

## **Implicações de um programa de prevenção de lesões na performance de jovens jogadores de futsal**

Dissertação apresentada com vista à obtenção do 2º ciclo em  
Desenvolvimento Motor da Faculdade de Desporto da  
Universidade do Porto (Decreto de lei nº.74/2006 de 24 de  
Março)

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Porto, Outubro, 2011

## FICHA DE CATALOGAÇÃO

Reis, I. (2011). Implicações de um programa de prevenção de lesões na performance de jovens jogadores de futsal. Dissertação apresentada para a obtenção do grau de Mestre em Desenvolvimento Motor, apresentado à Faculdade de Desporto da Universidade do Porto

**PALAVRAS-CHAVE:** FUTSAL, JOVENS, PREVENÇÃO DE LESÕES, PERFORMANCE DESPORTIVA.

À Lígia, meus Pais e Avós



## **AGRADECIMENTOS**

A elaboração deste trabalho foi possível com a colaboração de várias pessoas, às quais tenho de agradecer:

Ao Professor Doutor António Natal pela simplicidade, facilidade e frontalidade de relacionamento revelado durante todo este processo nem sempre fácil.

Ao impulsionador e dinamizador do meu estudo, o João, obrigado por todo o acompanhamento e disponibilidade.

Aos jogadores por todo o empenho e seriedade com que abraçaram este desafio.

À minha mais que tudo...sabes bem quem és...



## Resumo

O objectivo do presente estudo foi determinar se o programa de prevenção de lesões da FIFA "The 11+" influencia a performance física e técnica de jovens jogadores de futsal. Jogadores com  $17.3 \pm 0.7$  anos foram seleccionados para um grupo de intervenção (GI, n = 18) e um grupo de controlo (GCCG, n = 18). O realizou o programa de intervenção 2 vezes por semana durante 12 semanas. Para determinar a força máxima dos músculos flexores e extensores do joelho, foi realizada a avaliação isocinética da força no modo concêntrico a  $60^{\circ}\cdot s^{-1}$  e  $240^{\circ}\cdot s^{-1}$  e no modo excêntrico a  $30^{\circ}\cdot s^{-1}$ . Foi também avaliada a velocidade aos 5 e 30 metros, a agilidade, a impulsão vertical, o equilíbrio unipodal e a técnica individual. O GI, comparativamente ao grupo de controlo, mostrou um aumento significativo ( $p < 0.05$ ) do pico de torque dos isquiotibiais para a velocidade excêntrica de  $30^{\circ}\cdot s^{-1}$  (12.7% no membro dominante e 9.3% no membro não dominante), do rácio convencional antagonista/agonista para velocidade concêntrica de  $60^{\circ}\cdot s^{-1}$  (8.3% no membro dominante) e do rácio de controlo dinâmico (8.5% no membro dominante e 1.8% no membro não dominante). O GI melhorou também de forma significativa ( $p < 0.05$ ) a velocidade, agilidade, impulsão vertical e técnica individual, tendo igualmente apresentado uma diminuição (29.7%;  $p < 0.05$ ) do número de quedas no teste do equilíbrio do membro não dominante. Deste modo a introdução do programa de prevenção "The 11+" no treino parece ser uma estratégia adequada para a reduzir o risco de lesões, desenvolver a aptidão física e melhorar a técnica individual do jovem jogador de futsal.

**Palavras chave:** futsal, jovens, prevenção de lesões, performance



## Abstract

The purpose of this study was to evaluate if "The 11+", improves physical fitness and technical performance in youth futsal players. Players aged  $17.3 \pm 0.7$  years were randomized to an intervention group (IG,  $n = 18$ ) and a control group (CG,  $n = 18$ ). IG performed the intervention programme 2 times per week for 12 weeks. Bilateral isokinetic testing was performed to assess maximal hamstring and quadriceps strength at concentric  $60$  and  $240^\circ \cdot s^{-1}$  and eccentric  $30^\circ \cdot s^{-1}$ . Five and 30-m sprint, agility, muscle power, unilateral balance and technical skill were also tested. Peak torque of IG of dominant limb increased ( $p < 0.05$ ) by 14.7% for the knee extensor and by 13.3% for the knee flexor muscles, at concentric  $60^\circ \cdot s^{-1}$ . Peak torque of the knee flexor muscles of IG increased by 12.7% at eccentric  $30^\circ \cdot s^{-1}$ , whereas CG showed a decrease of 4.1%. IG increased ( $p < 0.05$ ) peak torque of the knee extensor and flexor muscles on non-dominant limb by 27.3% in concentric mode at  $60^\circ \cdot s^{-1}$ , and by 9.3% in eccentric mode at  $30^\circ \cdot s^{-1}$ . IG improved ( $p < 0.05$ ) by 8.3% conventional antagonist/agonist ratio of dominant limb at  $60^\circ \cdot s^{-1}$  and the dynamic control ratio by 8.5% in the dominant limb and by 1.8% in non-dominant limb ( $p < 0.05$ ). Improvements ( $p < 0.05$ ) in sprint, agility, vertical jump and technical skill performance were observed in IG but not in CG. IG decreased by 29.7% ( $p < 0.05$ ) the number of falls in the unilateral balance test for the non-dominant limb. Therefore, "The 11+" seems to be an adequate strategy to prevent injuries, and improve physical fitness and technical performance of youth futsal players.

**Keywords:** futsal, youth, injury prevention, performance



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## **INTRODUÇÃO GERAL**



O futsal surgiu em 1930 na América do Sul com o objetivo de permitir jogar futebol em recintos fechados (Barbero-Alvarez et al., 2007), sendo que o primeiro Campeonato do Mundo foi disputado em 1982, no Brasil. Desde 1989, todas as competições de futsal são reconhecidas pela Fédération Internationale de Football Association (FIFA), passando esta entidade a ser responsável pela organização do Campeonato do Mundo, que se realiza de 4 em 4 anos. Do mesmo modo, a Union of European Football Associations (UEFA), a partir de 1995/1996 assume a organização do Campeonato da Europa da modalidade. Desde então, a popularidade do futsal tem aumentado de forma exponencial. Atualmente, mais de 12 milhões de pessoas em 100 países praticam futsal, em campeonatos profissionais e amadores, homens e mulheres, rapazes e raparigas. Em Portugal, a modalidade tem assumido cada vez mais importância, revelada pelo aumento do número de praticantes e pelo destaque dado pelos meios de comunicação social, com transmissões televisivas em direto.

O futsal é um jogo disputado entre duas equipas com 5 jogadores, 1 guarda-redes e 4 jogadores de campo. Cada equipa pode ter 7 substitutos, 6 jogadores de campo e 1 guarda-redes, sem qualquer limite no número de substituições a realizar durante um jogo oficial. O campo de jogo pode variar entre os 38 m e 42 m no seu comprimento, enquanto a largura entre os 18 m e os 25 m, com balizas de 2 m de altura e 3 m de largura. O jogo é disputado em 40 minutos com duas partes de 20 minutos cada, o cronómetro pára cada vez que a bola sai do terreno de jogo, quando é assinalada falta, prestada assistência médica, é realizada limpeza do campo, etc. Ou seja a contagem de tempo é interrompida sempre que o jogo é interrompido. Isto significa que cada partida tem uma duração total que excede em 75% a 85% os 40 minutos inicialmente atribuídos ao jogo (Barbero-Alvarez et al., 2007). Cada equipa tem direito a um desconto de tempo por parte, tendo o intervalo a duração de 10 minutos. O futsal é um jogo desportivo coletivo caracterizado como intermitente e de alta intensidade, com uma alta exigência física, técnica e tática (Barbero-Alvarez et al., 2007; Goriostiaga et al., 2009, Dogramaci et al., 2010). Sendo as dimensões do campo reduzidas, os jogadores durante o jogo atingem picos de

atividade muito intensa, com intervalos de recuperação muito reduzidos que não são suficientes para uma recuperação total (Tessitore et al., 2008). Devido ao número ilimitado de substituições, a intensidade e o ritmo de jogo são muito elevados, mantendo-se ao longo do jogo (Barbero-Alvarez et al., 2007). Os jogadores realizam constantes mudanças de direção, a cada 3.28 s, sendo que 26% da distância percorrida no jogo é efetuada a alta intensidade (Castagna et al. 2009). A literatura refere também um aumento das exigências do jogo na última década, fundamentada com a evolução tática ofensiva e defensiva (Barbero-Alvarez et al., 2007).

Com o incremento do número de participantes na modalidade e o conseqüente aumento progressivo da exigência do jogo, torna-se importante perceber quais são as lesões mais frequentes e de que forma surgem. A literatura pesquisada referente à incidência e caracterização das lesões em futsal é escassa. Bolling et al. (2011) acompanharam jogadores de futsal brasileiros de sete escalões etários (desde os 12 anos até jogadores adultos) e observaram que os jogadores sofreram, em média 2.1 lesões durante uma época desportiva. A maioria das lesões surgiu por mecanismos de não contacto durante o treino, sendo que o risco de lesão pareceu aumentar com a idade. Cain et al. (2007) acompanharam 76 jovens australianos jogadores de futsal (12–17 anos) durante uma época competitiva, tendo observado que 32% dos jogadores sofreram pelo menos uma lesão do tornozelo ou pé durante a época. De igual modo, o mesmo estudo aponta para um risco acrescido de lesões de sobreuso.

Dada a escassez de estudos sobre lesões no futsal, e apesar da popularidade da modalidade, a FIFA, através do FIFA – Medical Assessment and Research Center (F-MARC) começou a mostrar interesse no estudo das lesões em futsal. Assim, recentemente, Junge e Dvorak (2010) realizaram um estudo sobre a ocorrência e características das lesões ocorridas durante três campeonatos do mundo de futsal. Verificaram que as lesões mais frequentes ocorreram no joelho (15.8%), na coxa (13.9%) e no tornozelo (12.1%). Estes autores revelaram ainda que 37% das lesões registadas ocorreram sem contacto com outro jogador, justificando este facto através das características do

jogo, i.e. múltiplos sprints com frequentes mudanças de direção. No entanto, o próprio F-MARC aponta que, dada a escassez de informação epidemiológica no futsal, são necessários mais estudos que permitam desenvolver programas de prevenção de lesões específicos para a modalidade.

Na verdade, na literatura por nós consultada, não existe nenhum estudo que tenha aplicado um programa de prevenção de lesões em futsal. Contudo, vários estudos têm sido efetuados sobre a aplicação e eficácia de programas de intervenção noutros jogos desportivos coletivos, como por exemplo no futebol, andebol, voleibol e basquetebol. De modo geral, os estudos revelam que o treino neuromuscular, o treino proprioceptivo e o treino da técnica podem ajudar a reduzir a incidência de lesões nos jogos desportivos coletivos.

Hewett et al. (1999) aplicaram um programa de treino neuromuscular durante 6 semanas, com a duração de 60 a 90 minutos, três vezes por semana, a jovens atletas de futebol, voleibol e basquetebol. O programa consistia em três partes: treino de saltos, com três níveis de dificuldade progressiva, acompanhados de alongamentos e treino com pesos livres. Os autores concluíram que o programa de treino reduziu a incidência de lesões graves no joelho, devido essencialmente às melhorias na técnica de salto e dos índices de força.

No andebol, Olsen et al. (2005) utilizaram um programa de prevenção em equipas masculinas e femininas, que consistia em exercícios técnicos, exercícios de equilíbrio e exercícios de força. Este estudo revelou que o programa reduziu a taxa de incidência lesional, especialmente de lesões graves do joelho e tornozelo.

O treino do equilíbrio ou proprioceptivo no futebol pode reduzir o número de lesões do ligamento cruzado anterior, como verificaram Caraffa et al. (1996) e Mandelbaum et al. (2005). Num estudo desenvolvido por Kraemer e Knobloch (2009), relativamente aos efeitos de um programa de treino de equilíbrio em jogadoras de futebol na prevenção de lesões dos músculos da coxa e joelho, conclui-se que o programa foi eficaz para a redução das lesões por não contacto dos músculos flexores da coxa e ligamentos do joelho. A inclusão de estratégias de prevenção de lesões no treino desde os escalões mais jovens,

como por exemplo exercícios de propriocepção e coordenação, assume um papel importante na redução não só de lesões no tornozelo mas também outras lesões (Ergen & Ulkar, 2008).

Vários estudos têm tentado também perceber qual a influência da aplicação de programas de intervenção na prevenção de lesões nos músculos isquiotibiais de jogadores e jogadoras de futebol. Num estudo realizado com jogadores de elite de futebol, divididos em dois grupos (grupo experimental e de controlo), os jogadores pertencentes ao primeiro grupo foram sujeitos a uma rotina de treino de força excêntrica específico antes do início da época desportiva (Askling, et al., 2003). Este grupo, registou menos lesões nos músculos flexores da coxa e ainda revelou maiores incrementos dos níveis de força e de velocidade quando comparado com o grupo de controlo. Arnason et al. (2008) usaram também um programa de intervenção composto por três partes, alongamentos, treino de flexibilidade e treino de força excêntrica, em jogadores de futebol. Estes autores, revelaram que o treino de força excêntrica, através do exercício normalmente denominado por isquiotibiais nórdicos, foi eficaz na prevenção de lesões dos músculos flexores da coxa. Num estudo comparativo entre o treino excêntrico e treino concêntrico de força nos músculos flexores da coxa, Mjølshes et al. (2004) demonstraram que o treino excêntrico é mais eficaz para o incremento dos índices de força e para o rácio entre isquiotibiais/quadríceps. Parece também ser importante para a diminuição do risco de lesão um bom equilíbrio entre agonista e antagonista (Croisier, et al., 2008). Desta forma, torna-se pertinente a inclusão no treino de exercícios promotores de equilíbrio muscular. Este tipo de intervenção não só beneficia os jogadores ao nível da prevenção, mas também na recuperação da recuperação de lesões (Lehance, et al., 2009).

Ao longo dos últimos anos, o F-MARC tem procurado desenvolver programas de prevenção de lesões, nomeadamente o "The 11" e "The 11+".

Inicialmente, o "The 11" consistia numa rotina de 15 minutos onde eram incluídos 10 exercícios que incidiam na estabilidade do *core*, controlo neuromuscular, força excêntrica dos músculos flexores do joelho e agilidade. Steffen et al. (2007b) e Kilding et al. (2008) apontaram algumas limitações no

uso deste programa de treino, nomeadamente a falta de incremento de carga progressiva nos exercícios e a pouca motivação verificada nos atletas durante a realização do programa. Além disso, alguns autores concluíram que a implementação de um programa de prevenção ("The 11") não reduziu a ocorrência de lesões, nem aumentam a performance desportiva de jovens jogadoras de futebol (Steffen et al., 2008a; Steffen et al., 2008b). No entanto, os mesmos autores referiram a pouca adesão das atletas ao programa como principal fator para não encontrar resultados significativos, sugerindo uma revisão do programa de prevenção. Outros autores apontaram também a baixa adesão a programas de prevenção como justificação para o insucesso da intervenção (Engebretsen et al., 2008). Contrariamente, Junge et al. (2002) verificou que a aplicação do programa de prevenção "The 11" em equipas de futebol amadoras reduz a incidência de lesões nos jogos em 12% e nos treinos em 25%, sobretudo em lesões por não contato. Kilding et al. (2008) encontraram um incremento na capacidade impulsão vertical e na velocidade de corrida em jovens jogadores de futebol, salientando, no entanto, a necessidade da alteração do programa.

Tendo em conta estas conclusões, o F-MARC reformulou o programa "The 11", surgindo assim o programa de prevenção "The 11+". Este programa é dividido em 3 partes: 1ª parte – exercícios de corrida lenta combinados com alongamentos ativos e contatos controlados com outro jogador; 2ª parte – seis conjuntos de exercícios que contemplam o trabalho da força, pliometria e equilíbrio, sendo que cada exercício possui três níveis de incremento de dificuldade; 3ª parte – exercícios de velocidade com súbitas mudanças de direção. Deste modo, a maior diferença entre o "The 11" e o "The 11+" surge precisamente na 2ª parte, uma vez que o segundo programa inclui exercícios com aumento progressivo de dificuldade.

Na verdade, a aplicação do programa de prevenção de lesões revisto ("The 11+") reduziu o risco de lesão em 33% em jovens jogadoras de futebol (Soligard et al., 2008). Além disso, Brito et al. (2010) verificaram que o "The 11+" promove aumentos na força dos membros inferiores, nomeadamente na força excêntrica dos músculos flexores do joelho, o que sugere que o programa

de intervenção "The 11+" é adequado e eficaz para o condicionamento e treino de futebol.

Em Portugal, a maioria das equipas de formação em futsal treina, por norma, 2 a 3 vezes por semana. Deste modo, a impossibilidade dos jovens atletas participarem em sessões de treino ou jogos por lesão poderá afetar o desenvolvimento do jogador numa fase fundamental para aquisição de competências base e vivências desportivas. Dada a escassez de informação sobre prevenção de lesões em futsal, parece-nos importante que sejam realizados estudos sobre a eficácia de programas de treino no desenvolvimento e melhoria da performance de jovens jogadores de futsal.

Diferentes estudos assinalaram que o comprometimento com programas de prevenção de lesões aumenta se os atletas perceberem os exercícios como tendo influência na melhoria da performance desportiva (Steffen et al., 2007b; Soligard et al., 2008). Soligard (2010) considera ser importante implementar o treino de prevenção de lesões desde o início da participação das crianças em desporto organizado, de forma a tornar uma parte integral das rotinas de treino. É necessário também que os treinadores de formação e de elite percebam os benefícios da prevenção de lesões. Uma vez que a FIFA tem difundido e fomentado a aplicação do programa de treino "The 11+", pensamos então ser importante perceber se o referido programa de prevenção de lesões poderá afetar a performance física de atletas em fase de formação no futsal.

**ARTIGO EXPERIMENTAL**



**Performance aspects of an injury prevention training programme in youth male futsal players**

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## **Abstract**

The purpose of this study was to evaluate if FIFA's Medical Assessment and Research Centre (F-MARC) injury prevention programme, "The 11+", improves physical fitness and technical performance in youth futsal players. Players aged  $17.3 \pm 0.7$  years were randomized individually to an intervention group (IG,  $n = 18$ ) and a control group (CG,  $n = 18$ ). IG performed the intervention programme 2 times per week for 12 weeks. Bilateral isokinetic testing was performed to assess maximal hamstring and quadriceps strength at concentric  $60$  and  $240^{\circ}\cdot\text{s}^{-1}$  and eccentric  $30^{\circ}\cdot\text{s}^{-1}$ . 5- and 30-m sprint, agility, technical skill, vertical jumps (squat jump, SJ; and countermovement jump, CMJ), unilateral balance performances were also tested. For the dominant limb, peak torque increased ( $p < 0.05$ ) by 14.7% for the knee extensor and by 13.3% for the knee flexor muscles, at concentric  $60^{\circ}\cdot\text{s}^{-1}$  for IG when in comparison with CG values that decreased. Peak torque of the knee flexor muscles of IG increased by 12.7% at eccentric  $30^{\circ}\cdot\text{s}^{-1}$ , whereas CG showed a decrease of 4.1%. In the non-dominant limb, IG increased ( $p < 0.05$ ) peak torque on the knee extensor and flexor muscles by 27.3% at concentric  $60^{\circ}\cdot\text{s}^{-1}$ , and by 9.3% at eccentric  $30^{\circ}\cdot\text{s}^{-1}$  respectively. No significant differences were observed for CG. The conventional antagonist/agonist ratio at concentric  $60^{\circ}\cdot\text{s}^{-1}$  for dominant limb improved ( $p < 0.05$ ) by 8.3% for IG but decreased in CG. IG improved dynamic control ratio by 8.5% for the dominant limb and by 1.8% for non-dominant limb ( $p < 0.05$ ). In both limbs, dynamic control ratio values decreased for CG. Significant improvements in sprint, agility and technical skill performances performance tests were observed for IG in comparison with CG ( $p < 0.05$ ). IG improved by 13.8% in SJ and by 9.9% in CMJ, whereas no differences were observed for CG. Unilateral balance changed only for the non-dominant limb ( $p < 0.05$ ), with IG decreasing the number of falls by 29.7% but no changes in CG. Therefore, "The 11+" training programme seems to be adequate and effective for futsal training and conditioning by improving physical fitness and technical performance.

**Keywords:** Futsal, Youth, Injury prevention, Performance

## **Introduction**

The FIFA's Medical Assessment and Research Centre (F-MARC) developed "The 11+", an injury prevention programme to be implemented in football. This programme is a 20-min routine consisting in running exercises, strength, plyometry and balance, with key exercises that provides variation and progression. Soligard et al. (2008) concluded that "The 11+" could in fact reduce by one third the risk of injury and by a half the risk of severe injuries in youth female football players. Junge et al. (2002) also showed that amateur football teams performing a previous version of "The 11+" (e.g. "The 11") reduced the incidence of match injuries by 12%, training injuries by 25% comparing with other teams that did not perform the injury prevention programme, with greater preventive effects in non contact injuries.

Injury prevention programmes that combine plyometric training, core strengthening, balance, resistance, or speed and agility training may have beneficial football-specific performance effects; alongside several parameters of lower extremity injury risk might be diminished (Askling et al., 2003; Ergen & Ulkar, 2008; Kilding et al., 2008; Brito et al., 2010). In fact, youth male football players improved lower limb power and speed by performing the previous "The 11" injury prevention programme (Kilding et al., 2008), whereas no changes were observed in isokinetic and isometric strength of the quadriceps and hamstrings, isometric hip adduction and abduction strength, vertical jump tests, sprint running and football skill tests after a 10-week training period with "The 11" in adolescent female players (Steffen et al., 2007b). Recently, Brito et al. (2010) showed that football players improved muscle strength balance around the knee joint by performing "The 11+" twice a week.

Futsal, officially recognized by FIFA as five-a-side indoor football, is a physically demanding intermittent high-intensity strenuous team sport (Dogramaci et al., 2010), with important emphasis on strength, running speed and endurance (Barbero-Alvarez, et al. 2007). Unluckily, the game is related with high risk of injuries (Junge, et al. 2010), and therefore an effective injury prevention programme is needed. Despite the similitudes between futsal and football, no study so far investigated the performance-related effects of an injury

prevention-training programme in futsal players. In fact, modifications to the established programmes (e.g. “The 11+”) might be required for enhancing futsal-specific physical performance adaptations, and therefore improving the potential injury prevention benefits of “The 11+” among futsal players. Hence, the aim of this study was to determine the effect of “The 11+” on performance after a 12-week training period in youth futsal players.

## **Material and methods**

### **Study population**

The study was conducted in the mid-season season. Adolescent male futsal players from two youth teams were invited to participate in the study. Before the start of the investigation, the players available received oral and written information about the study, and it was emphasized that participation in the “11+” programme was voluntary. Written consent was obtained. The players were screened for injuries using a self-constructed questionnaire, and they had to be uninjured to be included in the study. This resulted in a total of 36 players (mean  $\pm$  SD: age  $17.3 \pm 0.7$  years; height  $175.2 \pm 5.5$  cm; weight  $65.1 \pm 7.2$  kg), who were randomized individually to an intervention group (IG,  $n = 18$ ) and a control group (CG,  $n = 18$ ). The participants were competitive players with  $5.8 \pm 0.2$  hours of futsal activities per week and had been involved in organized futsal for  $5.2 \pm 3.1$  years. The project was approved by the research committee of the Faculty of Sport of the University of Porto and by club officials, and followed the Declaration of Helsinki.

### **The intervention programme**

The injury prevention programme “11+” developed by F-MARC was designed as a warm-up programme. It consisted of three parts. The initial part was running exercises at slow speed combined with active stretching and controlled contacts with a partner. The running course included six pairs of cones about four meters width and twenty meters length. The second part consisted of six different sets of exercises; these included strength, balance,

and jumping exercises, each with three levels of increasing difficulty. The final part was speed running combined with futsal specific movements with sudden changes in direction. The intervention programme was carried out two times per week during futsal training at the club. Participants completed the intervention program  $1.8 \pm 0.1$  times per week. The players from CG warmed-up as usual, with simple workout based on jogging and ball exercises.

### Anthropometry

Anthropometric measurements included body mass and height. Height was measured with a fixed stadiometer (Holtain Ltd., USA) to the nearest 0.1 cm. Body mass and the percentage of fat were assessed to the nearest 0.1 kg using a body fat monitor (Tanita<sup>®</sup>, BC-418MA, USA). Measurements were performed following the standardized techniques adopted by the International Working Group on Kinanthropometry (Ross & Marfell-Jones, 1983). Somatotype was estimated using the Heath-Carter anthropometric protocol (Carter & Heath, 1990). Each measurement was obtained twice.

### Physical fitness and technical performance

Each player was tested three times within a 1-week period. Technical skills, speed and agility tests were evaluated during the first visit. Anthropometric measurements, isokinetic muscle strength, jump tests, and unilateral balance were assessed during the second visit. With the exception of strength tests and jump tests, all the other tests were administered on an indoor futsal court. Players wore futsal clothing and shoes.

Bilateral isokinetic testing was performed to assess maximal hamstring and quadriceps muscle performance using an isokinetic dynamometer (Biodex System 2, NY, USA). The dominant leg was determined by a visual routine inspection in a simple target-kicking test requiring accuracy, after individual self-report. All measurements were preceded by a standardized warm-up consisting of 5-min period on a cycle ergometer (Monark E-824, USA) with a fixed load corresponding to 2% of body weight or intensity of 70–100 W. The players were seated on the dynamometer; straps were used around the thigh, waist and

chest in order to avoid compensatory movement. The distal point of the lateral femoral condyle was aligned with the axis of rotation of the dynamometer, being the angular movement of the knee  $90^\circ$  ( $0^\circ$  = fully extended knee). The hip angle was  $90^\circ$  and arms were held around the chest. To avoid influencing the strength generated by the tested limb, the contralateral leg was not strapped. Gravitational factor of the dynamometer's lever arm and lower segment ensemble was calculated and automatically compensated by the dynamometer during the measurements. The subjects did not received visual feedbacks, but verbal encouragement was given. All players performed a specific sub-maximal warm-up protocol on the Biodex device in order to familiarize with the isokinetic device and test procedure. Preliminary repetitions routinely preceded each test speed. The protocol included concentric exertions at angular speeds  $60^\circ \cdot s^{-1}$  (3 repetitions) and  $240^\circ \cdot s^{-1}$  (5 repetitions), both for extension and flexor muscles, and eccentric exertions at angular speed  $30^\circ \cdot s^{-1}$  (3 repetitions) of flexor muscles. The highest peak torque found during all repetitions was chosen for the calculation of the reciprocal and bilateral leg strength differences. The conventional concentric hamstring/quadriceps (H/Q) ratio was calculated. The dynamic control ratio (DCR) was defined as hamstrings eccentric  $30^\circ \cdot s^{-1}$ /quadriceps concentric  $240^\circ \cdot s^{-1}$ . The  $30^\circ \cdot s^{-1}$  velocity was selected because low speed is frequently recommended to optimize familiarization conditions with eccentric exercise (Croisier, et al., 2008).

Photoelectric cells (Speed Trap II – Brower Timing Systems, USA) were used for measuring 5- and 30-m sprint, agility and technical skill performance. For sprint tests, three pairs of photoelectric cells were at the starting point, and at 5 and 30 m, to obtain times. Players were instructed to run as quickly as possible from a standing start 0.3 m behind the starting line, to eliminate reaction time. The players started when ready. The lowest value obtained from 2 trials was used.

The T-test (Semenick, 1990) was used to evaluate agility. From standing position, with both feet 0.3 m behind the starting line (A), players were instructed, when ready, to sprint 10 m forward to point B and touch a cone with right hand. Then, sprint 5 m left and touch another cone (C) with left hand,

sprint to the opposite side 10 m and touch a third cone (D) with right hand. Sprint back to point B and touch the cone with left hand, turn 90° and return to point A, finishing the test. The photoelectric cells were placed in starting point (A) and the running time was measured. Players were instructed to run as quickly as possible. The lowest value obtained in two trials was used as the agility score.

To assess technical skill, a slalom test was used based on a straight dribbling test used by Steffen et al. (2007b). Five cones were placed in a straight line distancing from the start line (perpendicular to the line) 2.80, 4.80, 6, 8 and 10 m. After warming up with ball-based exercises, players were instructed to start from an upright position, when ready to dribble around alternate obstacles until the fifth cone was circled, then return the same way as fast as they could. The test was completed when the player passed the gate with photoelectric cells in control of the ball. The official ball of the Portuguese Championships was used (Mikasa FL450-YGR; Japan) with a pressure of 0.4 to 0.6. bar. Two trials successfully completed, the lowest value obtained was chosen for analysis.

The jumping ability of the players was evaluated using a jump mat (Digitime 1000, Digitest Finland). Two different types of jumps were tested; squat jump (SJ) and countermovement jump (CMJ), according to Bosco et al. (1983). The SJ was started from a static squat position: knees flexed at 90° and hands on hips, followed by a subsequent action, a maximal vertical jump and then land with straight knees on the mat. The starting position of CMJ was standing straight; players flex the knees to squat position, followed by a vertical jump as high as possible maintaining hands on hips. Subjects performed several trials for familiarization before the testing session. Only the best jump in two trials for each player was used in data analysis.

Unilateral balance was assessed using single-legged flamingo balance test (Sundstrup et al., 2010). Players were instructed to stand with open eyes on one limb on a 3-cm wide and 5-cm high bar, while the free leg was flexed at the knee joint and held at the ankle joint close to the buttocks. One minute of stance was performed and the number of falls was counted and used as a

measure of postural balance. One trial was performed for each leg interspersed by 30 s of rest. A 1-min period of familiarization was performed before all tests.

### Statistical analysis

Descriptive statistics were calculated for the total group and separately for competition level and field position. Pre- to post- intervention scores were tested with a two-way ANOVA for repeated measures. Significance was set at  $p < 0.05$ . SPSS 17.0 was used in all analyses.

### Results

Pre- to post- changes in isokinetic strength profile of IG and CG are presented in table 1. For the dominant limb, peak torque increased ( $p < 0.05$ ) by 14.7% for the knee extensor and by 13.3% for the knee flexor muscles, at concentric  $60^{\circ}\cdot s^{-1}$  for IG when in comparison with CG values that decreased. Additionally, peak torque of the knee flexor muscles of IG increased by 12.7% at eccentric  $30^{\circ}\cdot s^{-1}$ , whereas CG showed a decrease of 4.1%. In the non-dominant limb, IG increased ( $p < 0.05$ ) peak torque on the knee extensor and flexor muscles by 27.3% at concentric  $60^{\circ}\cdot s^{-1}$ , and by 9.3% at eccentric  $30^{\circ}\cdot s^{-1}$  respectively. No significant differences were observed for CG.

Although no significant differences were found between groups for isokinetic test at concentric  $240^{\circ}\cdot s^{-1}$ , isokinetic strength seemed increase for dominant and non-dominant limbs in IG, with a concomitant improvement in H/Q ratio for non-dominant limb ( $p > 0.05$ ).

The conventional H/Q ratio at concentric  $60^{\circ}\cdot s^{-1}$  for dominant limb improved ( $p < 0.05$ ) by 8.3% for IG and the same ratio decreased in CG. Differences were found between groups in DCR. IG improved DCR by 8.5% for the dominant limb and by 1.8% for non-dominant limb ( $p < 0.05$ ). In both limbs, DCR values decreased for CG.

Differences in physical fitness and technical performances from pre- to post-intervention are presented in table 2. Significant improvements in sprint, agility and technical skill performances performance tests were observed for IG

in comparison with CG ( $p < 0.05$ ). Also, significant between-groups differences ( $p < 0.05$ ) were observed in vertical jump performances. IG improved by 13.8% on SJ and by 9.9% on CMJ test, whereas no differences were observed for CG. Unilateral balance changed only for the non-dominant limb ( $p < 0.05$ ), with IG decreasing the number of falls by 29.7% and no changes in CG. No significant differences were found for the dominant limb.

Table1. Isokinetic peak torque (N·m), conventional and functional hamstrings/quadriceps ratios and percentage of change ( $\Delta$ ) from pre to post tests.

	Control group			Intervention group		
	Pre	Post	$\Delta\%$ (95% CI)	Pre	Post	$\Delta\%$ (95% CI)
<b>Dominant</b>						
Q <sub>60con</sub>	212.0±34.9	210.0±42.4	-1.0 (-7.1 to 5.0)	157.2±15.8	180.2±19.5	14.7 (10.8 to 18.6)*
H <sub>60con</sub>	102.7±22.8	98.7±17.1	-2.6 (-10.7 to 5.6)	93.7±13.3	106.0±18.6	13.3 (5.5 to 21.2)*
HQ <sub>60con</sub>	51.0±6.8	47.9±5.9	-6.1 (-7.4 to -4.8)	49.1±8.6	52.5±6.3	8.3 (2.2 to 14.6)*
Q <sub>240con</sub>	130.0±34.0	133.7±26.0	4.8 (-3.6 to 13.3)	103.3±17.7	120.4±14.4	18.6 (6.9 to 30.3)
H <sub>240con</sub>	87.3±13.6	87.6±11.9	0.9 (-4.8 to 6.6)	74.0±10.9	79.8±11.8	8.3 (2.3 to 14.3)
H/Q <sub>240con</sub>	70.5±8.3	68.0±7.7	-3.3 (-7.5 to 0.8)	69.9±9.9	67.7±8.3	-2.6 (-8.0 to 2.7)
H30 <sub>ecc</sub>	209.7±69.1	190.8±49.1	-4.1 (-19.8 to 11.7)	206.4±59.8	228.1±52.8	12.7 (3.7 to 21.8)*
DCR	2.1±0.7	1.7±0.4	-12.5 (-28.2 to 3.2)	1.7±0.6	1.8±0.6	8.5 (-2.8 to 19.7)*
<b>Non-dominant</b>						
Q <sub>60con</sub>	190.3±39.9	189.0±38.3	0.0 (-5.8 to 5.7)	141.3±16.9	176.2±32.0	27.3 (-3.9 to 58.6)*
H <sub>60con</sub>	80.2±9.3	84.2±8.9	5.8 (-2.7 to 14.3)	93.0±14.1	99.5±16.2	7.3 (0.4 to 14.3)
H/Q <sub>60con</sub>	51.5±2.1	50.0±5.8	2.8 (1.4 to 4.3)	50.8±5.8	52.5±6.3	2.2 (-4.2 to 8.7)
Q <sub>240con</sub>	116.0±28.6	121.1±26.0	5.3 (0.4 to 10.2)	103.5±21.3	117.7±19.9	16.6 (2.7 to 30.4)
H <sub>240con</sub>	68.5±9.7	70.5±8.2	4.8 (-7.3 to 16.9)	78.8±17.2	83.4±14.1	7.3 (1.4 to 13.2)
H/Q <sub>240con</sub>	64.6±8.8	68.6±9.1	6.3 (2.5 to 10.0)	68.6±11.4	64.1±9.7	-4.7 (-16.2 to 6.9)
H30 <sub>ecc</sub>	208.7±67.0	184.0±56.8	-8.6 (-23.2 to 6.0)	202.1±66.2	218.7±78.0	9.3 (-4.5 to 23.0)*
DCR	2.0±0.7	1.8±0.6	-6.2 (-17.3 to 4.8)	1.8±0.6	1.8±0.5	1.8 (-12.0 to 15.5)

Legend: Q, Quadriceps; H, Hamstrings; con, concentric; ecc, eccentric; DCR, dynamic control ratio. Positive values denote an increase from pre- to post-tests ( $\Delta$ ). \*p < 0.05

Table 2. Sprinting (s), agility (s), technical skills (s), jumping ability (m), balance (falls) results and percentage of change ( $\Delta$ ) from pre to post tests.

	Control group			Intervention group		
	Pre	Post	$\Delta\%$ (95% CI)	Pre	Post	$\Delta\%$ (95% CI)
5-m sprint	1.00 $\pm$ 0.70	1.08 $\pm$ 0.09	7.7 (3.8 to 11.7)	1.06 $\pm$ 0.10	0.96 $\pm$ 0.08	-8.9 (-11.8 to -6.1)*
30-m sprint	4.35 $\pm$ 0.16	4.44 $\pm$ 0.15	2.1 (0.3 to 3.9)	4.34 $\pm$ 0.14	4.20 $\pm$ 0.10	-3.3 (-4.7 to -1.8)*
Agility	9.06 $\pm$ 0.33	9.63 $\pm$ 0.39	6.4 (4.3 to 8.5)	9.32 $\pm$ 0.31	8.87 $\pm$ 0.36	-4.7 (-7.5 to 1.8)*
Slalom	9.32 $\pm$ 0.62	9.56 $\pm$ 0.59	3.7 (-3.3 to 10.1)	9.22 $\pm$ 0.53	8.78 $\pm$ 0.67	-4.8 (-7.3 to -2.4)*
SJ	0.310 $\pm$ 0.339	0.319 $\pm$ 0.029	3.7 (-4.5 to 11.8)	0.307 $\pm$ 0.441	0.347 $\pm$ 0.363	13.8 (7.9 to 19.7)*
CMJ	0.359 $\pm$ 0.614	0.338 $\pm$ 0.300	-3.9 (-11.6 to 3.8)	0.342 $\pm$ 0.348	0.375 $\pm$ 0.340	9.9 (4.4 to 15.5)*
Balance						
Dom	7.6 $\pm$ 4.0	7.8 $\pm$ 2.7	35.8 (-26.6 to 98.2)	7.5 $\pm$ 3.6	5.5 $\pm$ 2.6	-9.6 (-41.4 to 22.3)
Non Dom	7.5 $\pm$ 4.1	7.1 $\pm$ 3.5	1.7 (-21.4 to 24.7)	7.9 $\pm$ 3.4	5.1 $\pm$ 2.2	-29.7 (-47.8 to -11.6)*

Legend: SJ, Squat Jump; CMJ, Counter Movement Jump; Dom, Dominant; Non Dom, Non Dominant. Negative values denote an improvement from pre- to post-tests for sprint, agility, and slalom tests. \* $p < 0.05$

## Discussion

To our knowledge, this is the first study so far referring to the performance effects of an injury prevention-training programme in futsal. Previous studies (Kilding et al., 2008, Brito et al., 2010) showed that it is important to use prevention strategies in order to reduce the risk of lower limb injuries in football players. In present study, the physical and technical performance results suggest that implementation of "The 11+" programme can improve performance of youth futsal players, as showed by the significant changes in several of the performance abilities assessed. We found an increase in strength in the majority of isokinetic parameters tested, as well as improved sprinting, agility, jumping ability, balance, and technical skills performances.

Engebretsen et al. (2008) showed a low adherence to an injury prevention-training programme (ranging 20–30%), suggesting this as the main reason for the unsuccessful results of the intervention. Contrarily, our study revealed a compliance rate of 77%, as shown by some authors in other studies using F-MARC's proposal (Steffen et al., 2007a; Steffen et al., 2007b; Kilding et al., 2008; Soligard et al., 2010; Brito et al., 2010).

The knee flexor muscles play an important role during ball striking in slowing down the extension of the leg, during accelerations, decelerations, cutting and side-stepping manoeuvres (Lehance et al. 2009). This group of muscles contributes not only to athletic performance but also to control running activities and to stabilize knee turns (Zakas et al., 1995). Therefore, according to our results, we believe that "The 11+" programme allows the young futsal players to improve their performance. The concentric and eccentric peak torque of the hamstrings increased for both limbs comparing with CG. This fact might contribute for the capacity of the players to sustain progressive increase of training loads during the intervention period, as shown by IG particularly on the "Nordic hamstrings" exercise. This is in line with Brito et al. (2010) that showed an increase in concentric and eccentric peak torque of the knee flexor muscles on the non-dominant limb in sub-elite adult football players.

In respect to DCR, the significant increase for the dominant limb found in IG (8.5%) in comparison to CG can be justified by the differences found in

eccentric strength of the hamstrings muscles. We also observed significant changes in the conventional H/Q ratio in IG on the dominant lower extremity at concentric  $60^{\circ}\cdot\text{s}^{-1}$  in comparison to CG, which can be explained by the increase in peak torque of the knee extensors and flexors muscles, improving antagonist/agonist balance towards a more balanced reciprocal muscle groups around the knee joint. This suggests that youth futsal players might decrease the risk of hamstrings injuries as a result of the normalization of the isokinetic profile (Croisier et al., 2008). Moreover, it is important to refer that "The 11+" training programme include the "Nordic hamstrings" exercise, which has been shown to be effective in developing maximal eccentric hamstring strength and the H/Q ratio (Mjølsnes et al., 2004). The same authors suggested that the same exercise might reduce the risk of sustaining a hamstring strain.

In the present study, "The 11+" resulted in a significant improvement in sprint and jump abilities in IG comparing to CG. We likely associate this to improvements in lower limb muscle power. It has been shown that single-leg bound and jump exercises, as those included on "The 11+", improved strength and neuromuscular recruitment and coordination (Chimera et al., 2004), and these adaptations could thereby help on reducing lower limb injuries (Kilding et al., 2008). The same authors did not find improvements in agility performance when using a different intervention programme (i.e. "The 11"). Nevertheless, it has to be highlighted that the previous "The 11" training programme did not include exercises with progressive load, as "The 11+". Therefore, our findings support the idea that progressive load is important for developing several physical capacities in youth futsal players, such as agility.

Interestingly, "The 11+" can be important not only for injury prevention but also for technical performance, as suggested by the improvements observed in slalom and agility in IG comparing to CG. Futsal is an intermittent high-intensity sport, with locomotor activities changing every 3.28 s (Dogramaci & Watsford, 2006). Hence, technical skills are determinant for a good performance during the game, and futsal players need to have good slalom and agility abilities to face the characteristics of the game, particularly on changing

direction, to gain or to close space when performing attack or defence movements, respectively.

However, Junge and Dvorak (2010) assumed that multiple sprints with frequent changes in direction contribute to higher proportion of non-contact injuries in futsal (37%). The same authors reported that knee, thigh and ankle injuries are the most frequent in futsal. Previous studies found that football-specific balance training reduced non-contact lower limb injuries (Kraemer & Knobloch, 2009). Moreover, Caraffa et al. (1996) and Mandelbaum et al. (2005) also have shown that improving dynamic and static balance, neuromuscular control and proprioception can reduce the rate of anterior cruciate ligament injuries. In fact, during single leg balance training, the players are push off for balance, and this might have an additional challenge to maintain a stable core and proper alignment (Kraemer & Knobloch 2009). Thus, as youth futsal players improved balance with "The 11+", it can be speculated that the training programme might help youth futsal players to prevent non-contact lower limb injuries.

## **Conclusions**

Overall, we can assume that "The 11+" training programme is adequate and effective for youth futsal training and conditioning. Thus, the completion of the programme two times per week as a warm-up routine can help youth futsal players to reduce the injury risk, as well as to enhance performance and technical skills, preparing players for the main training session. We therefore believe that is important that coaches consider injury prevention programmes on their weekly training plan and take an active role on the awareness and education of the players to the importance of such intervention programmes. For a more comprehensive and realistic understanding of the qualities of "The 11+" applied to futsal, more studies must be conducted in different age groups and competitive levels.

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