Correlation of partial weight bearing lower extremity performance measure with self-assessed activity level

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Master of Science in Biomedical Sciences
Concentration in Physical Therapy

Correlation of a Partial-weight Bearing Lower Extremity Performance Measure with Self-assessed Activity Level

Submitted by

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Master of Science in Biomedical Sciences

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Correlation of partial weight bearing lower extremity performance measure with self-assessed activity level

Alison Pollacek B.S.
Abstract

**Study Design:** Correlational study

**Objectives:** To determine the validity of inferences drawn from two reliable partial weight bearing LE performance tests.

**Background:** Many clinicians today utilize full weight bearing performance tests to help assess an individual’s progress made in therapy and their readiness to return to unrestricted activity. The problem with these tests is that they require the individual to be full weight bearing and have no weight bearing restrictions. This leaves clinicians with no functional measure to assess those patients in the more acute stages of recovery.

**Methods and Measures:** Subjects recruited participated in one testing session. The functional partial weight bearing tests were performed on a sliding apparatus called the Total Gym. Subjects were acclimated to the functional performance tests and then completed the following, 1) Timed test to measure how long it took to complete 30 squats; 2) the number of squat repetitions completed in 20 seconds; and 3) Danish Physical Activity Scale.

**Results:** Data was statistically analyzed using a Pearson’s correlation analysis to determine how well the lower extremity performance tests correlated with the self-report scale. The three variables analyzed: 30 repetition test, 20 second repetition test, and METS/hr. No gender differences (p>0.10) were found for any of the dependent variables. An ICC of 0.95 was calculated for both PWB tests. Data analysis calculated an r-value of −0.284 (significant p<0.10) for the timed 30 repetition test and an r-value 0.384 (significant p<0.05) for the 20 second repetition test.

**Conclusions:** The results of this study provide preliminary correlation evidence to support using the two lower extremity performance tests to measure an individual’s lower extremity strength. These tests may also allow clinicians to estimate the functional ability of their patients earlier in
their recovery. This will allow clinicians to better document their patient’s progress throughout the rehabilitation period.
Introduction

Lower extremity (LE) injuries and dysfunction often result in a period of non- or partial weight bearing (PWB) for the involved individuals. The ultimate goal is to restore these individuals to their pre-injury level of activity. Therefore, clinicians need to be able to monitor performance, so they can progress these individuals to more demanding functional activities and ultimately determine when it is safe to return to unrestricted activities. Clinicians often use closed chain testing (functional weight bearing tests) to relate clinical performance to functional level.1-6

There are many functional performance tests used by clinicians today that provide reliable data and valid inferences about function. Some of these include the one-leg single hop test for distance, the shuttle run test, the lateral step-up test, running in a figure eight, and ascending and descending a staircase. The fact that these tests require full weight bearing limits their use to individuals who are in the earlier stages of rehabilitation.1-6,8

As a result, clinicians must use non-weight bearing (e.g., isokinetic devices, manual muscle testing) tests in an attempt to measure performance and predict function for individuals with limited/restricted weight bearing abilities (e.g., individuals with acute injuries/surgery). Many studies have found that these tests are not valid predictors of function.7,9

A new method of testing, using an inclined sliding apparatus, has recently been recommended for testing individuals who have a non or partial weight bearing status.13 This device is used to measure an individual’s LE performance based on two separate, single-leg squat tests. These tests include a timed test (i.e., the time it takes to complete 30 one-legged squat repetitions) and a repetition test (i.e., the number of one-legged squat repetitions a person can complete in 20 seconds). Both tests are performed in a partial weight bearing position. Although there are few studies to date about this method, it has been proven to yield reliable
However, there is no data to support the validity of the inferences drawn from these performance tests. While there is evidence that an inclined sliding apparatus is reliable for measuring performance, little research has been conducted about the ability of performance on this device to provide a valid inference about function.

Clinicians also utilize self-report instruments as a way to measure function in their patients. One instrument in particular has been shown to provide reliable data and valid inferences about a person’s self-reported activity level. This instrument, called the Danish Physical Activity Scale (DPAS), has been used to provide an estimate of the total energy expenditure of a person over the course of a day, estimated in metabolic equivalents (METS). This scale is useful because of its ability to provide clinicians with information regarding a patient’s activity level relative to an injured or healthy state. However, as with any self-report measure, the DPAS is an indirect, subjective measure of a person’s ability level.

Because of the limitations of current measurement procedures for individuals with lower extremity dysfunction, particularly persons of limited weight bearing status, the purpose of this study was to examine validity evidence of the two lower extremity partial weight bearing tests reported by Munich et al. The performance measures of these two tests were expected to correlate with a person’s self-reported activity level. Individuals reporting higher levels of physical activity were expected to perform better with the two lower extremity performance measures. The DPAS was used in this study to see if the subjects activity level as determined by the DPAS can be related to their performance on the partial weight bearing tests.

This study tested the activity level of healthy subjects using the two partial-weight bearing measures as well as the self-report instrument. On the Total Gym, the subjects performed two single leg squat tests: a 20-second repetition test (Right 20 S) and a timed 30-repetition test (Right 30 R). The subjects performed each of these two tests bilaterally. The
subjects then filled out the self-report instrument as a measure of their physical activity. The researchers took the results from this testing and analyzed them to determine if there was a correlation between the two PWB tests and the self-report instrument.

**Research Hypotheses**

The researchers hypothesized the following:

1. There would be a negative correlation between the time needed to complete 30 repetitions of a single leg squat on the Total Gym and the METS reported on the self-report activity survey.

2. There would be a positive correlation between the number of repetitions (in 20 seconds) of a single leg squat on the Total Gym and the METS reported on the self-report activity survey.
Literature Review

A therapist’s ability to test an individual’s functional capacity is an essential component of physical therapy. Functional testing allows clinicians to accurately assess a patient’s strength and ability to return to activities. These tests also allow clinicians to monitor a patient’s progress over time. The goal of therapy is to restore the joint function to the previous state so the patient can return to everyday life activities.

In the past, isokinetic strength testing was the preferred method used to determine a patient’s functional ability. This type of testing has often been referred to as open kinetic chain testing because the lower extremity is in a non-weight bearing (NWB) position. There are advantages and disadvantages associated with testing patients in this position. An advantage of isokinetic testing is that the clinician can isolate a specific joint or muscle to assess and reliably test and re-test the muscles strength and range of motion. However, some suggest that NWB tests cause harmful stresses to the knee. Stiene et al found that NWB exercises produced increased patellofemoral compressive forces. These increased forces may result in harm to a newly re-constructed anterior cruciate ligament or to the patellofemoral joint itself. Another concern with NWB tests is the insufficient validity evidence. Worrell et al investigated the functional lateral step up exercise by measuring improvement using isokinetic strength tests and weight bearing tests. The researchers concluded that performing the lateral step-ups increased the subject’s lower extremity functioning when measured with weight bearing tests. This increase was not detected by the isokinetic testing because the test did not match how the subjects were trained. This study concluded that the isokinetic testing has poor validity.

The inability of isokinetic testing to detect improvements in functioning is an important consideration when assessing functional ability. Weight bearing activities are preferred when therapists are making treatment plans. Recent literature suggests that functional performance
tests be incorporated to help assess and evaluate a patient’s lower extremity function. Some examples of these functional tests include the one-hop test, stair climbing, vertical jump and shuttle run. The goal of these tests is to recreate the functional forces that the lower extremity experiences in a typical day. These tests have been researched and proven to yield reliable data and valid inferences of lower extremity function. Research supports using these functional tests because they are simple, effective, easy to administer and provide a safe way to assess a patient’s lower extremity function. Stiene et al concluded that these weight bearing functional tests are also the preferred method of rehabilitation and a good predictor of function in those patients with patellofemoral problems.

Although full weight bearing tests are considered more effective in assessing a patient’s lower extremity function, not all patients are able to complete these functional tests due to acute injuries or limitations in weight bearing status. These individuals who are unable to bear their full weight through that extremity are unable to complete the functional tests mentioned above. An alternative approach has been proposed in the literature. Equipment such as the Total Gym (Engineering Fitness International, Inc., San Diego, CA), enables the patient to perform exercises in a partial weight bearing position. This apparatus consists of a sliding incline bench and a foot support that allows the patient to bear some weight through the lower extremity while performing an exercise. In addition to its use as an exercise device, it has been reported in the literature that this device can be used to measure partial weight bearing performance of the lower extremity.

Two partial weight bearing tests using the Total Gym were tested for reliability. The first test consisted of performing the maximum number of single leg squats in a timed 20 seconds. The second test consisted of timing how long it takes to perform 50 single leg squats. Munich et al examined how reliable these two tests were on the Total Gym. The study used 35 healthy
subjects to perform these tests on their dominant leg. The subjects underwent three sessions, the first to orient themselves to the two tests they would perform and the other two sessions were to record data. There was one week in between each session. It was concluded that the data from these tests were reliable with ICC values of .89 for the 20-second tests and .80 for the timed 50-repetition test. While these two tests have yielded reliable data, there has been no evidence shown that they provide valid inferences about function.

An additional alternative for clinicians to measure their patient’s functional ability is the use of self-report instruments. There are many different instruments used but recently Aadahl et al completed a study validating the use of a new self-report instrument (Danish Physical Activity Scale, DPAS) to measure a patient’s physical activity level. The goal of this study was to develop an instrument for measuring the total physical activity level in a 24-hour period of an average day. Having a self-report such as the DPAS can be used as an indicator of how active a patient might be relative to their health status. The study examined concurrent validity evidence of this self-report instrument by comparing it to information from an activity diary, another self-report method. There was a correlation of 0.74 between the METS calculated using the activity scale and the diary. The researchers concluded that this new activity scale was a simple device that yielded reliable data and valid inferences of a patient’s physical activity. A drawback of the self-report instrument is that it is only an estimate of activity level and it is subject to reporter error. The DPAS is also not a true physical measure.

**Purpose**

There is a need in physical therapy for a partial weight bearing measure of lower extremity function. Two tests using a sliding board apparatus have the potential to measure function. These tests appear to yield reliable data; there is currently no validity evidence of these tests. The purpose of this study was to test how well the PWB performance measures correlate
with self-reported activity levels in healthy individuals. This study attempted to obtain concurrent validity evidence by comparing the performance of individuals on the PWB tests with their levels of perceived activity. It was hypothesized that individuals who report higher physical activity levels using the DPAS would also perform greater on the PWB tests compared with individuals who reported low physical activity levels.
Methods

Design

This was a correlational study with three dependent variables: the number (count) of single leg squat repetitions a person could perform in 20 seconds on the Total Gym, the time (seconds) to complete 30 single leg squat repetitions on the Total Gym, and the self-reported activity level, estimated in METS.

Subjects

The researchers recruited 24 subjects from The Medical College of Ohio community. In order to participate in this study, the subject had to be 18 years of age or older and healthy. In addition, the individual must have no known lower extremity dysfunction. Exclusion of subjects occurred if the individual reported that she was pregnant or if the individual was unable to follow directions. All subjects provided written informed consent in accordance with the Medical College of Ohio’s Institutional Review Board (IRB approval #104507).

Apparatus

The subjects completed the two different single leg squat tests using the Total Gym (Engineering Fitness International, Inc., San Diego, CA). The Total Gym consisted of an adjustable incline bench that slides on a track and a foot support (Figure 1).

Figure 1 – The Total Gym (Engineering Fitness International, Inc.)
Procedures

To complete this study, the subjects underwent one testing session where they performed both timed squat tests, the 20-second single leg squat repetition test and the timed 30 single leg squat repetition test, and completed the self-report activity instrument. Investigators demonstrated both tests to each subject. All tests were performed with the subjects PWB, which was approximately 60% of his or her body weight. Subjects were given the opportunity to practice each of the squat tests. Following familiarity with the testing procedure, the subjects were tested with the following two physical tests, assigned in random order:

1. time to complete 30 one-legged squat repetitions on the Total Gym
2. number of one-legged squat repetitions completed in 20 second

For each of these tests, the researchers encouraged the subjects to work at their own pace in order to ensure their safety. Following completion of the physical tests, subjects were asked to complete the DPAS (Figure 2).

20-second squat repetition test

This test involved performing single leg squats on the Total Gym for 20 seconds, as described by Munich et al. The subjects moved through a range of 0° of knee extension to a maximum of 70° of knee flexion. Subjects were requested to flex the knee as far as comfortable and safe for that individual with a goal to flex to 70 degrees. The subjects received instructions on the proper technique and performed practice squats to reinforce their understanding of the test. Following the practice squats, the subjects rested for one-minute before completing the actual test.
Timed 30 single leg repetition test

Researchers measured the amount of time it takes the subjects to perform 30 single leg squats on the Total Gym, as described by Munich et al. The subjects moved through a range of 0° of knee extension to a maximum of 70° of knee flexion. Subjects were only required to flex the knee as far as comfortable and safe for that individual. The subjects received instructions on the proper technique and performed practice squats to reinforce their understanding of the test. Following the practice squats, the subjects rested for one-minute before completing the actual test.

Subjects were encouraged to self determine the rate of test performance and to use as much of the available range. Subjects were given approximately one minute between performing each test and each test was performed on Level 10 of the sliding apparatus, which is equal to approximately 65% of his or her body weight.

Danish Physical Activity Scale

This scale asked respondents to estimate the amount of time they spend in nine different activities during the day. The nine activity levels ranged from sleep or inactivity to strenuous activity. Each level represented a certain range of activity that can be seen in Figure 2. The time was then used to convert an estimate of metabolic work (METS) for each individual. For each activity level the MET-time was calculated by multiplying the MET value by the time spent on that particular level. For example, seven hours on level A= 7 hrs. x 0.9 MET = 6.3 MET-time.
Figure 2 DPAS Activity Levels

<table>
<thead>
<tr>
<th>Test Level</th>
<th>Example of Activity</th>
<th>MET Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sleeping or resting</td>
<td>0.9 MET</td>
</tr>
<tr>
<td>B</td>
<td>Sitting, Watching T.V., Reading</td>
<td>1.0 MET</td>
</tr>
<tr>
<td>C</td>
<td>Working at desk, sitting in meeting, eating meals</td>
<td>1.5 MET</td>
</tr>
<tr>
<td>D</td>
<td>Standing, cooking, washing dishes, driving</td>
<td>2.0 MET</td>
</tr>
<tr>
<td>E</td>
<td>Light cleaning, vacuuming, walking downstairs, slow dancing, grocery shopping</td>
<td>3.0 MET</td>
</tr>
<tr>
<td>F</td>
<td>Bicycling for pleasure, brisk walking, painting or plastering</td>
<td>4.0 MET</td>
</tr>
<tr>
<td>G</td>
<td>Gardening, carrying wood, carrying light objects, walking upstairs</td>
<td>5.0 MET</td>
</tr>
<tr>
<td>H</td>
<td>Aerobics, exercising, shoveling snow</td>
<td>6.0 MET</td>
</tr>
<tr>
<td>I</td>
<td>More effort than level H: bicycle racing, playing sports</td>
<td>7.0 MET</td>
</tr>
</tbody>
</table>

Additional Data Collected

Subjects provided the following additional information: age, gender, height, and weight. This information was used for the purpose of descriptive statistics about the subjects.

Data Analysis

The researchers statistically analyzed the data using a Pearson’s correlation analysis in order to determine how well the lower extremity performance tests correlated with the self-report scale. Because many of the subjects did not fully account for all 24-hours of a day, in terms of activity level, the estimated MET’s were standardized to represent MET/hour for each subject. The lower extremity performance measures were correlated with the estimated METS/hour values for each subject. T-tests were run for equality of the means to assure that there were no
gender differences. The three variables analyzed were the 20-second repetition test, 30 repetition timed test and the total MET/hr.
Results

Twenty-four subjects participated in this study, eighteen females and six males. The subjects completed all three components of the experiment once. ICC values for both tests were 0.95 when analyzing for differences between lower extremities. For all analyses shown below, the data collected from the right lower extremity was used. The age range of subjects was 34 years (21-55 years), with an average age of 27.125 ± 10 years. There were no gender differences (p > .10) for any of the dependent variables (Table 1).

Table 1: Group Statistics

<table>
<thead>
<tr>
<th>Gender (N)</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>30Rep</td>
<td>Female (18)</td>
<td>23.98 sec.</td>
<td>4.50 sec.</td>
</tr>
<tr>
<td></td>
<td>Male (6)</td>
<td>24.54 sec.</td>
<td>3.01 sec.</td>
</tr>
<tr>
<td>20Sec</td>
<td>Female (18)</td>
<td>26.54 reps</td>
<td>4.87 reps</td>
</tr>
<tr>
<td></td>
<td>Male (6)</td>
<td>25.83 reps</td>
<td>2.79 reps</td>
</tr>
<tr>
<td>MET/hr</td>
<td>Female (18)</td>
<td>1.81 MET/hr</td>
<td>.38 MET/hr</td>
</tr>
<tr>
<td></td>
<td>Male (6)</td>
<td>2.03 MET/hr</td>
<td>.53 MET/hr</td>
</tr>
</tbody>
</table>
Group descriptive statistics are displayed in Table 2.

**Table 2 Group Descriptive Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right 30 R</td>
<td>24.12 sec.</td>
<td>4.12 reps</td>
<td>24</td>
</tr>
<tr>
<td>Right 20 S</td>
<td>26.36 reps</td>
<td>4.39 sec</td>
<td>24</td>
</tr>
<tr>
<td>Tot MET</td>
<td>40.27 MET</td>
<td>11.97 MET</td>
<td>24</td>
</tr>
<tr>
<td>MET/hr</td>
<td>1.87 MET/hr</td>
<td>.42 MET/hr</td>
<td>24</td>
</tr>
</tbody>
</table>

The correlations between the PWB tests and the DPAS are show in Table 3. The correlations were significant at p < .10.

**Table 3- R-values**

<table>
<thead>
<tr>
<th></th>
<th>MET per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right 30 R</td>
<td>-.284 *</td>
</tr>
<tr>
<td>Right 20 S</td>
<td>.384*</td>
</tr>
</tbody>
</table>

* Significant (p<.10)

Scatter plots of data collected can be seen below. Figure 1 shows the correlation between the number of repetitions performed in 20 seconds and increasing MET’s/hr. This shows that those subjects who rated themselves on the DPAS as more active also performed more single leg squats in a timed 20 seconds. Figure 2 shows the correlation between how long it took in seconds to perform 30 repetitions and decreasing MET's/hr. This shows that those subjects who rated themselves as more active on the DPAS needed less time to complete the 30 single leg squats.
Figure 1: 20 second repetition test

![Figure 1: 20 second repetition test](image1)

Figure 2: Timed 30 repetition test

![Figure 2: Timed 30 repetition test](image2)
Discussion

Being able to assess a patient’s functional status is a necessary component of physical therapy. This study examined concurrent validity evidence of two lower extremity partial weight bearing tests using the Total Gym. The results of this study revealed statistically significant correlations between these two tests and the DPAS. This provides preliminary evidence to support using these two partial weight-bearing tests as a measuring tool to examine function of the lower extremity during the rehabilitation process.

The 20-second partial weight bearing test and DPAS

This study showed statistically significant correlations between the DPAS and the 20-second timed squat test (r=0.384). The number of single leg squats that a subject performed in 20 seconds positively correlated with the activity level as determined by the DPAS. That means that the more active the subject reported to be, the greater number of single leg squats they were able to perform in 20 seconds. Similarly, the subjects who reported less activity completed fewer single leg squats in 20 seconds.

The 30-repetition partial weight bearing test and DPAS.

This study also showed statistically significant correlations between the DPAS and the 30 repetition squat test (r=−0.284). The length of time needed for the subject to perform 30 repetitions negatively correlated with the activity level determined by the DPAS. That means that the more active the subject was the less time it took for them to perform 30 single leg squats. Similarly, the subjects who were less active according to the DPAS took longer to complete the 30 repetition squat test.

These results are consistent with the energy requirements to perform this test. When performing single leg squats the more repetitions a subject can perform depends on the strength and level of conditioning of the subject. Subjects with a high activity level, a more active
lifestyle will be used to the demands of the single leg squats. As a result of having a more active lifestyle, these subjects are more likely to have the muscular strength to perform a greater number of squats in the 20 seconds. As seen in Table 3, there was a weaker correlation between the 30-repetition test and the DPAS. In general, the more active subjects performed better while the less active subjects did not perform as well. The data shown above shows that the lower extremity performance test performed on the Total Gym truly do measure lower extremity performance. These finding are important for clinicians to know. This lets clinicians know that there can be some degree of confidence from the inferences of the PWB tests. These correlations will also allow clinicians to use these PWB tests as a method of documenting a patient’s progress.

Limitations

There are a few limitations of this study that need to be mentioned. First, the small sample size which resulted in a narrow, very similar sample. Another limitation was that not all subjects understood that when filling out their DPAS, they should have accounted for an entire 24 hours.

Future Studies

Future research of these lower extremity tests performed on the Total Gym would be beneficial in giving a true representation of the correlation between the DPAS and the lower extremity tests. It would be beneficial to also increase the sample size and a larger age range of subjects, more representative of the population. This research could also be reproduced and focused on one specific PT setting, for example the typical patients seen in a skilled nursing facility.
Conclusion

The results of this study provide preliminary correlation evidence to support using the two lower extremity performance tests to measure an individual’s lower extremity strength. These tests may also allow clinicians to estimate the functional ability of their patients earlier in their recovery. This will allow clinicians to better document their patient’s progress throughout their rehabilitation.
References


