Relationships Between Eccentric Hip Isokinetic Torque and Functional Performance

Rodrigo de Marche Baldon, Daniel Ferreira Moreira Lobato, Lívia Pinheiro Carvalho, Paloma Yan Lam Wun, Cátia Valéria Presotti, and Fábio Viadanna Serrão

Context: Recently, attention in sports has been given to eccentric hip-muscle function, both in preventing musculoskeletal injuries and improving performance. Objective: To determine the key isokinetic variables of eccentric hip torque that predict the functional performance of women in the single-leg triple long jump (TLJ) and the timed 6-m single-leg hop (TH). Design: Within-subject correlational study. Setting: Musculoskeletal laboratory. Participants: 32 healthy women age 18–25 y. Intervention: The participants performed 2 sets of 5 eccentric hip-abductor/adductor and lateral/medial-rotator isokinetic contractions (30°/s) and 3 attempts in the TLJ and TH. Main Outcome Measurements: The independent variables were the eccentric hip-abductor and -adductor and medial- and lateral-rotator isokinetic peak torque, normalized according to body mass (Nm/kg). The dependent variables were the longest distance achieved in the TLJ normalized according to body height and the shortest time spent during the execution of the TH. Results: The forward-stepwise-regression analysis showed that the combination of the eccentric hip lateral-rotator and -abductor isokinetic peak torque provided the most efficient estimate of both functional tests, explaining 65% of the TLJ variance (£.001) and 55% of the TH variance (£.001). Conclusions: Higher values for eccentric hip lateral-rotator and hip-abductor torques reflected better performance. Thus, the eccentric action of these muscles should be considered in the development of physical training programs that aim to increase functional performance.

Keywords: biomechanics, dynamic knee valgus, hop tests, patellofemoral pain syndrome

In many sports training programs, strengthening of the lower limb muscles is carried out exhaustively to improve athletes’ functional performance. There is a common belief that strength and muscle power can influence the performance of activities involving agility, which require rapid acceleration of the center of mass, as well as in the execution of hopping activities. Although some studies have found strong correlation between lower limb muscle strength and functional performance, there is no consensus in the literature on the true relationship between these variables. This is mainly because of studies that showed low correlation between the strength of the quadriceps and values found in various activities such as horizontal jumping, vertical jumping, and sprinting. Thus, some authors believe that individually assessed muscle strength shows a limited contribution to the estimation of performance.

Currently, some orthopedic knee disorders such as patellofemoral pain syndrome (PFPS) and anterior cruciate ligament (ACL) rupture have been associated with a deficit in eccentric hip function. Moreover, investigators have shown an important role of the eccentric action of the hip-abductor and lateral-rotator muscles to control excessive femoral and knee movements during weight-bearing activities. Poor femoral-adduction and internal-rotation control may increase dynamic knee valgus and lead to greater lateral patellar contact pressure and ACL stress. If not corrected, subjects with such a lower limb alignment will undoubtedly have a greater likelihood of having PFPS and ACL rupture.

The contribution of the eccentric action of the hip-abductor and lateral-rotator muscles to the estimation of performance in jump activities carried out in the sagittal plane is still not understood. Eccentric-action deficits of the hip-abductor and lateral-rotator muscles have been associated with greater hip-adduction and -rotation control may increase dynamic knee valgus and lead to greater lateral patellar contact pressure and ACL stress. During the acceleration phase of jump tasks, the propulsion force must be oriented in the sagittal plane to optimize performance. Theoretically, an eccentric deficit of the hip-abductor and lateral-rotator muscles would increase dynamic knee valgus during the landing phase of the jump, medially changing the orientation of the propulsion force vector. In this new scenario, the propulsion force generated in the sagittal plane by the extensor kinetic chain would be reduced, impairing performance. To our knowledge, no study has yet verified the influence of eccentric hip-abductor and lateral-rotator strength on performance of activities performed in the
sagittal plane. In addition, only 1 study has shown the influence of these muscles on performance in jump tasks carried out in the coronal plane.\textsuperscript{13} However, muscle strength was not found to correlate with performance.

Some studies that, among other measures, focused on strengthening eccentric action of the hip muscle as a preventive measure showed favorable changes in the pattern of movement (decreased dynamic knee valgus).\textsuperscript{14,15} Furthermore, Myer et al\textsuperscript{16} revealed improved performance of their volunteers, reflecting a possible link among eccentric hip strength, dynamic alignment of the lower limb, and performance.

The incidence of PFPS and ACL rupture has been reported to be 2.2\textsuperscript{17} and 6\textsuperscript{18} times greater, respectively, in females than in males. Studies in this area have suggested that females exhibit a biomechanical profile that places them at an increased risk for these injuries. Females have greater hip adduction and medial rotation,\textsuperscript{19,20} as well as greater knee-valgus excursion,\textsuperscript{21,22} during some functional activities than males. Moreover, Ferber et al\textsuperscript{19} verified that greater eccentric demand is placed on the hip-abductor muscles of females during the stance phase of running to control the external hip-abductor moment acting at this joint.

Information acquired from studying the relationship between eccentric hip action and performance in females might improve the prescription of physical training that aims to increase functional performance and concomitantly help prevent knee injuries in this population. Thus, the objectives of our study were to examine (1) the relationship between eccentric hip-abductor, hip-adductor, medial-rotator, and lateral-rotator isokinetic peak torque and the performance of women in 2 functional tests, the single-leg triple long jump (TLJ) and the timed 6-m single-leg hop (TH), and (2) whether one or more of the isokinetic variables assessed can predict the performance of the functional activities proposed. We hypothesized that women with lower eccentric hip-abductor and lateral-rotator torque would demonstrate worse functional performance than those with greater eccentric hip-abductor and lateral-rotator torque.

**Methods**

**Design**

We used a within-subject correlation design to determine possible interactions between independent variables (eccentric hip-abductor, hip-adductor, medial-rotator, and lateral-rotator isokinetic peak torque) and dependent variables (distance achieved in the TLJ and time spent in the execution of the TH). In addition, we developed two multiple-linear-regression models to predict the performance of the functional activities from the isokinetic variables studied.

**Participants**

We recruited for this study 32 female recreational athletes (age 20.3 ± 1.7 y, mass 59.3 ± 6.1 kg, height 163.7 ± 6.4 cm) from a university campus. A recreational athlete was defined as anyone participating in aerobic or athletic activity at least 3 times per week.\textsuperscript{23} The exclusion criteria were the presence of cardiovascular, respiratory, vestibular, neurological, or metabolic disease as referred by the volunteers; the presence of bone, joint, and ligament injury; prior lower limb surgery; presence of pain in the hip, knee, or ankle during physical activity; and body-mass index above 26. All participants read and signed an informed-consent form before the assessments, and all testing procedures were approved by our university’s institutional review board.

**Procedures**

Before testing, we collected demographic information and age, height, body mass, and dominant lower limb from each participant. We defined the dominant limb as the one preferred by the volunteers to kick a ball as far as possible. All the tests were performed with this limb because we believe that it better reflects the maximum strength and muscle power of the volunteers. A physical therapist then submitted the participants to a standardized physical examination to screen them based on the inclusion and exclusion criteria.

**Functional Assessment.** Before the functional assessment, each participant completed a 5-minute submaximal warm-up on a treadmill (Explorer Proaction, BH Fitness, Vitoria-Gasteiz, Spain) at a speed of 1.66 m/s, followed by stretching of the thigh muscles. Standing with the hip extended and knee flexed, the subjects were instructed to grasp the ankle without arching the back to stretch the knee extensors. Sitting at the edge of a treatment table with the leg to be stretched extended across the table and the other foot on the floor, the subjects were instructed to incline the trunk toward the thigh to stretch the knee flexors. Three 30-second series were carried out for each stretching exercise. Next, they were submitted to a familiarization process consisting of 3 attempts at each functional test conducted in a random order so that the influence of one test on the others was minimized. All the functional assessments were carried out by the same evaluator in a protocol similar to that used by Bolgla and Keskula.\textsuperscript{24} To measure the distance jumped in the TLJ, a standard tape measure was fixed to the ground, perpendicular to the starting line of the test, while a progressive digital stopwatch (Timex Marathon, Timex Group USA Inc, Middlebury, CT) was used to measure the execution time of the TH. Each subject began both tests standing on the dominant limb with the foot immediately behind the starting line. The arms were positioned behind the body to prevent any contribution of balancing during the activity (increasing the functional demand on the limb under consideration). To carry out the TLJ, the subjects were instructed to execute 3 consecutive maximum jumps on the dominant limb and maintain their balance on the last landing for at least 2 seconds before placing the contralateral limb on the ground. For the TH, the volunteers were instructed to complete the set distance (6 m) performing consecutive jumps on the dominant limb as quickly as possible and crossing the finishing line without slowing down at any point in the test.
The tests were repeated if the volunteers used their arms as a propulsion strategy or lost their balance during the test. Three valid attempts of each test were carried out. The longest distance achieved during the TLJ normalized according to body height and the shortest time achieved in the TH were used for the statistical analyses.

Prior test–retest reliability of both tests was assessed by the primary investigator. Twelve women were tested on 2 occasions, which were separated by 1 week. Intraclass correlation coefficients (ICC 3,1) and standard errors of measurement (SEM) were .91 (0.09) for the TLJ and .86 (0.09 s) for the TH.

**Isokinetic Assessment.** The evaluations of eccentric hip-abductor, hip-adductor, medial-rotator, and lateral-rotator torque were carried out using an isokinetic dynamometer (Biodex Multi-Joint System 2, Biodex Medical System Inc, New York, NY) 48 to 96 hours after the functional assessment. The dynamometer was calibrated at the start of every day of testing. Before testing, each participant completed a warm-up procedure similar to that described previously, plus stretching of the hip muscles. Standing with the side to be stretched toward a wall, the subjects were instructed to extend and adduct the dominant lower limb and cross it behind the other extremity to stretch the hip-abductor muscles. In this position, the subjects were asked to shift the pelvis toward the wall and bend the trunk away from the side being stretched. Hip-adductor stretching was carried out with the subjects seated on the floor, with the soles of the feet together and the hands on the inner surfaces of the knees. In this position, the subjects were instructed to push their knees toward the floor. Hip lateral- and medial-rotator stretching was carried out by the evaluator with the subjects seated on the chair. For the stretching of both muscles, the thigh was stabilized by applying pressure on it with 1 hand. The hip lateral-rotator muscles were stretched by rotating the hip medially by applying force to the medial aspect of the lower leg, and the hip lateral-rotator muscles were stretched in the opposite way.

All the isokinetic assessments were performed by the same evaluator using a protocol similar to that used in previous studies. Specifically, eccentric hip-abductor and -adductor torque were tested with the subjects in a side-lying position. The dominant limb was positioned parallel to the ground in neutral hip flexion/extension and mediolateral rotation. The contralateral hip and knee were flexed and fixed with straps. The trunk was stabilized using a single belt proximal to the iliac crest. The mechanical rotation axis of the dynamometer was aligned with a point representing the intersection of 2 lines: 1 line directed inferiorly from the posterosuperior iliac spine toward the knee and the other posteriorly and medially directed from the greater trochanter of the femur toward the midline of the body. The lever arm of the dynamometer was laterally attached to the thigh under test, 5 cm above the base of the patella. The participants were instructed not to bend their knees during the test (Figure 1). The range of motion of the test was from 0° (neutral) to 30° of hip abduction.
small range of motion during the eccentric test of the hip-abductor and -adductor muscles, high isokinetic testing speeds might decrease the time of the isokinetic phase\textsuperscript{26} and, consequently, underestimate torque-production capacity. Furthermore, because Kea et al\textsuperscript{13} did not verify a relationship between eccentric hip-abductor torque evaluated at 60°/s and functional performance, a lower velocity was chosen in the current study.

For the familiarization procedure, the participants performed 1 series of 5 submaximal and 1 series of 2 maximal reciprocal eccentric contractions, with a 1-minute interval between series. After another 1-minute interval, the participants performed 2 series of 5 maximal repetitions with a 3-minute rest period between series. Oral encouragement was provided to stimulate the participants to produce the maximum torque. To correct for the influence of gravity on the torque data acquired, the limb was weighed before each test according to the instructions found in the manual of the dynamometer, and thus the results of the test were automatically corrected by the data-acquisition software. In the statistical analyses, we used the isokinetic peak torque normalized according to body mass (Nm/kg), which could be from either the first or the second series.

Prior test–retest reliability of eccentric hip-torque measurements was assessed by the primary investigator. Nine subjects were tested on 2 occasions separated by 1 week. ICC\textsubscript{3,1} (SEM) was .97 (0.07 Nm/kg) for abduction, .78 (0.16 Nm/kg) for adduction, .87 (0.07 Nm/kg) for external rotation, and .92 (0.11 Nm/kg) for internal rotation.

Statistical Analyses

All statistical analyses were performed using Statistica software (version 7.0, StatSoft Inc, Tulsa, OK). We obtained descriptive values (means, SDs, and intervals of variation) for each variable, and we calculated the Pearson correlation coefficients between the dependent and independent variables. The $r$ values were interpreted using the following guidelines: .00 to .19 = none to slight, .20 to .39 = low, .40 to .69 = modest, .70 to .89 = high, and .90 to 1.00 = very high.\textsuperscript{27} Two forward-stepwise-regression analyses were then used to determine the main predictive variables for each functional test. The level of significance used to determine whether the independent variables entered the models was .05.

Results

Descriptive data are presented in Table 1. Table 2 lists the Pearson correlation coefficients between the independent variables and the TLJ and TH. Tables 3 and 4 provide a summary of the steps used in the multiple-linear-regression analysis for both the functional tests.

All the isokinetic variables except eccentric hip-adductor torque were significantly correlated with the TLJ. The TLJ showed high positive correlation with the eccentric hip-lateral-rotator torque (.72) and modest positive correlation with the eccentric hip-abductor (.56) and medial-rotator (.65) torque (Table 2). All the torque variables were significantly correlated with the TH. The TH presented modest negative correlation with eccentric hip-abductor (–.55), lateral-rotator (–.68), and medial-rotator (–.54) torque and low negative correlation with eccentric hip-adductor torque (–.39; Table 2).

### Table 1 Descriptive Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-leg triple long jump\textsuperscript{a}</td>
<td>2.19 ± 0.26</td>
<td>1.67–2.72</td>
</tr>
<tr>
<td>Timed 6-m single-leg hop\textsuperscript{b}</td>
<td>2.33 ± 0.28</td>
<td>1.80–2.75</td>
</tr>
<tr>
<td>Hip abductor\textsuperscript{c}</td>
<td>1.32 ± 0.19</td>
<td>1.01–1.84</td>
</tr>
<tr>
<td>Hip adductor\textsuperscript{c}</td>
<td>2.02 ± 0.24</td>
<td>1.58–2.6</td>
</tr>
<tr>
<td>Hip lateral rotator\textsuperscript{c}</td>
<td>0.82 ± 0.14</td>
<td>0.58–1.22</td>
</tr>
<tr>
<td>Hip medial rotator\textsuperscript{c}</td>
<td>1.53 ± 0.35</td>
<td>0.88–2.25</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Distance covered (cm) normalized according to body height (cm).
\textsuperscript{b} Time taken (s).
\textsuperscript{c} Eccentric isokinetic peak torque normalized according to body mass (Nm/kg).

### Table 2 Pearson Product–Moment Correlation Coefficients

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
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<tbody>
<tr>
<td>1. Single-leg triple long jump</td>
<td>1.00</td>
<td>-.73*</td>
<td>.56*</td>
<td>.26</td>
<td>.72*</td>
</tr>
<tr>
<td>2. Timed 6-m single-leg hop</td>
<td>1.00</td>
<td>-.55*</td>
<td>-.39*</td>
<td>-.68*</td>
<td>-.54*</td>
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<tr>
<td>3. Hip abductor</td>
<td>1.00</td>
<td>.68*</td>
<td>.36*</td>
<td>.59*</td>
<td></td>
</tr>
<tr>
<td>4. Hip adductor</td>
<td>1.00</td>
<td>.20</td>
<td>.38*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Hip lateral rotator</td>
<td>1.00</td>
<td>.65*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Hip medial rotator</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\*P < .05.
The results of the regression analysis showed that although the eccentric hip lateral-rotator torque alone accounted for 51% of the variability in the TLJ results and 45% of the variability in the TH data, the combination of the eccentric hip-lateral rotator torque with the eccentric hip-abductor torque provided the most effective estimate for the TLJ ($R^2 = .79$, $R^2 = .63$, $R^2$ fitted = .60, $F_{2,28} = 20.50$, $P < .001$; Table 3) and for the TH ($R = .76$, $R^2 = .58$, $R^2$ fitted = .55, $F_{2,29} = 12.74$, $P < .001$; Table 4).

**Discussion**

Most of the studies reported in the literature that aimed to correlate the individual strength of lower limb muscles with functional performance evaluated the perarticular knee muscles.2–6 On the other hand, there is only 1 study that verified the role of eccentric hip torque on the prediction of function performance.13 Therefore, our objective was to determine the relationship between eccentric hip torque and performance in functional tests. We showed that the greater the values for eccentric hip-abductor and lateral- and medial-rotator torque, the greater the distances covered in TLJ and the shorter the times in TH. Furthermore, our results demonstrated that eccentric hip lateral-rotator and -abductor torque were the best variables that contributed to predicting the yield in both of the functional activities carried out.

Our interest in studying the relationship between eccentric hip strength and functional performance in women came from the increasing attention to the hip muscles in recent years and the greater incidence of knee injuries observed in females.11 Recently, some studies have associated a deficit in eccentric hip-abductor and lateral-rotator strength with the development of PFPS7,8 and rupture of the ACL.9 Boling et al7 reported that the PFPS group was weaker than the control group for eccentric hip-abduction torque and eccentric hip external-rotation torque, and Baldon et al8 demonstrated impaired eccentric hip-abductor torque in females with PFPS. It has been suggested that an eccentric deficit of the hip muscles might cause misalignment of the lower limb during dynamic activities,9,10 resulting in knee-valgus collapse, especially in females.9 Excessive knee valgus would increase the quadriceps angle and, consequently, the lateral pressures within the patellofemoral joint.28 In addition, McLean et al29 showed that a small change of 2° in knee-valgus angle corresponds with an approximately 100% increase in valgus loads, making the knee more sensitive to valgus buckling and ACL rupture.

In our study, eccentric hip-lateral-rotator and hip-abductor torque accounted for 60% of the variability in the TLJ and 55% of the variability in the TH. We speculated that lower values of eccentric hip-lateral-rotator and hip-abductor torque might have predisposed the women to misalignment of the lower limb during the landing phase of a jump. Decreased eccentric hip-abductor and lateral-rotator strength have been proposed to increase femoral adduction and internal rotation and, consequently, dynamic knee valgus.11 Jacobs and Matacola9 and Claiborne et al30 showed a negative correlation between eccentric hip-abductor strength and dynamic knee valgus during landing after a horizontal jump and single-leg squatting, respectively. We believe that a greater excursion in knee valgus during the landing phase could reduce the ability of the hip- (gluteus maximus and hamstrings) and knee- (quadriceps) extensor muscles to produce propulsive force. The contraction of the extensor kinetic chain with the knee in a valgus position would decompose the force responsible for accelerating the center of mass in the sagittal plane. The propulsive force would no longer only act in the sagittal plane but be decomposed in the sagittal and coronal planes, reducing performance (Figure 3).

Another possible explanation for the correlation among eccentric hip-abductor and lateral- and medial-rotator torques and functional performance concerns the maintenance of pelvic stability in the coronal plane. It has been proposed that the gluteus medius,31 tensor fasciae latae,11 and superior fibers of the gluteus maximus32 are the muscle groups primarily responsible for preventing

### Table 3 Results for the Regression Analysis Estimating the Distance Covered in the Single-Leg Triple Long Jump

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>PE</th>
<th>SE</th>
<th>$P^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>First step$^b$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hip-lateral-rotator peak torque</td>
<td>1.32</td>
<td>.22</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Second step$^c$</td>
<td></td>
<td></td>
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<tr>
<td>hip-lateral-rotator peak torque</td>
<td>1.09</td>
<td>.21</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>hip-abductor peak torque</td>
<td>0.45</td>
<td>.16</td>
<td>.009</td>
</tr>
</tbody>
</table>

PE, parameter estimated; SE, standard error.

$^a$ For each variable at each step.

$^b$ $R^2$ fitted = .51, $P < .001$ (for the model in this step).

$^c$ $R^2$ fitted = .60, $P < .001$ (for the model in this step).

### Table 4 Results for the Regression Analysis Estimating the Time Taken in the Timed 6-m Single-Leg Hop

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>PE</th>
<th>SE</th>
<th>$P^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>First step$^b$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hip-lateral-rotator peak torque</td>
<td>–1.29</td>
<td>.26</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Second step$^c$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hip-lateral-rotator peak torque</td>
<td>–1.06</td>
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<td>&lt;.001</td>
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<tr>
<td>hip-abductor peak torque</td>
<td>–0.51</td>
<td>.18</td>
<td>.009</td>
</tr>
</tbody>
</table>

PE, parameter estimated; SE, standard error.

$^a$ For each variable at each step.

$^b$ $R^2$ fitted = .45, $P < .001$ (for the model in this step).

$^c$ $R^2$ fitted = .55, $P < .001$ (for the model in this step).
the fall of the contralateral pelvis during the stance phase of weight-bearing activities such as walking. When these muscles do not act effectively to control the pelvis in the coronal plane, a woman could displace her body-mass center in the direction of the supporting limb as a consequence of a compensatory lateral inclination of her trunk to the same side.21 This maneuver moves the resultant ground-reaction-force vector closer to the hip-joint center, thereby reducing eccentric demand on the hip abductors. However, the excessive displacement of the center of mass toward the stance limb during the landing from a jump could move the resultant ground-reaction-force vector lateral to the knee-joint center, creating a valgus external moment.11 This compensation associated with excessive femoral adduction and medial rotation might increase dynamic knee valgus, impairing the propulsive phase of the jump and, consequently, performance.

In addition, Bobbert and van Zandwijk33 have reported that the ability of the quadriceps and hamstrings to resist forces experienced by the lower extremity when jumping is significantly improved by increased hip-muscle activity during a vertical jump. Those authors also showed that an increase in hip-joint moment, earlier and faster than the other lower limb joint moments, was the only way to promote an upward–forward acceleration of the center of mass, necessary for better jump performance.

Thus, by either improving pelvic alignment or enhancing the function of the quadriceps and hamstrings, the resulting increase in strength of the hip-abductor and lateral-rotator muscles may improve neuromuscular control of the knee during landing from a jump, as stated by Jacobs et al.34 This finding adds to the biomechanical link between hip function and knee control proposed by Cowan and Crossley,35 whereas increased hip-abductor strength promoted enhanced vasti neuromotor control. We believe that all these factors may be related in promoting better alignment of the lower limb and, consequently, improving performance during jump tasks.

We found only 1 article in the literature that aimed to correlate eccentric hip torque with performance. Kea et al13 showed no correlation between eccentric hip-abductor torque and the distance covered in lateral and medial single-leg jumps by male hockey players. We believe that the different methodologies used contributed to divergences in the results. In our study, the subjects performed consecutive jumps in the sagittal plane, whereas Kea et al evaluated a functional activity involving only 1 jump in the coronal plane. We believe that eccentric hip-abduction action may be more important to maintain lower limb alignment in more complex activities performed in the sagittal plane. In addition, we evaluated only female recreational athletes, and Kea et al
studied male hockey players. Ferber et al\textsuperscript{19} reported that the eccentric demand on hip muscles is greater in women than in men during functional activities. Therefore, the greater correlation observed in our study might indicate that women had more need of the hip-abductor and lateral-rotator muscles to control lower limb movements during the stance phase from the jump and, consequently, to perform both functional tests.

We recognize that there were some limitations in this study. Although we hypothesized that a misalignment of the lower limb was responsible for the poorer performance in women with lower eccentric hip torque, the kinematic variables were not assessed. Thus, we believe that more studies are required to elucidate the relationship between eccentric hip torque, lower limb alignment, and performance in functional activities. In addition, because we were interested in studying the primary factors for controlling the lower limb in the coronal and transversal planes, we evaluated only 4 muscle groups. Our findings suggest that there are additional factors that affect function in women. Thus, we recommend that further studies verify the relationship between the strength of other muscle groups and performance. Finally, the correlation design of the current study did not allow for the conclusion that specific training of the eccentric action of the hip-abductor and lateral-rotator muscles could improve performance in jump activities. To verify the clinical applicability of the current results, further prospective studies are required.

Conclusions

The values obtained for eccentric hip-abductor and lateral- and medial-rotator torque showed positive correlation with the distance covered in the TLJ and negative correlation with time spent in the TH. The current results showed that eccentric hip lateral-rotator and hip-abductor torque were the variables providing the best estimates in the functional tests. Therefore, it is recommended that the eccentric action of these muscles be evaluated during sporting activities and that emphasis be given to strengthening these muscles with the objective of improving functional performance.

References


