Rev Bras Cineantropom Hum

original article

DOI: http://dx.doi.org/10.5007/1980-0037.2017v19n4p406

Effect of FIFA 11+ in addition to conventional handball training on balance and isokinetic strength

Efeito do FIFA11+ e do treinamento convencional de handebol sobre força isocinética e equilíbrio

Vinícius Jardim Oliano[1]
Lilian Pinto Teixeira[1]
Simone Lara[1]
Rodrigo de Souza Balk[1]
Stefany Guimarães Fagundes[1]

Abstract - Considering that handball is a sport that requires physical contact, jumps, and fast movements, it is relevant to create prevention strategies to avoid injuries. It is known that better proprioceptive conditions and muscular balance are associated with reductions in sport injuries. The aim of this study was to analyse the cumulative effect of a twelve-week FIFA11+ training program in addition to conventional handball training on postural balance and isokinetic strength of the knee joint in female handball athletes. Twenty-one athletes (aged 11-14 years) were assessed and divided into two groups: intervention group (IG), composed of girls who practiced FIFA11+ associated with regular handball training, and control group (CG) composed of girls who participated only in team training. Both groups were assessed at pre- and post-intervention including knee muscular power using isokinetic dynamometer. Postural balance was assessed through computerized dynamic posturography, with sensory organization test (SOT), analysis of sensorial systems, and unilateral test. IG performed the FIFA11+ program exercises, twice a week, with sessions lasting 40 minutes on average, during 12 weeks. The results demonstrate an improvement in postural balance in IG group at condition 5 of SOT, and in the use of vestibular system at post-intervention, which did not occur in CG. As far as knee isokinetic muscular power is concerned, both groups showed improvements. In conclusion, the practice of FIFA11+ in addition to conventional handball training demonstrated important contributions on the postural balance of young players.

Key words: Postural balance; Muscle strength; Sports Injuries.

Resumo – *Considerando que o handebol é um esporte com características de contato físico, saltos e movimentos rápidos, é relevante criar estratégias de prevenção de lesão nessa modalidade. Sabe-se que uma melhor condição proprioceptiva e um equilíbrio muscular está associado à redução de lesão esportiva. O objetivo desse estudo foi analisar o efeito cumulativo de doze semanas do programa FIFA11+ ao treinamento convencional de handebol, sobre o equilíbrio postural e força isocinética da articulação de joelho, em atletas de handebol feminino. Foram avaliadas 21 atletas (11 à 14 anos), divididas em dois grupos, sendo, o grupo intervenção (GI), integrando as atletas que praticaram o FIFA11+ associado ao treino regular do handebol, e o grupo controle (GC), cujas jovens praticaram apenas o treinamento do time. Ambos os grupos foram avaliados pré e pós-intervenção, incluindo a avaliação da força por meio de um dinamômetro isocinético. O equilíbrio postural foi avaliado por meio da posturografia dinâmica computadorizada, com os testes de organização sensorial (TOS), análise dos sistemas sensoriais e teste unilateral. O GI praticou os exercícios do programa FIFA11+, sendo duas vezes por semana, com média de 40 minutos cada sessão, durante 12 semanas. Como resultados, houve melhora do equilíbrio postural no GI, na condição 5 do TOS, e no uso do sistema vestibular, pós-intervenção, o que não ocorreu no GC. Quanto à força isocinética, ambos os grupos obtiveram melhoras. Concluímos que a prática do FIFA11+ associada ao treinamento convencional de handebol apresentou contribuições importantes sobre o equilíbrio postural de jovens atletas.*

Palavras-chave: *Equilíbrio postural; Força muscular; Lesões esportivas.*

1 Federal University of Pampa. Uruguaiana, RS. Brasil.

Received: 10 December 2016
Accepted: 17 July 2017

INTRODUCTION

Handball is a complex collective sport, which is determined by the individual performance of each player, as well as tactical components and interaction among team members[1]. It is an Olympic modality, which includes running, jumping, pushing and blocking actions[2].

Due to these characteristics, the risk for the development of lesions in young female athletes is high, and most of them affect the knee joint[3]. In fact, during two major Brazilian championships, out of a total of 339 athletes from 21 elite handball teams, 312 injuries were identified in 201 athletes, with ankle and knee being the most affected regions[4]. Considering the high rates of injuries in this sport, it is relevant to identify the variables that may predispose to the development of injuries in order to create prevention strategies in sports, such as muscular strength and postural balance.

The systematic evaluation of lower limb muscle strength throughout the training cycle in handball athletes is relevant not only from the perspective of training performance, but also as a health promoter in relation to injury prevention[5]. Moreover, proprioceptive work allows the athlete to obtain better stabilization during the sporting gesture, and, therefore, it seems to contribute to the prevention of sports injuries. In fact, there is evidence of the efficacy of neuromuscular training strategies in reducing injuries, especially of the lower limbs in numerous collective sports[6].

Injury prevention becomes essential to avoid long-term consequences of severe sports injuries[7]. Thus, more and more research is being conducted on injury prevention programs in athletes, such as "FIFA 11+", initially developed to reduce injuries in soccer players. This program consists of a physical exercise-based training that focuses on central stabilizing muscle strength (CORE), neuromuscular control and balance, eccentric training of the thigh muscles, plyometry and agility[8].

Considering that female handball athletes have a potential risk of developing lower extremity injuries[9], together with the scarcity of studies reporting the effects of injury prevention programs, the aim of this study was to analyze the cumulative effect of a twelve-week FIFA11+ training program in addition to conventional handball training on postural balance and isokinetic muscle strength of the knee joint in female handball athletes.

METHODOLOGICAL PROCEDURES

This experimental study included a convenience sample composed of athletes aged 11-14 years, members of an amateur female handball team, who have been in regular handball training for at least 03 months. Exclusion criteria were athletes leaving the team for any musculoskeletal injury attested by means of a medical report. All ethical criteria were established, in accordance with Resolution 466 of the National Health Council, where the legal representatives of athletes signed the informed consent form (TCLE), and participants signed the consent term. The study was ap-

proved by the Institutional Ethics Research Committee (No. 1.473.781).

Initially, 40 athletes were included; however, after analyzing the exclusion criteria, 19 athletes were excluded, totaling 21 athletes. These athletes were randomly allocated into two groups: intervention group (GI), who practiced the FIFA11+ protocol and regular team training (N = 8), and control group (CG), who practiced only regular team training (N = 13). A similar study to identify the effects of an exercise protocol was carried out by Raeder, Fernandez-Fernandez and Ferrauti[10], in which 28 female handball players were divided into two groups, 15 were allocated to an experimental group, and 13 were controls.

Age and biological maturation were evaluated, and anthropometric data were measured (body mass and height). Athletes were evaluated before and after intervention, according to the protocol:

- Muscle strength of the knee joint: by means of isokinetic dynamometer (Biodex- System PRO 4). Before starting the test, athletes performed a five-minute warm-up on an exercise bike and three submaximal repetitions prior to familiarization with procedures[11]. Then, they performed five maximal repetitions of knee flexion and extension in the concentric-concentric mode at speed of 60°/s, in which they received verbal stimulation to develop maximum strength at each repetition[11]. It was chosen in the present study by the concentric form, because it is safer and of easier understanding for the athlete's execution[12].
- Postural balance: evaluated through computerized dynamic posturography (CDP), EquiTest® System, including the following tests:
  a) Sensory Organization Test (SOT): Provides information about the integration and proportion of the visual, proprioceptive and vestibular balance components [13]. It consists of six conditions, in which conditions 1, 3 and 6 evaluate the visual, proprioceptive and vestibular system, conditions 2 and 5 evaluate the proprioceptive and vestibular system and condition 4 evaluates the proprioceptive system. At the end of the test, the result is expressed for each condition assessed and by the Total Balance Index (Composite), evaluated as a weighted average of scores of the six SOT conditions. Sensory analysis of balance was also performed by means of the ratio between the means of one condition over the other: somatosensory system (SOT2 / SOT1), visual system (SOT4 / SOT1) and vestibular system (SOT5 / SOT1);
  b) Unilateral test: Evaluates the degree of instability of each lower limb (with and without visual restraint), and higher values indicate greater instabilities.

Regarding the intervention protocol (Box 1), CG and IG performed two weekly handball training sessions for 12 weeks with approximate duration of 1 hour and 30 minutes. In addition to conventional handball training during this period, IG performed the FIFA11+ program twice a

week with mean of 40 minutes each session, based on the study by Soligard et al.[8]. The main differences between training sessions are that the FIFA11+ program presents a greater focus on injury prevention, especially by approaching the central stabilizing musculature through boards, and by strengthening hamstring muscles, whereas conventional handball training addresses the specific fundamentals of the sport, such as passes and pitches in order to improve sporting performance. In addition, FIFA11+ prioritizes static balancing exercises, while handball emphasizes dynamic balance. As similarities between them, forward running and running with jumps are worked in both training types.

Box 1. Intervention Protocol

FIFA11+ Protocol	
Exercises	Repetitions/ time
I - Running exercises (opening with warm-up in pairs, where the course is composed of 6 pairs of parallel cones with 5 meters distance between them, totaling the distance of 50m in each exercise and repetition)	
Forward running exercise	2
Running exercise with knee out	2
Running exercise with knee in	2
Running exercise around the partner	2
Running exercise with jump and shoulder-to-shoulder contact	2
Running exercise with sprints back and forth	2
II - Strength, plyometry and balance exercises	
Board - both legs	3/ 20-30 sec
Side board - Static	3/20-30 sec
Hamstring strengthening exercise	5
Balance in one leg - holding a ball	2/30 sec
Balance in one leg - throwing the ball to the partner	2/30 sec
Balance in one leg - partner testing	2/30 sec
Squats - raising toes	2/ 30 sec
Squats - front lunge	2 x 10 (each limb)
Conventional Handball Protocol	
Warm-up - normal ball pass work	10 min
Warm-up - short pass work	10 min
Driving practice with ball touching	10 min
Goal throwing exercises	10min
Collective training	50 min

For statistical analysis, the SPSS software, version 20.0 was used, with descriptive analysis by mean and standard deviation measures. After testing data normality using the Kolmogorov-Smirnov test, a parametric distribution was indicated. Thus, the differences between tests (pre- and post-tests) were evaluated by paired student's t test. For the comparison between groups (IG and CG), the Student's t-test for independent samples was used. Significance level of 0.05 was considered for all analyses.

RESULTS

The sample consisted of post-pubertal girls, in which IG included 8 athletes aged 12.88 ± 0.83 years (weight of 53.07 ± 5.68kg and height of 1.57 ± 0.04m) and CG included 13 athletes aged 13.23 ± 0.92 years (weight of 47.26 ± 6.39Kg and height of 1.54 ± 0.07m).

The analysis of the postural balance of athletes (Table 1), identified that, in the intragroup comparison of SOT, there was a significant increase in condition 5 and a borderline significance in the composite value (p = 0.05) in IG post-intervention. Regarding neural systems, the intragroup analysis identified that IG obtained an improvement in the post-interventional vestibular system. In the other variables, there were no differences.

Table 1. Intra and intergroup comparisons of postural balance of pre- and post-intervention athletes

Variable	IG PRE	IG POST	p'	CG PRE	CG POST	p'	p''	p'''
Sensory Organization test								
SOT 1	93.33±2.51	93.95±1.80	0.42	93.56 ±2.45	94.68±1.46	0.09	0.83	0.32
SOT 2	91.28±3.12	92.04±2.01	0.55	92.33±2.41	92.97±2.13	0.09	0.40	0.33
SOT 3	91.33±2.30	90.24±2.77	0.45	87.48±10.51	91.45±3.19	0.16	0.32	0.38
SOT 4	79.70±13.26	86.66±6.03	0.25	76.76±15.86	78.20±18.17	0.83	0.66	0.22
SOT 5	53.24±16.95	69.45±11.99	0.04*	58.43±13.37	60.35±18.34	0.74	0.44	0.22
SOT 6	50.58±17.78	68.12±14.74	0.07	52.43±17.88	62.76±19.66	0.08	0.82	0.51
Composite	72.12±8.64	80.75±6.54	0.05	72.30±8.53	76.07±11.39	0.30	0.96	0.30
Unilateral Test								
MIND open	0.81±0.33	0.70±0.17	0.23	0.78±0.28	0.67±0.19	0.06	0.80	0.73
MIND closed	1.75±0.60	1.63±0.49	0.45	1.65±0.77	1.59±0.62	0.79	0.75	0.90
MID open	0.78±0.24	0.69±0.08	0.34	0.78±0.27	0.76±0.15	0.76	0.99	0.27
MID closed	1.73±0.80	1.62±0.38	0.67	1.64±0.46	1.65±0.57	0.97	0.75	0.90
Sensory System								
Somatosensory System	0.97±0.03	0.97±0.01	0.93	0.98±0.03	0.97±0.02	0.51	0.55	0.64
Visual System	0.85±0.14	0.91±0.06	0.29	0.81±0.16	0.82±0.19	0.93	0.62	0.20
Vestibular System	0.56±0.17	0.73±0.12	0.04*	0.62±0.14	0.63±0.19	0.84	0.44	0.19

IG = Intervention Group; CG = Control Group; SOT = Sensory Organization Test; MIND = Non-dominant lower limb; MID = Dominant lower limb; p' = Intra-group comparison (pre- x post-test), p'' = pre-intervention intergroup comparison, p'''= post-intervention intergroup comparison, data expressed as mean and standard deviation SD ±, * indicates significant difference (p <0.05).

The isokinetic performance of the dominant limb of athletes is shown in Table 2. Regarding the intragroup analysis, IG obtained an improvement in the flexor/extensor ratio, while CG increased the total work and power of the knee flexors. In the intergroup comparison, there was a difference in the total work of knee extensors in the pre-intervention period, and in the torque peak in post-intervention flexion, indicating higher values in IG compared to CG.

Table 3 shows the isokinetic data on the non-dominant side. In the intragroup comparison, there was an increase in the power of knee extensors and flexors in IG, and an increase in torque peak, flexor power and flexor/extensor ratio in CG. In the pre-intervention intergroup comparison, there was difference in relation to the torque peak of extensors and flexors,

Table 2. Intra and intergroup comparisons of isokinetic variables of the dominant limb pre- and post-intervention

Variables	IG			CG				
	PRE	POST	p'	PRE	POST	p'	p''	p'''
TP extensors	119.35±22.21	117.61±12.70	0.73	101.24±20.77	106.03±23.95	0.18	0.07	0.22
TP flexors	56.22±8.14	70.70±15.45	0.06	48.80±11.85	54.35±17.75	0.11	0.13	0.04*
TW extensors	561.73±88.61	521.86±110.33	0.19	450.87±117.73	459.07±110.66	0.72	0.03*	0.22
TW flexors	295.17±65.10	308.58±40.18	0.62	227.80±81.71	264.78±89.18	0.02*	0.06	0.20
POT extensors	72.86±13.91	74.86±10.43	0.51	62.30±15.28	66.02±15.66	0.15	0.12	0.17
POT flexors	37.90±9.20	43.05±5.33	0.16	30.91±11.39	38.26±13.98	<0.01*	0.16	0.36
Flex/ext ratio	47.61±5.25	61.08±16.62	0.03*	48.13±5.83	50.63±8.35	0.26	0.84	0.06

TP = torque peak, TT = total work, POT = power, Flex / ext ratio = flexor / extensor ratio between flexors and extensors, p '= intragroup comparisons (pre x post-test), p''= pre-intervention intergroup comparison, p'''= post-intervention intergroup comparison, data expressed as mean and standard deviation SD ±, * indicates significant difference (p <0.05).

Table 3. Intra and intergroup comparisons of isokinetic variables of the pre- and post-intervention non-dominant side

Variables	IG			CG				
	PRE	POST	p'	PRE	POST	p'	p''	p'''
TP extensors	117.37±16.11	117.10±16.46	0.96	98.34±19.99	95.53±24.26	0.28	0.03*	0.04*
TP flexors	56.07±12.26	64.00±7.90	0.07	44.95±10.24	51.86±13.38	<0.01*	0.03*	0.03*
TW extensors	535.47±87.66	590.20±72.53	0.15	441.89±97.58	418.78±108.64	0.18	0.03*	<0.01*
TW flexors	281.46±77.33	334.66±34.76	0.09	227.42±67.85	246.70±65.42	0.10	0.10	<0.01*
POT extensors	68.26±11.86	78.51±12.10	<0.01*	60.39±11.96	59.39±15.56	0.60	0.15	<0.01*
POT flexors	35.40±9.81	44.16±5.21	0.03*	31.41±9.20	35.30±9.73	0.01*	0.35	0.02*
Flex/ext ratio	48.90±14.55	55.61±10.06	0.21	45.76±5.92	54.60±7.67	<0.01*	0.49	0.79

TP = torque peak, TT = total work, POT = power, Flex / ext ratio = flexor / extensor ratio between flexors and extensors, p '= intragroup comparisons (pre x post-test), p''= pre-intervention intergroup comparison, p'''= post-intervention intergroup comparison, data expressed as mean and standard deviation SD ±, * indicates significant difference (p <0.05).

and to the total work of extensors, indicating higher values for IG. In the post-intervention intergroup comparison, with the exception of the flexor / extensor ratio, all variables analyzed were different between groups, being higher in IG when compared to CG.

DISCUSSION

The present study showed positive effects of the FIFA 11+ program associated with conventional handball training on the postural balance of athletes. Young Canadian female athletes who performed FIFA 11+ during one season improved their functional balance[14]. A systematic review with meta-analysis[15] found significant improvements in dynamic balance in soccer athletes after FIFA11 + practice.

An important issue to consider is that the ability of organization and integration of the sensory information, including the visual, somatosensory, and vestibular systems, occurs gradually in the individual as maturation occurs[16]. Steindl et al.[17] describe that the maturation of proprioceptive function occurs around 3-4 years of age, whereas the visual and vestibular systems seem to reach the adult level at 15-16 years. However, there is little evidence to establish whether the regular practice of physical activity during the process of maturation and refinement of the neuro-musculoskeletal

structure has a greater effect on postural control[18].

Thus, this study identified contributions from the FIFA11+ program on the proprioceptive and vestibular systems in athletes who are still at the stage of neuronal maturation. It is suggested that the improvement of these sensory systems is linked to the characteristics of the FIFA11+ protocol, which include balancing exercises in unipodal support associated with destabilization activities, such as holding the ball forward and throwing the ball to the partner. In addition, squatting exercises such as lifting toes and front lunge reduce the support base, which increases the degree of difficulty of the athlete to remain stable.

Considering that proprioceptive function is of paramount importance for joint stability and is associated with the prevention of sports injuries[19], it is suggested that the improvement of this variable may secondarily contribute to the prevention of injuries in the athletes analyzed in the present study. There is evidence that exposure to multiple programs, including proprioceptive and muscle strength training, has been associated with injury prevention[20].

Thus, the effects of FIFA11+ on the reduction of injury rates have been elucidated in different sports modalities, such as soccer[21] and basketball[22]. Gomes Neto et al.[15], in their review study, identified that FIFA11+ resulted in a significant reduction in the risk of injury in soccer players.

Olsen et al.[23] reported positive effects of a handball injury prevention program with similar characteristics to FIFA 11+. Accordingly, Steib et al.[9] found that a neuromuscular training program, including balance, jumps and strength components, had beneficial effects on measures of dynamic balance in female handball athletes, indicating that this type of intervention can successfully modify one important risk factor for injury.

In the present study, the effects of FIFA11 + on the isokinetic muscle strength of athletes could not be highlighted, since gains of this variable were observed in both groups (IG and CG) after intervention. Similarly, Ghareeb et al.[24] compared the effects of two injury prevention programs (FIFA11 + and another warm-up program) on the isokinetic performance of the knee joint in soccer players, and identified improvements in muscle strength in both groups.

It is noteworthy that in this study, there was no muscular imbalance greater than 10% between the dominant and non-dominant limbs both in IG and CG, in both evaluated moments (pre- and post-test), indicating that the athletes in this study did not present this risk factor for injuries, since this indicative occurs when there are asymmetries higher than 10% between limbs[25]. However, athletes from both groups, both in the dominant and non-dominant limbs, presented flexors/extensors ratio below 50% before intervention, indicating muscle imbalance in the knee joint[26], a factor that predisposes athletes to injuries in this joint.

From this perspective, Holm and Vollestad[27] have identified that female athletes aged 8-12 years exhibit lower flexor / extensor ratio when compared to male athletes in the same age group, indicating weakness

in the posterior thigh muscles in girls compared to quadriceps. Due to the fact that many children begin their handball careers before the age of 10, the authors[27] reiterate that prevention programs, including hamstring strength training should be prescribed at an earlier age than recommended in previously published studies.

Although muscle strength gains occurred in both post-intervention groups, it should be emphasized that they were distinct, since in IG, there was an improvement in the flexor / extensor ratio in the dominant limb, while in CG, this improvement occurred on the non-dominant limb. This may be justified by the fact that IG performed the FIFA 11+ protocol, which recommends the athlete in a more symmetrical way, involving the central stabilizing muscles, as well as quadriceps and hamstring activation in both limbs; whereas CG performed only regular handball training, where the main motor gestures occur more predominantly on the non-dominant limb, such as vertical jump. In this respect, some authors[28] indicate that, for the performance of unipodal jumps, athletes have one leg in which they can jump higher than the other, and, in this way, there is a tendency of the body to use one limb preferentially, developing possible asymmetries between dominant and non-dominant limb.

As limitations of this work, we highlight: a) the lack of works reporting effects of injury prevention programs, such as FIFA11+ on variables postural balance and isokinetic dynamometry in young female handball players; b) the solely concentric evaluation of muscular performance. Further studies should be carried out to evaluate the profile of athletes in relation to the eccentric muscular performance, considering that this evaluation would also aid in prevention programs of sports injuries[29].

CONCLUSION

The practice of FIFA11+ associated with conventional handball training has made important contributions to the postural balance of young handball players.

REFERENCES

1. Wagner H, Finkenzeller T, Würth S, VonDuvillard SP. Individual and Team Performance in Team-Handball: A Review. J Sports Sci Med 2014; 13(4): 808–16.
2. Krüger K, Pilat C, Uckert K, Frech T, Mooren FC. Physical performance profile of handball players is related to playing position and playing class. J Strength Cond Res 2014;28(1):117–25.
3. 3.Bencke J, Zebis MK. The influence of gender on neuromuscular pre-activity during side-cutting. J Electromyogr Kinesiol 2011;21(2):371-5.
4. Giroto N, Hespanho Junior LC, Gomes MR, Lopes AD. Incidence and risk factors of injuries in Brazilian elite handball players: A prospective cohort study. Scand J Med Sci Sports 2017; 27(2):195-202.
5. Xaverova Z, Dirnberger J, Lehnert M, Belka J, Wagner H, Orechovska K. Isokinetic Strength Profile of Elite Female Handball Players. J Hum Kinet 2015; 30(49):257-66.
6. Emery CA, Roy TO, Whittaker JL, Nettel-Aguirre A, Mechelen WV. Neuro-

muscular training injury prevention strategies in youth sport: a systematic review and meta-analysis. Br J Sports Med 2015; 49(13):865-70.
7. Ristolainen L, Kettunen JA, Kujala UM, Heinonen A. Sport injuries as the main cause of sport career termination among Finnish top-level athletes. Eur J Sport Sci 2012;12(3):274-82.
8. Soligard T, Myklebust G, Steffen K, Holme I, Silvers H, Bizzini, M. et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. BMJ 2008; 337(92):1-9.
9. Steib S, Zahn P, Eulenburg CZ, Pfeifer K, Zech A.Time-dependent postural control adaptations following a neuromuscular warm-up in female handball players: a randomized controlled trial. BMC Sports Sci Med Rehabil 2016; 8(33):1-7.
10. Raeder C, Fernandez-Fernandez J, Ferrauti A. Effects of Six Weeks of Medicine Ball Training on Throwing Velocity, Throwing Precision, and Isokinetic Strength of Shoulder Rotators in Female Handball Players. J Strength Cond Res 2015;29(7):1904-14.
11. Bittencourt NFN, Amaral GM, Anjos MTS, D'Alessandro R, Silva AA, Fonseca ST. Avaliação muscular isocinética da articulação do joelho em atletas das seleções brasileiras infanto e juvenil de voleibol masculino. Rev Bras Med Esporte 2005; 11(6):331-6.
12. Terreri ASAP, Greve JMD, Amatuzzi MM. Avaliação isocinética no joelho do atleta. Rev Bras Med Esporte 2001;7(2):62-6.
13. Hu M, Chen T, Dong H, Wang W, Xu K, Lin P. Clinical values of the sensory organization test in vestibular diseases. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi 2015 ;50(9):712-7.
14. Steffen K, Emery CA, Romiti M, Kang J, Bizzini M, Dvorak J, 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.
15. Gomes Neto M, Conceição CS, de Lima Brasileiro AJ, de Sousa CS, Carvalho VO, de Jesus FL. Effects of the FIFA 11 training program on injury prevention and performance in football players: A systematic review and meta-analysis. Clin Rehabil 2017; 31(5):651-9.
16. Moraes AG, David AC, Castro OG, Marques BL, Carolino MS, Maia E. Comparação do equilíbrio postural unipodalentre crianças e adultos. Rev Bras Educ Fís Esporte 2014;28(4):571-7.
17. Steindl R, Kunz K, Schrott-Fischer A, Scholtz AW. Effect of age and sex on maturation of sensory systems and balance control. Dev Med Child Neurol 2006; 48(6):77-82.
18. Oliveira TP, Santos AMC, Andrade MC, Avila AOV. Avaliação do controle postural de crianças praticantes e não praticantes de atividade física regular. Rev Bras Biom 2008;9(16):41-6.
19. Ozenci AM, Inanmaz E, Ozcanli H, Soyuncu Y, Samanci N, Dagseven T, et al. Proprioceptive comparison of allograft and autograft anterior cruciate ligament reconstructions. Knee Surg Sports Traumatol Arthrosc 2007; 15(12):1432-7.
20. Lauersen JB, Bertelsen DM, Anderson LB. The effectiveness of exercise interventions to prevent sports injuries: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 2014; 48(11):871-7.
21. Owoeye OB, Akinbo SR, Tella BA, Olawale OA. Efficacy of the FIFA 11+ Warm-Up Programme in Male Youth Football: A Cluster Randomised Controlled Trial. J Sports Med Sci 2014;13(2):321-8.
22. 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 May 2012; 40(5):996-1005.
23. 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.
24. Ghareeb DM, McLaine AJ, Wojcik JR, Boyd JM. Effects Of Two Warm-Up

Programs On Balance And Isokinetic Strength In Male High School Soccer Players. J Strength Cond Res 2017; 31(2):372-9.
25. Ferreira AP, Gomes SA, Ferreira CES, Arruda MD, França NMD. Avaliação do desempenho isocinético da musculatura extensora e flexora do joelho de atletas de futsal em membro dominante e não dominante. Rev Bras Cienc Esporte 2010; 32(1): 229-43.
26. Brown LE, Weir JP. Recomendação de procedimentos da Sociedade Americana de Fisiologia do Exercício (ASEP) I: avaliação precisa da força e potência muscular. Rev Bras Cienc Mov 2003;11(4):95-110.
27. Holm I, Vollestad N. Significant effect of gender on hamstring-to-quadriceps strength ratio and static balance in prepubescent children from 7 to 12 years of age. Am J Sports Med 2008;36(10):2007-13.
28. Stephens TM, Lawson BR, Reiser RF. Bilateral asymmetries in max effort single-leg vertical jumps. Biomed Sci Instrum 2005;41(1):317-22.
29. Fonseca ST da, Ocarino JM, Silva PLP da, Bricio RS, Costa CA, Wanner LL. Caracterização da performance muscular em atletas profissionais de futebol. Rev Bras Med Esporte 2007;13(3):143-47.

CORRESPONDING AUTHOR

Simone Lara
Universidade Federal do Pampa
Campus Uruguaiana/RS, BR 472, KM 592, 97508-000, Brasil
E-mail: simonelara@unipampa.edu.br