypothesis as true, longer interventions phases than that conducted in both studies, Impellizzeri et al. (2013) and the current study, may be needed to reflect meaningful changes in physical performance. This circumstance may be especially relevant because the FIFA 11+ has demonstrated being effective in reducing the injury rates in those teams that have implemented it in their daily routines for at least three month (12 weeks) with a frequency of three days per week. On the other hand, it should be noticed that Impellizeri et al. (2013) did find between-group differences in favour of the FIFA 11+ players for some variables related to the neuromuscular control (core and knee stability and dynamic knee stability and time-to-stabilisation). Thus, these authors suggested that the improvement in the neuromuscular control might be a candidate key mechanism for explaining the

injury prevention effect of FIFA 11+ rather than improvement in physical performance measures. Taking both arguments in consideration, it might be possible that multi-joints, field-based and open tasks would require higher magnitudes of changes to reflect a real improvement as their internal validity and reliability could be lower than laboratory controlled measures. However, based on the speculative nature of the hypothesis just mentioned, this aspect should be taken with a high degree of caution.

Therefore, future studies that investigate the effects of long interventions phases (> 9 weeks) on several physical performance and neuromuscular control variables using randomized control trial with placebo control group designs are needed to understand better potential mechanisms behind the reported reduction in injury incidence reported by the FIFA 11+.

### *Limitations*

Although the current study is novel in several aspects (testing procedures, statistical analyses and design), some limitations should be noted. The small sample size used in each group (interventions or controls) may be considered a limitation. However, the sample size that was enrolled in each group in both sub-studies was similar than previous studies (Bizzini et al., 2013; Daneshjoo et al., 2013). Another possible limitation of the current study is the sampling frame. The age distribution of participants ( $16.4 \pm 1.3$  y) and their physical skills level (amateur) were narrow the generalizability cannot be ascertained.

### CONCLUSIONS

The findings of the current study show that the exercises included in the FIFA 11+, in addition to being potentially effective for reducing the risk of injuries, are also adequate for eliciting positive acute effects on physical performance measures in youth amateur football players. Therefore, the FIFA 11 + may be considered an appropriate warm-up inducing improvements comparable with those obtained with other warm-up routines in football players. In addition, the results of this study report that the training stimuli provided by the implementation of the FIFA 11+ three times per week for 4 weeks (12 sessions) appear to be not enough to elicit chronic (training) positive effects on physical performance measures. This circumstance support the use of moderate to long-term adherence to an injury prevention programme in order to have positive effects on injury risk factors.

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