



## Article

# A neuromuscular training program enhances dynamic neuromuscular control and physical performance in court-sport athletes

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1 **A neuromuscular training programme enhances dynamic neuromuscular control and physical**  
2 **performance in court-sport athletes**

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26 **Abstract**

27 This study aimed to investigate the effects of an 8 week neuromuscular training protocol on dynamic  
28 neuromuscular control and physical performance. Twenty female court-sport athletes were randomly  
29 allocated to two groups, a control (n = 10) and an intervention group (n = 10). All participants performed  
30 pre-testing inclusive of; a 20-m sprint, countermovement jump (CMJ), Illinois agility test and the qualitative  
31 analysis of a single-leg squat (QASLS), which is an assessment of dynamic neuromuscular control.  
32 Subsequently the intervention group engaged in a modified version of the FIFA 11+ neuromuscular training  
33 programme twice weekly for eight weeks. At post-testing there were between-group differences in CMJ  
34 (Intervention; +3.96-cm vs Control; -1.36-cm,  $p = 0.003$ ) and QASLS for both legs ( $p < 0.001$ ) (Right-Leg,  
35 Intervention; Pre: 3.75 Post: 1.91, Control; Pre: 4.11 Post: 4.08) (Left-Leg, Intervention; Pre: 3.72 Post:  
36 0.98, Control; Pre: 4.05 Post: 4.23). There was a within-group improvement in 20-m sprint for the  
37 intervention group only post-training (Pre: 3.69-s Post: 3.60-s,  $p = 0.043$ ), whilst no differences occurred  
38 in Illinois agility test for either group. A modified FIFA 11+ protocol can be considered an effective  
39 neuromuscular training programme for enhancing dynamic neuromuscular control and sport-specific  
40 physical performance in female court-sport athletes.

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**52 Introduction**

53 Court-sport athletes, such as those involved in badminton, squash, netball, basketball and volleyball are  
54 required to repetitively perform movements patterns such as jumping, landing and changing direction  
55 quickly whilst competing.<sup>1,2</sup> Irrespective of sex, the movement patterns performed by court-sport athletes  
56 inherently present a risk of injury if performed with compromised technique and body mechanics.<sup>3</sup>  
57 Repetitive quick changes in direction can cause anterior translation of the tibia relative to femur, which  
58 places a significant amount of force on the anterior cruciate ligament (ACL).<sup>4</sup> This excessive force exerted  
59 on the ACL can cause ligament rupture, with females reported to be up to eight times more likely to suffer  
60 an ACL injury in comparison to males.<sup>5</sup> Subsequently, ACL annual injury risk in female court athletes (up  
61 to 7.3% of surveyed population suffering a current ACL injury) are some of the highest reported when  
62 compared to variety of sporting populations.<sup>6</sup> The speculated reasons why females are at an increased risk  
63 of injuring their ACL include hormonal and anatomical factors which affect the rigidity of the ACL.<sup>7</sup>

64 Abnormal dynamic alignment and neuromuscular-control of the lower limb during athletic tasks  
65 such as jumping, landing and changing direction has been associated with numerous lower limb pathologies  
66 including ACL injury.<sup>3</sup> Kinematic analysis of the single-leg squat has been shown to predict and mirror  
67 movement dysfunction in a netball specific leap-landing task, and subsequently is recognized as an effective  
68 field-based screening method for identifying netball players who display biomechanical deficits during  
69 landing.<sup>1</sup> In addition, mixed sport elite collegiate athletes displaying poor movement performance on a  
70 single-leg squat had significantly greater subsequent incidence of lower extremity injury, when compared  
71 to athletes displaying superior movement competency.<sup>8</sup> The qualitative analysis of single-leg squat  
72 (QASLS) scoring system was developed to quantify neuromuscular control at various body regions during  
73 a single-leg squat. This method has demonstrated high validity in relation to 3D motion capture (percentage  
74 of agreement; 98%, range 97%-100%).<sup>9</sup>

75 Females often demonstrate neuromuscular deficiencies in comparison to males in actions such as  
76 eccentric muscular landing control and trunk to lower-limb alignment during landing and changing  
77 direction.<sup>3</sup> Electromyography (EMG) research has demonstrated females appear to have a lower ability to

78 recruit the muscle groups needed to protect the integrity of the ACL, notably the hamstrings group and local  
79 trunk stabilisers such as the transversus abdominis and multifidus.<sup>3,10</sup> However, it has been demonstrated,  
80 that if females engage in an effective neuromuscular training programme it can increase their ability to  
81 recruit such protective muscles groups.<sup>11</sup> Neuromuscular training programmes include plyometric, balance,  
82 perturbation and strength exercises. These forms of training induce specific neural adaptations within the  
83 descending corticospinal tracts, motor units, neuromuscular junctions as well as improving the reflex  
84 potential of the muscle spindles.<sup>12,13</sup> One neuromuscular training programme that has demonstrated  
85 significant promise for decreasing the risk of injury and improving performance variables is the FIFA  
86 11+.<sup>14,15</sup> Soligard et al.<sup>15</sup> reported significant reductions in minor and severe injury within female soccer  
87 players performing the FIFA 11+ protocol over an eight-month period compared to a control group.  
88 Subsequent authors have also reported the FIFA 11+ programme to have beneficial effects in reducing  
89 injuries.<sup>11,14,16</sup> The FIFA 11+ protocol has shown to improve physical performance variables such jump  
90 height, and sprint ability when implemented both acutely and longitudinally as a training intervention.<sup>17,18</sup>  
91 The FIFA 11+ protocol has demonstrated to reduce injury risk and increase performance indicators in  
92 mostly soccer players.<sup>14,15</sup> However there is noticeable lack of research on how the FIFA 11+ protocol  
93 benefits those in other sporting contexts. Considering a female's increased risk of an ACL injury and the  
94 additional risk of injuring this ligament through participating in a court-sport,<sup>3</sup> it seems appropriate to  
95 investigate the effects of the FIFA 11+ programme on physical performance and lower limb neuromuscular  
96 control, which has been emphasised as a predictive marker of ACL injury.<sup>1,8</sup>

97         The purpose of this study was to investigate the effects of an 8 week neuromuscular training  
98 protocol on dynamic neuromuscular control of the lower limb and physical performance in female court-  
99 sport athletes. Subsequently, it was hypothesised that the intervention group performing neuromuscular  
100 training would experience significant improvements in 20-m sprint, agility performance, countermovement  
101 jump height and neuromuscular control of the lower-limb as assessed via single-leg squat, when compared  
102 to the control group.

103

## 104 **Materials and Methods**

### 105 *Participants*

106 Twenty female court-sport athletes participated (stature:  $169 \pm 7$ -cm, mass:  $61.3 \pm 8.3$ -kg, age:  $22.3 \pm 2.0$ -  
107 years). The participants came from a variety of different sporting backgrounds which included badminton,  
108 squash, futsal, netball, basketball and volleyball. Participants were randomly assigned to either an  
109 intervention group ( $n = 10$ ) or a control group ( $n = 10$ ). Participants had no history of knee, thigh, hip or  
110 lower back injuries within the past year and had not previously suffered an ACL tear. Participants provided  
111 written informed consent to participate in the study, which was approved by the local ethics committee in-  
112 line with the Helsinki Declarations for research with human volunteers. Prior to data collection, the  
113 reproducibility of the featured assessments over three separate trials spaced by a 48-h period, was  
114 established using 10 female university netball players who were part of the study cohort. The data was  
115 analysed using procedures published by Hopkins<sup>19</sup> to establish typical error as a percentage (TE %). Mean  
116 typical error as a percentage observed for each assessment is provided below.

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### 118 *Experimental assessment protocol*

119 Before the assessments were conducted, all participants took part in a standardised warm-up consisting of  
120 full-body static stretching followed by 5-min of jogging. All participants performed pre-testing; 20-m sprint  
121 (TE = 1.3%) recorded with Smart Speed electronic timing gates (Fusion Sport, Queensland, Australia). This  
122 involved three maximal 20-m sprint attempts with 60-s rest in-between each sprint. Each sprint begin from  
123 a standing start with the toe of the leading leg was placed behind start line, participants were instructed to  
124 sprint as fast as possible on each sprint. Three individual countermovement jumps (CMJ) (TE = 1.1%) with  
125 60-s rest in-between. The maximal vertical displacement of the participant's jump was assessed with the  
126 use of a Just Jump mat (Just Jump, Probotics, Huntsville, AL, USA). Participants were instructed to place  
127 their hands on hips and when prompted by the assessor squat down to a self-selected depth, and jump  
128 vertically as high as possible. The Illinois agility test (TE = 2.7%) recorded with Smart Speed electronic  
129 timing gates (Fusion Sport, Queensland, Australia), which involved three maximal test attempts with 180-

130 s rest in-between each attempt. The test began from a standing start with the toe of the leading leg placed  
131 behind start line, participants were instructed to complete the test as quickly as possible. For 20-m sprint,  
132 CMJ and Illinois agility the mean value of the three maximal assessment attempts was used for subsequent  
133 data analysis.

134 The QASLS was performed on both the right-leg (TE = 2.0%) and left-leg (TE = 2.3%) to assess  
135 the dynamic neuromuscular control of the lower limb. All assessments were conducted by the same member  
136 of the experimental team, who was experienced in using the assessment with athletes in an applied setting.  
137 The protocol from Herrington and Munro<sup>9</sup> was adopted, which requires the single-leg squat movement to  
138 be recorded and reviewed, scoring the movement at different regions of the body (arm, trunk, pelvis, thigh,  
139 knee and foot). The associated scoring scale runs from 0-10, a higher score indicates poor dynamic  
140 neuromuscular control.<sup>9</sup> This required each participant to position themselves 5-m away from the video  
141 camera (Sony Handycam CX250). Participants' were then required to stand on one leg and squat down to  
142 a depth at which their knee angle was between 45°-60°, they were asked to perform this movement over a  
143 5-s period. The participants were given the opportunity to familiarise themselves with the depth of single-  
144 leg squat with the use of a goniometer and three trials on each leg with a timer in front of them so they  
145 stayed within the 5-s period. Participants were then required to perform three recorded single-leg squats on  
146 each leg, and trials were only accepted if the squat was within the desired depth via goniometer monitoring.  
147 Once the scores for each leg were collected, the three scores for each leg were averaged and this gave the  
148 overall result for the left and right-leg. Both groups then completed post-testing, featuring all the described  
149 assessments, following the training intervention (described below). Testing was performed two days after  
150 training or competition to allow for sufficient recovery. All tests were carried out on basketball court  
151 surface.

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### 153 *Neuromuscular training intervention*

154 After pre-testing the intervention group engaged in a modified FIFA 11+ neuromuscular training  
155 programme, twice weekly for eight weeks (Table 1). The original FIFA 11+ protocol included football

156 specific drills, subsequently these were removed from the current protocol and replaced with alternative  
157 exercises specific to court-based sports to increase the opportunity for neuromuscular improvements  
158 specific to the sports involved.<sup>20</sup> All participants began each exercise of the training protocol at level one,  
159 progressions for an individual were not considered until their participation of the third session. Each session  
160 took ~35-min to complete. During the intervention period both groups continued with their habitual training  
161 regimes as delivered by their sport coaches.

162 **INSERT TABLE 1 HERE**

163

#### 164 *Statistical analysis*

165 Results are presented as mean ( $\pm$  standard deviation) unless stated. A 2x2 mixed ANOVA was performed  
166 using the IBM SPSS version 22 to determine any significant differences ( $p < 0.05$ ) between the two groups  
167 performance measurements (20-m sprint, CMJ, Illinois agility test and QASLS). Assumptions of sphericity  
168 were assessed using Mauchly's test of sphericity, post-hoc pairwise-comparisons were conducted using the  
169 Bonferroni correction. Within effect size for intervention and control groups pre to post change on assessed  
170 measures was calculated using Cohen's  $d$ , with interpretation of observed effect sizes are as follows; trivial  
171  $< 0.2$ , small 0.2-0.6, moderate 0.6-1.2, large 1.2-2.0, very large  $> 2.0$ .<sup>21</sup>

172

#### 173 **Results**

174 There was a significant effect over time for CMJ height ( $F = 9.998$ ,  $p = 0.005$ ) and a significant trial x group  
175 interaction ( $F_{1,9} = 36.571$ ,  $p < 0.001$ ). At post-testing CMJ significantly differed between the intervention  
176 and control group (6.58-cm [95% CI: 2.48 – 10.69-cm],  $p = 0.003$ ;  $d = 1.51$ ). The intervention group's CMJ  
177 height was significantly increased from pre to post-testing (3.96-cm [95% CI: 2.68 – 5.24-cm],  $p < 0.001$ ;  
178  $d = 0.99$ ), whilst the control group experienced no significant change in from pre to post-testing CMJ height  
179 (-1.36-cm [95% CI: -2.52 – -0.37-cm],  $p = 0.056$ ;  $d = -0.27$ ).

180 There were no between-group differences for 20-m sprint ( $F_{1,9} = 1.704$ ,  $p = 0.208$ ). A significant  
181 within-group effect for 20-m performance was evident for the intervention group as performance



182 significantly improved following the training intervention (-0.09-s [95% CI: -0.003 - -0.18-s],  $p = 0.043$ ,  $d$   
 183 = -0.40). No significant within-group effect was evident for the control group (-0.02-s [95% CI: -0.10 -  
 184 0.08-s],  $p = 0.747$ ,  $d = 0.07$ ). There was no effect over time for the Illinois agility test ( $F = 0.915$ ,  $p = 0.351$ ),  
 185 and no between-group differences ( $F_{1,9} = 2.299$ ,  $p = 0.147$ ). There were no significant changes for either  
 186 group pre-to-post (Intervention group; -0.22-s [95% CI: -0.47 - 0.04-s],  $p = 0.097$ ,  $d = -0.32$ ), (Control  
 187 group; 0.05-s [95% CI: -0.21 - 0.30-s],  $p = 0.697$ ,  $d = 0.04$ ).

188 There was a significant effect over time for QASLS right-leg scores ( $F = 14.814$ ,  $p = 0.001$ ) and  
 189 left-leg scores ( $F = 38.400$ ,  $p < 0.001$ ). A significant trial x group interaction was present for QASLS right-  
 190 leg scores ( $F_{1,9} = 13.88$ ,  $p = 0.002$ ) and left-leg scores ( $F_{1,9} = 50.00$ ,  $p < 0.001$ ). At post-testing QASLS  
 191 scores for both the right-leg (2.22 [95% CI: 1.09 - 3.25],  $p = 0.001$ ;  $d = -1.30$ ) and left-leg (3.25 [95% CI:  
 192 2.00 - 4.50],  $p < 0.001$ ;  $d = -1.98$ ) were significantly different between the two groups. The intervention  
 193 group reduced their right-leg (-1.84 [95% CI: -1.12 - -2.56],  $p = 0.001$ ;  $d = 1.41$ ) and left-leg (-2.74 [-2.13  
 194 - -3.35],  $p < 0.001$ ;  $d = 2.36$ ) QASLS scores significantly from pre to post, the control group scores were  
 195 unchanged (Right-leg; -0.03 [95% CI: -0.75 - 0.69],  $p = 0.931$ ;  $d = 0.02$ , Left-leg; 0.18 [95% CI: -0.43 -  
 196 0.79],  $p = 0.545$ ;  $d = 0.11$ ).

197 **INSERT TABLE 2 HERE**

198

## 199 **Discussion**

200 The results demonstrate the FIFA 11+ protocol significantly increased CMJ height and reduced QASLS  
 201 scores when compared to the control group outcomes, indicating improved lower limb neuromuscular  
 202 control and stability which represents an improvement in a screening measure of ACL injury risk.<sup>1</sup>  
 203 Significant within-group improvements for the intervention group's CMJ, QASLS and 20-m sprint times  
 204 were evidenced. Previous research has demonstrated neuromuscular training programmes can improve  
 205 performance indicators such as sprint time, lower body power, agility, and proprioception as well as reduce  
 206 the risk of ACL injury in female soccer and basketball populations.<sup>15,20,22</sup>

207 At post-testing the intervention group significantly increased their CMJ in comparison to the

208 control group. There are several potential reasons why the CMJ height increased significantly within the  
209 intervention group. The featured neuromuscular programme included exercises such as box jumps and  
210 depth jumps which are designed to elicit increases in lower body power and stretch shortening cycle  
211 function.<sup>23</sup> In addition, exercises such as planks, Nordic curls, unilateral balancing and bounding runs also  
212 featured. Previous studies have highlighted the positive relationship between increased neuromuscular  
213 activity within the core, hip and leg muscles all of which contribute towards the efficiency of a CMJ.<sup>12,13</sup>  
214 Previous cohorts of athletes have recorded increased CMJ performance following prolonged interventions  
215 utilizing the FIFA 11+ programme. Bonato et al<sup>20</sup> speculated an increase in postural control due to  
216 performing the neuromuscular training programme may have attributed toward a significant increase in  
217 CMJ height within female basketball athletes. Furthermore youth soccer populations performing FIFA 11+  
218 intervention have experienced significant increases in CMJ height in comparison to control following  
219 interventions lasting 8-10 weeks.<sup>12,24</sup>

220         Following the neuromuscular programme there was a significant improvement in neuromuscular  
221 control observed during the QASLS test for both right and left-leg. These findings correspond with previous  
222 research regarding the benefit of neuromuscular training programmes for improving neuromuscular control  
223 and stability and reducing indicators of ACL injury risk in females. Bonato et al<sup>20</sup> previously showed that a  
224 season-long, neuromuscular-training programme significantly improved postural control and reduced  
225 injury occurrence within female basketball players. While Benis et al<sup>13</sup> found that twice weekly for  
226 neuromuscular training for 8 weeks, led to significant improvements in balance when compared to a control  
227 group within female basketball players. In addition, researchers have reported a lower injury occurrence  
228 within female youth soccer players following a season long, neuromuscular training programme.<sup>15,22</sup> The  
229 training protocol used within this study included exercises designed to elicit neural adaptations between the  
230 motor cortex and the targeted muscle.<sup>11,12,13</sup> The revised FIFA 11+ protocol was designed to condition the  
231 following muscles: piriformis; superior and inferior gemelli; obturator internus / externus; quadratus  
232 femoris; and the hamstrings and quadriceps muscle groups. Female athletes have been shown to have lower  
233 recruitment of the muscles targeted by the intervention programme, which in turn cause misalignments in

234 the lower body.<sup>3,10</sup> Subsequently this places a significant amount of pressure on the ACL and its ability to  
235 prevent anterior tibial subluxation, a common cause of ACL rupture.<sup>4,7</sup> This study included exercises  
236 specially chosen by Santa Monica Sports Medicine Foundation and the Oslo Trauma and Research Centre  
237 (i.e. Nordic curls, unilateral balancing, box jumps, inline lunges and depth jumps) with the intention of  
238 recruiting the aforementioned muscle groups responsible for protecting the integrity of the knee.<sup>14</sup>

239 A significant within-group reduction in 20-m sprint time pre to post for the intervention group was  
240 apparent (2.4% decrease). Similar to this study previous researchers have found the FIFA 11+ protocol or  
241 similar training programmes to be effective for improving sprint performance; Kilding et al<sup>25</sup> recorded a  
242 2% significant decrease in male soccer players 20-m sprint time after performing the FIFA 11+ training  
243 programme five-times weekly for six weeks. In addition, Reis et al<sup>16</sup> found significant improvements in 30-  
244 m (3.3% reduction) sprint for an intervention group of male futsal players performing the FIFA 11+ training  
245 programme twice-weekly for 12 weeks. The intervention protocol within the present study included a  
246 combination of lower body strengthening exercises (inline lunges, Nordic curls) and plyometric exercises  
247 (box jumps, depth jumps). Previous literature has found such exercises to invoke substantial muscular  
248 recruitment and activation within hamstring, quadriceps and gluteal group musculature.<sup>26,27,28,29</sup> These such  
249 muscle groups are strongly recruited during sprinting.<sup>30</sup> Subsequently the observed enhancements in sprint  
250 performance may have been due to an enhanced recruitment and firing rate of muscle fibres needed to  
251 improve sprint mechanics and power output.<sup>11,12,13</sup> However shorter (4 week) FIFA 11+ training  
252 interventions have not shown such improvements in 20-m sprint time.<sup>31</sup> Taking this study and other pieces  
253 of evidence into consideration the FIFA 11+ or a slightly amended version of the programme can be  
254 considered a useful tool to maintain or reduce 20-m sprint times in court-sport athletes.<sup>13,15,20</sup>

255 No significant differences between the intervention and control groups Illinois agility test time post  
256 eight weeks were discovered. The findings are in accordance with Kilding et al<sup>25</sup> who found no significant  
257 differences in Illinois agility test time following a FIFA 11+ training programme of 6 weeks duration when  
258 compared to a control group within male soccer players. Since court-based athletes frequently engage in  
259 change of direction cutting actions within their sport, they may have been less responsive to positively adapt

260 to such movements within the training intervention.<sup>1</sup> It is also important to note, a meta-analysis conducted  
261 by Gomes Neto et al<sup>18</sup> who analyzed eleven FIFA 11+ studies, including 4700 participants. The analysis  
262 indicated an overall significant improvement in agility performance following engagement in the FIFA 11+  
263 programme.<sup>18</sup> This may be indicative of the benefit of longitudinal implementation of the FIFA 11+ on  
264 agility.

265         The high adherence rate of participants within this study likely had a meaningful influence on the  
266 improvement in numerous post-intervention measures. In total 90% of the intervention group participants  
267 completed all 16 sessions. Participant adherence for neuromuscular training programmes which are  
268 relatively short in duration such as the one implemented within this study (approximately 35-min to  
269 complete), is essential for achieving improvements in physical performance and reducing the risk of sport  
270 related injuries. A systematic review supported this claim and concluded that neuromuscular training  
271 programmes approximately 25-min duration with compliance rates of 75% significantly reduced the risk of  
272 lower extremity injuries.<sup>32</sup> Another study created three different groups to assess how adherence rates of  
273 the FIFA 11+ programme affect the risk of injury.<sup>33</sup> Participants were either assigned to unsupervised  
274 group (control), a group with a coach and physiotherapist (comprehensive) or a group with a coach and no  
275 physiotherapist (regular). The comprehensive, regular and control group achieved 86%, 81% and 73%  
276 completion of total possible sessions, respectively. The authors discovered that high player adherence to  
277 the intervention resulted in significant improvements in functional balance and a reduced injury risk.<sup>33</sup>

278         In conclusion, the results demonstrate a modified FIFA 11+ protocol can improve dynamic lower  
279 limb neuromuscular control and stability which represents an improvement in a screening measure of ACL  
280 injury risk. Considering that females are at greater risk of ACL injury in comparison to males and that the  
281 movements performed by court-sport athletes during performance can contribute further to the risk of an  
282 ACL injury, implementation of preventative regimes such as the FIFA 11+ programme are justified. The  
283 neuromuscular training programme also proved to significantly increase CMJ height in comparison to the  
284 control group and lead to a within-group improvement in 20-m sprint for the intervention group. This  
285 demonstrated the FIFA 11+ training programme can be used for improving desirable physical attributes for

286 court-sport athletes

287

## 288 **Perspectives**

289 An amended FIFA 11+ programme performed twice weekly can be considered an appropriate  
290 neuromuscular training regime to induce improvements in certain sport-specific performance measures and  
291 neuromuscular control within a single-leg squat. This is in support of previous neuromuscular training  
292 interventions which have shown to improve physical performance, proprioception and reduce the risk of  
293 ACL injury in female soccer and basketball populations.<sup>15,20,22</sup> Strength and conditioning practitioners  
294 should explore the use of neuromuscular training programmes in court-based sports which have a high  
295 prevalence of ACL injury especially in female populations.<sup>1,2,3,8</sup> The QASLS scoring scale is considered a  
296 cost and time effective indirect screening method of assessing ACL injury risk, making it a practical and  
297 realistic tool for strength and conditioning practitioners.<sup>1,8,9</sup> Considering that neuromuscular training  
298 programmes, such as the FIFA 11+ routine, require minimal equipment to conduct, they can be performed  
299 effectively as a strength and conditioning session and do not have to be performed as a warm-up routine  
300 alone.

301

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441 **Tables**

442 Table 1. Adapted version of FIFA 11+ protocol performed by the intervention group. Training session  
 443 exercises listed as sets x repetitions.

<b>Exercise and section</b>	<b>Sets and repetitions</b>
<p style="text-align: center;"><i>Warm-up (cones 10 m apart)</i></p> <ul style="list-style-type: none"> <li>• Straight ahead</li> <li>• Hip out</li> <li>• Hip in</li> <li>• Circle partner</li> <li>• Single-leg bounding (added from main work out section)</li> <li>• Quick forwards and backwards</li> </ul>	<p>All exercises are to be performed two times in the allocated area</p>
<p style="text-align: center;"><i>Main training session</i></p> <ul style="list-style-type: none"> <li>• Plank (3 levels of difficulty)</li> <li>• Side plank (3 levels of difficulty)</li> <li>• Nordic curls (3 levels of difficulty)</li> <li>• Test your partners balance (single-leg) <i>(football removed)</i></li> <li>• Box jumps (3 different heights) <i>(replaced for jumps)</i></li> <li>• Inline lunges (3 levels of difficulty)</li> <li>• Depth jumps (3 different heights) <i>(added)</i></li> <li>• Running and cutting (3 levels of difficulty)</li> </ul>	<p>1 min rest between each set</p> <ul style="list-style-type: none"> <li>• 2 x 60 s</li> <li>• 2 x 60 s (each side)</li> <li>• 3 x 6, 8, 10</li> <li>• 3 x 60 s (each leg)</li> <li>• 2 x 30 s</li> <li>• 2 x 16 (each leg)</li> <li>• 2 x 6</li> <li>• 2 sets within 10 m space</li> </ul>
<p style="text-align: center;"><i>Cool-down (added)</i></p>	<p>Full body static-stretch</p>

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449 Table 2. Mean and (standard deviation) of all assessments pre and post-testing for both groups

Assessment	Control group		Intervention group	
	Pre	Post	Pre	Post
20-m (s)	3.86 (0.24)	3.84 (0.30)	3.69 (0.27)	3.60 (0.17)*
Illinois Agility (s)	18.64 (1.24)	18.69 (1.51)	17.67 (0.70)	17.45 (0.67)
CMJ (cm)	38.58 (4.69)	37.34 (4.55)	39.97 (3.84)	43.93 (4.18)*#
QASLS RL (1-10 scale)	4.11 (1.21)	4.08 (1.24)	3.75 (1.51)	1.91 (1.05)*#
QASLS LL (1-10 scale)	4.05 (1.54)	4.23 (1.62)	3.72 (1.34)	0.98 (0.94)*#

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451 # = Significant interaction (group x time) pre to post. \* = Significant within-group difference pre to post.

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