Association of Stair Climb Power Test with Muscle Strength in Healthy Individuals – A Cross Sectional Study

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INTRODUCTION

Stair climbing is a form of exercise that everyone can do to some degree. The stair climb power test (SCPT) recently was proposed as a simple and safe alternative to more sophisticated tests for measuring lower limb muscle impairments. The SCPT is a simple and safe measure of lower limb muscle strength, power, and functional performance in older adults. Because the SCPT does not require additional equipment, it could be a reasonable alternative to more sophisticated tests for measuring lower limb muscle impairments.

OBJECTIVE: To explore association of the stair climb power test with muscle strength in healthy individuals.

STUDY DESIGN: A cross-sectional study

METHOD: 50 people who were healthy were tested with the SCPT. Knee extensor and flexor muscle torque was assessed with an isokinetic dynamometer.

RESULTS: The association of the SCPT with knee extensor muscle torque tended to be stronger (r=0.69). Knee flexor muscle torque also strongly associated with SCPT (r=0.74).

CONCLUSIONS: The SCPT is a simple and safe test associated with muscle strength in healthy individuals. The SCPT can be used as an alternative to the expensive devices and time-consuming laboratory based tests.

INTRODUCTION

In a clinical setting it is sometimes not practical or efficient to evaluate muscle function with expensive devices and time-consuming laboratory based tests. Furthermore, in research and patients care there is need to measure performance in tasks that are more similar to activities of daily living (ADLs) and instrumental activities of daily living (IADLs) than many sophisticated laboratory tests. These two considerations have resulted in the development of simple, inexpensive and easy to administer tests of neuro-muscular function or performance. These measurements do not represent direct evaluation of skeletal muscle or any other isolated physiologic characteristic but rather an integrated response of the human body to the demands of particular task.

Leg muscle power has generally been measured with large, expensive and specialized equipment.1,2 The stair climb power test (SCPT) was proposed as a simple and safe measure associated with measures of lower limb muscle strength, power and functional performance in older adults.3 The stair climb power test is an inexpensive test that is simple to perform. This test can be completed in less than 1 minute and requires only access to a flight of stairs, a scale and a stopwatch. In this study it is hypothesized that among healthy individuals, the SCPT would be a clinically relevant measurement of leg muscle strength. Therefore, a cross-sectional study was conducted among healthy individuals comparing SCPT with lower limb muscle strength measured with isokinetic dynamometer.

METHODS

Participants

People who were healthy were recruited on a voluntary basis from the local community. Verbal consent regarding the study was taken from the participants.

To be included in the study, people who were healthy had to be sedentary. “Sedentary” was defined as “only performs activities with low metabolic cost, including light activities such as slow walking or cooking.” Exclusion criteria were regular participation in a formal exercise program during the 1-year period before the study; current smoking; and respiratory, cardiovascular, or neurological disease or lower-extremity musculo-skeletal problems that could interfere with or could cause undue risk during the performance of a study test.

50 people who were healthy but sedentary and matched for age, sex, and body mass were included in the study. The characteristics of the participants are shown in Table 1.

Table 1: Characteristics of study participants

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>MEAN(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(year)</td>
<td>21.82(1.3)</td>
</tr>
<tr>
<td>Measurements</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>160.21 (5.14)</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>55.6 (7.8)</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>21.54 (3.72)</td>
</tr>
</tbody>
</table>

**SCPT**

The examiner stood with each subject at the base of a well-lighted, 12 stair flight of stairs. Subjects were instructed to safely ascend the stairs as fast as they could. They were further instructed that they could use the handrail if they thought it was necessary for safety purpose and to begin when the examiner said, “Ready, set, go.” Timing began after the examiner said “go” and once each subject began moving. When both feet of a subject reached the top step, the timing stopped. Time was recorded and the average of two trials was taken. Test-Retest reliability for this measure is excellent (R=.99). Stair climb power was calculated with the following formulas: power equals force times velocity. Velocity is calculated by dividing the distance, which in this case is the total vertical height of the stairs, by the time required to climb the 10 stairs (v=d/t). Force is calculated by multiplying body weight by acceleration (F=m×a); the latter is the constant for the effect of gravity (9.81 N). Thus, power (P=F×v) for the SCPT is the product of (total vertical height of the stairs/time) × (body weight × 9.81).

**Isokinetic Strength Testing**

The concentric average peak torque of the knee extensor and flexor muscles of the dominant leg (determined by preference for kicking a ball) was assessed with a Humac norm, cybex GSMI dynamometer at angular velocity of 60°/s. Previous researchers have established the mechanical reliability of the cybex and have shown that reciprocal, concentric peak torque measures obtained at 60° is very consistent from day to day when a standardized protocol is used.

Participants were tested for concentric knee extension and flexion in a seated position, with hip and thigh stabilization straps applied. Seat angle was set at 85° and the knee angle at 90°. The knee axis of rotation was aligned with the dynamometer shaft, and the lower edge of the resistance pad was placed just superior to the medial malleolus and was secured with a stabilization strap. Range-of-motion stops were set at 90° of flexion and 20° of extension for a total range of motion of 70°, and gravity correction was performed. This range of motion was selected to diminish joint discomfort and force variability produced by the action of the hamstring muscles at the end of knee extension. The rationale for using a 20° extension limit for this baseline testing protocol was for better comparisons with strength values after injury or surgery, when full extension may be voluntarily or involuntarily limited. Although a separate reliability study was not performed for this limited-range protocol, researchers have shown that reducing the range of motion does not compromise reproducibility of peak torque values.

After a warm-up consisting of 5 submaximal contractions, participants were asked to extend their knee as fast and as hard as they could. Knee flexor muscles were tested with the same procedures except that participants were asked to bend their knee.
RESULTS

Data were analyzed using SPSS version 16 with 2-tailed probability tests with the level of significance set at P<.05. Pearson product moment correlation was used to explore association between the SCPT and measures of knee extensor muscle torque. The strength of the correlations (r) was categorized as low (0–.25), moderate (> .25–.50), strong (> .50–.75) and very strong (> .75). Data are presented as means, standard deviations, and 95% confidence intervals.

The Pearson correlation analysis confirmed that the SCPT was very strongly associated (r=.69, P<.001) with measures of knee extensor muscle concentric torque in the healthy individuals. Knee flexor muscle concentric torque (r=.74, P<.001) also showed strong associations with the SCPT. The associations between the SCPT and the various torque measures are shown in following Tables:

**Table 2: Power and peak torque**

<table>
<thead>
<tr>
<th>MEASURES</th>
<th>SCPT</th>
<th>PEAK TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTENSION</td>
<td>350.33</td>
<td>69.4</td>
</tr>
<tr>
<td>FLEXION</td>
<td>40</td>
<td>20.69</td>
</tr>
<tr>
<td>SD±</td>
<td>82.14</td>
<td>35.17</td>
</tr>
</tbody>
</table>

**Table 3: Association between the stair climb power test and muscle torque**

<table>
<thead>
<tr>
<th>TORQUE MEASURES</th>
<th>PEARSON CORRELATION COEFFICIENT, r</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee extensor muscles</td>
<td>0.694</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Knee flexor muscles</td>
<td>0.748</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

DISCUSSION

The primary finding of the study was that Stair Climb Power Test was a strong predictor of strength tests. SCPT was strongly related to the knee extensor muscle torque in healthy individuals. Knee flexor muscle torque was also strongly associated with SCPT. This result suggests that Stair Climb power test is a valid predictor of lower limb strength in healthy individuals.

Previous authors have examined the clinical relevance of the stair climb power test as measures of leg power impairment in mobility limited older adults. Their study has also shown that the association between the SCPT is sufficiently strong to consider the SCPT a relevant clinical measures of leg muscle power impairments which is consistent with our study.

In another study, SCPT was moderately associated with concentric knee extensor and flexor muscle torque in COPD group and strongly associated with healthy people which is similar to our study results. A potential explanation for the different degrees of association between groups is that in people with COPD, factors other than muscle strength come into play during the SCPT.

Muscle power is particularly important in clinical evaluations because it is more closely related to functional performance, 9 postural control, 10, 11 and possibly fall prevention strategies (e.g., fast anticipatory movements) 12, 13 than is muscle strength. Therefore, the SCPT may add some new clinical information to the characterization of functional impairments.

In future studies, the sensitivity and responsiveness of the SCPT for detecting functional improvements after training interventions should be explored.

CONCLUSION

Our study has shown that the association between the SCPT and concentric knee extension and flexion muscle torque is strong to consider the SCPT a relevant clinical measure of lower limb muscle strength in healthy individuals. The stair climb power test (SCPT) can be used as a simple, inexpensive and easy to administer tests for assessing muscle strength as an alternative to expensive devices and time-consuming laboratory based tests.

REFERENCES


