Development of Normative Values for the Single Leg Bridge Endurance Test

True A. Gane

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Development of Normative Values for the Single Leg Bridge Endurance Test

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in the Water’s College of Health Professions

By
True Gane

Under the mentorship of Dr. Haley Worst

ABSTRACT
The aim of this study is to determine the duration of time a healthy individual could hold a single-leg bridge. There is a lack of research on the amount of time a healthy individual should be capable of maintaining the correct form of this exercise, which is part of the special testing of the lumbar spine. The goal of this research was to give physical therapists a baseline for their patients during rehabilitation. This study recruited 35 healthy individuals between the ages of 18 and 60 to participate. The participants were asked to complete a general health questionnaire, and anyone who did not meet the minimum requirements were excluded from participating. Those with lumbar, knee, or hamstring injuries within the last six months were also excluded. The participants began with a warm-up then were instructed on the correct form of a single-leg bridge with a video example presentation. The participants were then asked to perform a double-leg bridge at a 90-degree angle on a flat surface. Then, after 5 seconds, the participants were asked to transition into a single-leg bridge. The dominant leg was reported by the participants and recorded. The angle of the participant’s legs was measured by placing red markers on the bony landmarks as guides for editing in the angles app (Version 1.6, ©2020 Nathaniel Joseph Cochran). The duration of time the participants could maintain the correct form of the exercise was timed. Each session was filmed and the time in which the participants either stopped or broke form was recorded.

Thesis Mentor: __________________________
Dr. Haley Worst

Honors Director: _________________________
Dr. Steven Engel

April 2022
Water’s College of Health Professions- Rehabilitation Sciences
Honors College
Georgia Southern University
Development of Normative Values for the Single-Leg Bridge Endurance Test

INTRODUCTION

Physical therapy promotes, maintains, and/or restores functionality to improve quality of life through physical examination, diagnosis, patient education, and rehabilitation. The single-leg bridge is an exercise used as part of the special testing of the lumbar spine, builds gluteal, hamstring, and lumbar multifidus strength, and promotes core stability. Strength in these areas can reduce the risk of injury. There is currently a lack of research regarding the duration of time a healthy individual should be capable of maintaining the correct form of a single-leg bridge.

The single-leg bridge is a commonly used exercise to build gluteus maximus, gluteus medius, gluteus minimus and tensor fasciae latae strength. “Gluteal strength plays a role in injury prevention, normal gait patterns, eliminating pain, and enhancing athletic performance. Research shows high gluteal muscle activity during a single-leg bridge compared to other gluteal strengthening exercises” (Leheka, 2017, p. 543). The gluteal muscles greatly impact other areas of the body as well. Dysfunction of the gluteal muscles can cause pain in the ankles, knees, hips, and lower back. For this reason, it is essential that physical therapists encourage their patients to strengthen their gluteal muscles, and single-leg bridges are one way to do it.

Another benefit of single-leg bridges is core stability. Improving core strength can impact patients in many ways. “Low back pain, hip dysfunction, and lower extremity dysfunction are examples of conditions that often warrant core, and lower extremity strengthening” (Youdas, 2015, p. 418). Bridging exercises, such as the single-leg bridge, require patients to recruit core muscles to maintain postural stability.

The purpose of this study is to develop normative values for the single-leg bridge endurance test for physical therapists to utilize in the rehabilitation of their patients. The single-
leg bridge will help patients build gluteal, hamstring, core, and lumbar multifidus strength which can reduce pain in the ankles, knees, hips, and lower back and reduce the risk of injury.

**METHODOLOGY**

**Subjects**
Thirty-five healthy subjects volunteered to participate in this study. Subject demographics are summarized in Figure 1. Subjects were recruited on the Georgia Southern University's Armstrong Campus in a sample of convenience. To be eligible to participate in this study participants needed to be between the ages of 18 and 60. The participants completed a general health questionnaire, and anyone who did not meet the minimum requirements were excluded from participating. Those with lumbar, knee, or hamstring injuries within the last six months were also excluded from the study.

**Figure 1.**
*Sociodemographic Characteristics of Participants*

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<thead>
<tr>
<th></th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
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<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>26</td>
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<td>Male</td>
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<td>25.7</td>
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<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>2.9</td>
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<td>20</td>
<td>2</td>
<td>5.7</td>
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<tr>
<td>21</td>
<td>5</td>
<td>14.3</td>
</tr>
<tr>
<td>22</td>
<td>5</td>
<td>14.3</td>
</tr>
<tr>
<td>23</td>
<td>10</td>
<td>28.6</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>11.4</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Frequency and percent of the sexes and ages of participants

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>31</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>38</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Instrumentation

The duration of time the participants were capable of performing the correct form of a single-leg bridge was recorded manually with a stopwatch by the researcher and also through a recording on the Angles-Video goniometer application. Red markers were placed on the participant’s bony landmarks (lateral acromion, greater trochanter, and lateral femoral condyle) as guides for editing in the Angles-Video goniometer app to determine the angle of the participant’s leg.

Testing procedure

Data was collected in the Research Annex in the Armstrong Center at Georgia Southern University’s Armstrong campus. The participants began with a 5-minute warm-up consisting of light jogging, high knees, forward leg kicks, and static hamstring and lumbar rotation stretches. Participants were then asked to lay hooklying on a mat table. Participants were shown a video presentation on the correct form of a single-leg bridge. The participants were then asked to perform a double leg bridge at a 90-degree angle. Then, after 5 seconds, the participants were prompted to transition into a single-leg bridge. The stopwatch was started by the researcher when the single leg was lifted off the table and stopped when the form was perceived as lost. One verbal cue was allowed for form correction. A two-minute rest break was given before the participant was asked to repeat the exercise on the opposite leg. The dominant leg was reported
by the participants and recorded. After the procedures were completed, the participants approved their videos.

**Figure 2.**

*Single-leg bridge set-up*

Example of setup for the single-leg bridge endurance test

**Statistical analysis**

Data was initially entered into Google Sheets and was coded in that system. Then at the completion of testing, the data was transferred to the IBM SPSS Statistics 27.0 software to create frequency tables of the demographics and normalcy graphs for the duration of time each sex, age group, and activity group could maintain the correct form of the single-leg bridge to look for correlation.
RESULTS

Figure 3 shows the estimated time for the dominant leg manually recorded with a stopwatch. The average estimated hold time was 67.62121951 seconds with a standard deviation of 31.96716528 seconds. The maximum time was 124.00 seconds. The minimum was 9.25 seconds.

Figure 3. 
Estimated Time for the dominant leg

<table>
<thead>
<tr>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard deviation</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
</tbody>
</table>

Estimated time for the dominant leg manually recorded with a stopwatch

Figure 4 shows the estimated time for the non-dominant leg manually recorded with a stopwatch. The average estimated hold time was 64.5311 seconds with a standard deviation of 30.09468 seconds. The minimum time was 16.00 seconds, and the maximum time was 120.00 seconds.

Figure 4. 
Estimated Time for the non-dominant leg

<table>
<thead>
<tr>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard deviation</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
</tbody>
</table>

Estimated time for the non-dominant leg manually recorded with a stopwatch
Figure 5 shows the actual time for the dominant leg manually determined with the Angles-Video Goniometer App. The average estimated hold time was 61.6517 seconds with a standard deviation of 33.23574 seconds. The minimum time was 9.07 seconds, and the maximum time was 141.62 seconds.

Figure 5.
Actual Time for the dominant leg

<table>
<thead>
<tr>
<th>Seconds</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard deviation</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
</tbody>
</table>

Actual time for the dominant leg determined with the Angles-Video Goniometer App

Figure 6 shows the actual time for the non-dominant leg determined with the Angles-Video Goniometer App. The average estimated hold time was 54.9557 seconds with a standard deviation of 34.79079 seconds. The minimum time was 11.50 seconds, and the maximum time was 158.39 seconds.

Figure 6.
Actual Time for the non-dominant leg

<table>
<thead>
<tr>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Standard deviation</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
</tbody>
</table>

Actual time for the non-dominant leg determined with the Angles-Video Goniometer App

Figures 7-10 serve to show the activity levels and types of activities performed by the participants. This indicates that participants that have some level
of physical activity have a greater hold time for the single-leg bridge endurance test than those who do not.

**Figure 7.**
*Number of activities of participants*

<table>
<thead>
<tr>
<th>Number of activities</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>3</td>
<td>8.6</td>
</tr>
<tr>
<td>1</td>
<td>17</td>
<td>48.6</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>40.0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Number of activities each participant actively participates in

**Figure 8.**
*Activity 1*

<table>
<thead>
<tr>
<th>Activity 1</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
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<tbody>
<tr>
<td>General</td>
<td>8</td>
<td>22.9</td>
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<tr>
<td>Walking dogs</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Swimming</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Running</td>
<td>4</td>
<td>11.4</td>
</tr>
<tr>
<td>Softball</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Lifting</td>
<td>11</td>
<td>31.4</td>
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<tr>
<td>Soccer</td>
<td>1</td>
<td>2.9</td>
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<tr>
<td>Cycling</td>
<td>2</td>
<td>5.7</td>
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<tr>
<td>Spin</td>
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<td>2.9</td>
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<td>Wrestling</td>
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<td>Frisbee</td>
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<td>2.9</td>
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<tr>
<td>None</td>
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<td>8.6</td>
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</table>

Number of days per week for Activity 1

<table>
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<tr>
<th>Frequency (n)</th>
<th>Percent (%)</th>
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<td>2</td>
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<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2-3</td>
<td>1</td>
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<tr>
<td>3</td>
<td>6</td>
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<td>3-4</td>
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<td>3</td>
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<td>4-5</td>
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<td>5-6</td>
<td>1</td>
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<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
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</table>

**Activity 1 Duration (min)**

<p>| | | |</p>
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<th></th>
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<tbody>
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<td>8.6</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>45</td>
<td>3</td>
<td>8.6</td>
</tr>
<tr>
<td>45-60</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>45-90</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>48</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>60</td>
<td>15</td>
<td>42.9</td>
</tr>
<tr>
<td>60-90</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>75</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>90-120</td>
<td>2</td>
<td>5.7</td>
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<td>5</td>
<td>14.3</td>
</tr>
<tr>
<td>240</td>
<td>1</td>
<td>2.9</td>
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</tbody>
</table>

**Number of years doing Activity 1**

<p>| | | |</p>
<table>
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<tbody>
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<td>11.4</td>
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<td>3</td>
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<td>8.6</td>
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<tr>
<td>4</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>
The type of activity, number of days per week that activity is done, the duration of that activity, and the number of years doing that activity

**Figure 9.**
*Activity 2*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
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</thead>
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<td>Activity 1</td>
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<td></td>
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<tr>
<td>General</td>
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<td>2.9</td>
</tr>
<tr>
<td>Running</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Yoga</td>
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<td>2.9</td>
</tr>
<tr>
<td>Lifting</td>
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<td>14.3</td>
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<tr>
<td>Soccer</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Intramural</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>HIIT</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Frisbee</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Basketball</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>Aerobic Activity</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>None</td>
<td>19</td>
<td>54.3</td>
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</table>

Number of days per week for Activity 2

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<th>Days per Week</th>
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<th>Percent (%)</th>
</tr>
</thead>
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<td>60.0</td>
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<tr>
<td>1</td>
<td>4</td>
<td>11.4</td>
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<td>3</td>
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<td>5.7</td>
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<tr>
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<td>3</td>
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</table>
Activity 2 Duration (min)

<table>
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<th>Duration</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
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<td>45</td>
<td>2</td>
<td>5.7</td>
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<td>45-60</td>
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</table>

Number of years doing Activity 2

<table>
<thead>
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<th>Years</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
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</thead>
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<td>1</td>
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<td>5.7</td>
</tr>
<tr>
<td>1.5</td>
<td>1</td>
<td>2.9</td>
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<tr>
<td>3</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>11.4</td>
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<tr>
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<td>2.9</td>
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<tr>
<td>16</td>
<td>2</td>
<td>2.9</td>
</tr>
</tbody>
</table>

The type of activity, number of days per week that activity is done, the duration of that activity, and the number of years doing that activity.

Figure 10.

Activity 3

<table>
<thead>
<tr>
<th>Activity 3</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>1</td>
<td>2.9</td>
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<tr>
<td>Lifting</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>None</td>
<td>33</td>
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</tr>
</tbody>
</table>

Number of days per week for Activity 3

<table>
<thead>
<tr>
<th>Days</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>34</td>
<td>97.1</td>
</tr>
</tbody>
</table>
The type of activity, number of days per week that activity is done, the duration of that activity, and the number of years doing that activity

In Figures 11-14, for both the dominant and non-dominant legs estimated by the stopwatch and recorded with the Angles-Video Goniometer App, males had a greater average hold time than females indicating that males have a greater normative value for the single leg bridge endurance test than females.

**Figure 11.**

*Sex vs. Mean estimated time for the dominant leg*
The mean estimated time for the dominant leg manually recorded with a stopwatch for males versus females

Figure 12.

*Sex vs. Mean estimated time for the non-dominant leg*
The mean estimated time for the non-dominant leg manually recorded with a stopwatch for males versus females

**Figure 13.**

*Sex vs. Mean actual time for the non-dominant leg*
The mean actual time for the non-dominant leg determined with the Angles-Video Goniometer App for males versus females

**Figure 14.**

*Sex vs. Mean actual time for the dominant leg*
The mean actual time for the dominant leg determined with the Angles-Video Goniometer App for males versus females.

Figures 15-18 have some variability especially in the estimated however, the two younger age groupings 18-22 and 23-27 had significantly longer hold times than the older groupings for the dominant and non-dominant legs when recorded by the Angles-Video Goniometer App. This indicates that younger individuals may have a greater normative value for the single leg bridge endurance test than older individuals.

**Figure 15.**

*Age v. Mean estimated time for the dominant leg*
The mean estimated time for the dominant leg manually recorded with a stopwatch for each of the 5-year increment age groupings

Figure 16.

*Age vs. Mean estimated time for the non-dominant leg*
The mean estimated time for the non-dominant leg manually recorded with a stopwatch for each of the 5-year increment age groupings

**Figure 17.**

*Age vs. Mean actual time for the dominant leg*
The mean actual time for the dominant leg determined with the Angles-Video Goniometer App for each of the 5-year increment age groupings

**Figure 18.**

*Age vs. Mean actual time for the non-dominant leg*
The mean actual time for the non-dominant leg determined with the Angles-Video Goniometer App for each of the 5-year increment age groupings

In Figures 19-22, for both dominant and non-dominant legs, those who reported no activity had lower hold times than any other category. Then, those who reported strength focused workouts, had a slightly greater hold time. This indicates that physical activity may result in a greater normative value for the single leg bridge endurance test, and strength-based workouts can increase the normative value for the single leg bridge endurance test even further.

**Figure 19.**

*Activity vs. Mean estimated time for the dominant leg*
The mean estimated time for the dominant leg manually recorded with a stopwatch for each type of activity

**Figure 20.**

*Activity vs. Mean estimated time for the non-dominant leg*
The mean estimated time for the non-dominant leg manually recorded with a stopwatch for each type of activity

**Figure 21.**

*Activity vs. Mean actual time for the dominant leg*
The mean actual time for the dominant leg determined with the Angles-Video Goniometer App for each type of activity.

**Figure 22.**

*Activity vs. Mean actual time for the non-dominant leg*
DISCUSSION

The main goal of this research was to develop normative values for the single leg bridge endurance test. Other studies looked at the single-leg bridge at different angles, reliability of tests related to core stability such as strength, endurance, flexibility, motor control, and function, core activation during supine bridging to neutral exercises, and electromyographic activation in the gluteus medius and the gluteus minimus. One study looked at the activation of the gluteus maximus and gluteus medius during the single-leg bridge endurance test with the knee flexed at a 135-degree angle rather than a 90-degree angle (Leheka, 2017, p. 543). The results of that study showed that hamstring activation decreased, and gluteal activation remained high with the knee flexed at a 135-degree angle rather than the traditional 90-degree angle. This indicates that having a 135-degree angle rather than the traditional 90-degree angle could serve to minimize hamstring activation while maintaining high gluteal activation. A second study sought to
determine the reliability of tests related to core stability such as strength, endurance, flexibility, motor control, and function (Waldhelm, 2012, p.121). The endurance-based tests used in that study were the trunk flexor test, trunk extensor test, and bilateral side bridge tests. The endurance tests assessed in this study had moderate to high reliability with the left side bridge test having the greatest reliability. A third study compared core activation during supine bridging to neutral exercises (Youdas, 2015, p. 418). The lumbar multifidus activation remained moderate regardless of the supine bridging to neutral exercise. There was high muscle recruitment in the gluteus medius during the single-leg bridge to neutral. Low-moderate activation was seen in the gluteus maximus regardless of the exercise. Hamstring activation was greater during the double-leg hamstring curl than during the double and single leg bridges to neutral position. A fourth study found that for the middle gluteus medius segment, the single leg bridge, side-lying hip abduction with internal rotation, lateral step-up, standing hip abduction on stance or swing leg with added resistance, and the resisted side-step were the most effective in generating at least high activity (Moore, 2020, p. 856). For the posterior gluteus medius segment, the side-lying hip abduction, the dip test, the single leg bridge, and the single leg squat can be used to target activation.

The limitations of this study include the small sample size. This study served as a starting point for developing normative values for the single leg bridge endurance test. This research should be continued with a greater number of subjects to determine if the findings are consistent. Having a greater number of participants of each sex, age group, and physical activity level would help to determine if the findings in this study are consistent across a larger population. Another aspect that could be added to future studies would be to investigate the influence of tactical athlete affiliations on hold times. Continuing this research could lead to the baseline times being
utilized by physical therapists in the plan of care for their patients to test the lumbar spine, build gluteal, hamstring, and lumbar multifidus strength, and promote core stability.

CONCLUSION

The objective of this study was to develop normative values for the single leg bridge endurance test to give physical therapists a baseline time for their patients during rehabilitation. The average hold time for the dominant leg was estimated to be 67.62121951 seconds and was actually 61.6517 seconds. The average hold time for the non-dominant leg was estimated to be 64.5311 seconds and was actually 54.69557 seconds. For both the dominant and non-dominant legs, males had a greater average hold time than females indicating the males have a greater normative value for the single leg bridge endurance test than females. The two younger age groupings 18-22 and 23-27 had significantly longer hold times than the older groupings for the dominant and non-dominant legs when recorded by the Angles-Video Goniometer App which indicates that younger individuals may have a greater normative value for the single leg bridge endurance test than older individuals. Physical activity can increase the normative value for the single leg bridge endurance test, and those who focus on strength-based workouts may have an even greater normative value for the single leg bridge endurance test than those who do more cardio based workouts. These average times will allow Physical Therapists to have a baseline time goal for each patient to reach towards throughout their rehabilitation process.
REFERENCES