ESTABLISHING NORMATIVE VALUES FOR THE STAIR CLIMB TEST

Delia Istrate, Sharlene Johnson, David Paek, Ben Wilkening

Introduction

- Gait speed is a useful tool in:
  - Predicting morbidity and mortality
  - Assessing fall risks and functional mobility
  - Typically, gait speed is measured on level terrain over different distances or time intervals

Introduction

• Many studies have been conducted on the use of stair climbing as an outcome measure, mainly because it is:
  • Readily available
  • Easily applicable and inexpensive
  • May be more viable in some settings when compared with the Six-Minute Walk Test (6MWT)
• The Stair Climb Test (SCT), however, lacks standardization


Introduction

• Timed stair tests were introduced in the 1960s, primarily as a preoperative assessment tool for thoracic surgery patients
• Three main types of SCT used in literature:
  • Symptom Limited Test
  • Power Test
  • Timed Stair Test

Existing Literature


• Results (22 Studies - Ascent):
  • ages 18-49: .48 (+/- .14) sec/step
  • ages 50-65: .46 (+/- .17) sec/step
  • ages 65+: .65 (+/- .41) sec/step

• Conclusions:
  • Timed stair climb tests are:
    • Quick, simple ways to assess function and fitness
    • Responsive to age and functional level
    • Great alternative for the 6MWT

Significance of Present Research

• Quick, valid, and reliable measures are necessary to assess cardiovascular capacity
• Need a challenging test for higher functioning patients
• The SCT lacks normative values for the adult population
• The SCT has not been standardized or validated against the 6MWT
• The SCT may be more useful in space-limited inpatient, outpatient, and home care settings
Introduction

• Methodology adapted from Nightingale et al. (2014):
  • Create consistent, reproducible testing method
  • Instruct subjects to perform the SCT “as quickly and as safely as possible”
  • Handrail should be used only for balance
  • Flights tested should involve at least 10 steps per flight

Research Questions

• What is the correlation, if any, between the SCT and 6MWT?
• Is the SCT a more challenging and viable alternative to the 6MWT in higher functioning individuals?
• What are the normative speed values on the SCT for the normal population?
Purpose

- To establish normative speed values in the adult population for height ascended during a SCT and to compare the SCT with the 6MWT

Hypothesis

- A non-directional two-tailed hypothesis was used

The hypothesis was two-fold:

1. Vitals taken after the SCT would show a significant correlation with vitals after the 6MWT and,
2. Speed of ascent on the SCT would show a significant correlation with distance walked on the 6MWT
Methodology

Research Design

- **Inclusion Criteria:**
  - Males and females between the ages of 20 and 60
- **Exclusion Criteria:**
  - Current injury
  - Pregnancy
  - Inability to climb a flight of stairs
  - Use of an assistive device
  - Existing medical condition that required examination by a physician prior to exercise as determined by the 2014 Physical Activity Readiness Questionnaire (PARQ+)
Research Design - Power Analysis

Sample of 96 subjects needed to achieve power

- alpha = 0.05
- beta = 0.20

Research Design

Assessed for eligibility (n=140)

- Excluded (n=3)
  Ruled out by 2014 PARQ+

Tested (n=137)
- Males (n=44)
- Females (n=93)

- 20-29 y.o. (n=71)
- 30-39 y.o. (n=25)
- 40-49 y.o. (n=19)
- 50-60 y.o. (n=22)
Research Design

**Independent Variable**

**Type of Test:**
1. 6MWT
2. SCT

**Dependent Variable**

1. Distance Walked on 6MWT
2. Ascent Time on SCT
3. Vitals (Heart Rate, Blood Pressure, Oxygen Saturation, Respiratory Rate, Self-Reported Dyspnea)

Materials

1. Stopwatch
2. Chairs
3. Forms, including data sheet, consent form, dyspnea scale and PARQ+
4. Electronic sphygmomanometer
5. Pulse oximeter
6. Telephone
7. Automated electronic defibrillator
8. Scale
9. Height tape
Protocol

- 6MWT Instructions
- Post 6MWT
- Pre SCT
- Post SCT

Six Minute Walk Test Specifics

- 6MWT Course
- Turning Points
- 6MWT Instructions
- Record Distance
Stair Climb Test Specifics

4 flights of stairs → 10.52 m Height → Chair Placement → SCT Instructions

Results and Discussion
Mean Test Results

<table>
<thead>
<tr>
<th></th>
<th>6 Minute Walk Test</th>
<th>Stair Climb Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance Walked (m)</td>
<td>582.85 (+/- 85.89)</td>
<td></td>
</tr>
<tr>
<td>Time (s)</td>
<td>23.35 s (+/- 6.21)</td>
<td></td>
</tr>
<tr>
<td>Speed (m/s)</td>
<td>0.45 (+/- 0.12)</td>
<td></td>
</tr>
<tr>
<td>Seconds/Step</td>
<td>0.36 (+/- .10)</td>
<td></td>
</tr>
</tbody>
</table>

Total Sample: 582.85 (+/- 85.89) 23.35 s (+/- 6.21) 0.45 (+/- 0.12) 0.36 (+/- .10)

Analysis of Mean Test Results

- Moderate, positive correlation was found between distance walked in the 6MWT and ascent speed in the SCT for total sample (r= 0.54, p= 0.00, n= 137)
Statistical Analysis for Vitals

- Significant correlation was found between vitals post 6MWT and post SCT in all cases except Oxygen Saturation

<table>
<thead>
<tr>
<th></th>
<th>HR: r = 0.68, p = 0.00</th>
<th>Dyspnea: r = 0.67, p = 0.00</th>
<th>RR: r = 0.65, p = 0.00</th>
<th>Systolic BP: r = 0.58, p = 0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair correlation for Diastolic BP:</td>
<td>r = 0.49, p = 0.00</td>
<td></td>
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<tr>
<td>Little or no correlation for O₂ Saturation:</td>
<td>r = 0.12, p = 0.17</td>
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</tbody>
</table>

Pre- and Post- Heart Rate Values

<table>
<thead>
<tr>
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<th>HR pre 6MWT</th>
<th>HR post 6MWT</th>
<th>HR pre SCT</th>
<th>HR post SCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sample</td>
<td>78.35 (+/- 13.67)</td>
<td>108.51 (+/- 24.81)</td>
<td>83.91 (+/- 15.23)</td>
<td>137.14 (+/- 18.76)</td>
</tr>
</tbody>
</table>

Significant difference between HR post 6MWT and HR post SCT; \( t(137) = 18.30, p = 0.00 \)
**Percent Change in Heart Rate**

**Percent increase in HR:**
- 6MWT: 39.76%
- SCT: 66.86%

Percent change in HR from SCT significantly higher than percent change in HR from 6MWT
- Two-tailed t-test ($t = 8.00$, $p = 0.00$)

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**Conclusions**
Clinical Relevance

- Based on the consistent correlations between the two tests:
  - The SCT may be a viable alternative to the 6MWT, but places higher cardiovascular demands on the individual
  - The SCT may be useful in settings where the 6MWT cannot be performed due to either time or space constraints
  - Ascending speed means can serve as normative values for clinical use

Conclusions

<table>
<thead>
<tr>
<th>Age</th>
<th>Speed in m/s (95% Confidence Interval)</th>
<th>Seconds/Step (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 29</td>
<td>0.48 (0.45 to 0.51)</td>
<td>0.34 (0.32 to 0.37)</td>
</tr>
<tr>
<td>30 - 39</td>
<td>0.50 (0.46 to 0.54)</td>
<td>0.33 (0.30 to 0.36)</td>
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<td>40 - 49</td>
<td>0.43 (0.37 to 0.46)</td>
<td>0.40 (0.36 to 0.44)</td>
</tr>
<tr>
<td>50 - 60</td>
<td>0.38 (0.33 to 0.41)</td>
<td>0.45 (0.40 to 0.50)</td>
</tr>
<tr>
<td>Total Sample</td>
<td>0.45 (0.43 to 0.47)</td>
<td>0.36 (0.35 to 0.38)</td>
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</tbody>
</table>
Limitations

- Were unable to draw significant conclusions for age groups
- The overall sample size favored females
- Differences in motivation for subjects
- Definite conclusion cannot be drawn for different stairs or different populations

Recommendations for Future Research

- Compare speed on various number of flights and number of steps to see how these factors impact speed and vitals
- Compare the Stair Climb Test to other functional outcome measures
- Larger number of participants for each age group and wider age range
- Include subjects with medical conditions
- Include testing descent time on stairs for a comprehensive ascent-descent Stair Climb Test
Faculty Advisors

Dr. Kathleen Schaefer PT, MBA, DPT, Dr. Anne Thompson PT, EdD

Dr. Anthony Parish Ph.D., Dr. Greg Wimer Ph.D.

Questions?

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  • Delia Istrate, SPT: istdelia2000@yahoo.com
  • Sharlene Johnson, SPT: svj1421@yahoo.com
References

11. Bohdan M Pichurko MD. Exercising Your Patient: Which Test(s) and When?. Respiratory Care. 2012; 57 (1)

References


### Stair Climb Test Results

<table>
<thead>
<tr>
<th>SCT Speed (m/s)</th>
<th>M 20-29</th>
<th>F 20-29</th>
<th>M 30-39</th>
<th>F 30-39</th>
<th>M 40-49</th>
<th>F 40-49</th>
<th>M 50-60</th>
<th>F 50-60</th>
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<tbody>
<tr>
<td>0.2</td>
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<td>0.3</td>
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<td>0.4</td>
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<td>0.5</td>
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<td>0.6</td>
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Legend:
- M: Male
- F: Female
- M 20-29: Men aged 20-29
- F 20-29: Women aged 20-29
- M 30-39: Men aged 30-39
- F 30-39: Women aged 30-39
- M 40-49: Men aged 40-49
- F 40-49: Women aged 40-49
- M 50-60: Men aged 50-60
- F 50-60: Women aged 50-60
Six Minute Walk Test Results

6MWT Norms Comparison

<table>
<thead>
<tr>
<th>Authors and Publication</th>
<th># of Subjects</th>
<th>6MWT Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maria Raquel Soares, Carlos Alberto de Castro Pereira, 2011</td>
<td>132</td>
<td>20-80 y.o</td>
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<tr>
<td>Iwama, G.N, Andrade, P. Shima, S.E. Tanni, I. Godoy, and V.Z. Dourado, 2009</td>
<td>134</td>
<td>13-84 y.o</td>
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<tr>
<td>Alfredo Chetta, Andrea Zanini, Giovanna Pasci, Marina Vetto, Panagiota Tzania, Margherita Nerib, Dario Olivieria, 2006</td>
<td>102</td>
<td>20-50 y.o</td>
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<tr>
<td>PAUL L. ENRIGHT and DUANE L. SHERRILL, 1998</td>
<td>290</td>
<td>40-80 y.o</td>
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<tr>
<td>Sue Jenkins, Nola Cecins, Bernadine Camant, Crystal Williams, Philip Thompson, and Peter Eastwood, 2009</td>
<td>109</td>
<td>45-85 y.o</td>
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</tbody>
</table>

Our total sample: 582.85 (+/- 85.89) meters (m)
Comparison of SCT in seconds/step

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>20-29: 0.34 (+/- 0.09)</td>
<td>Males: 0.24 (+/- 0.03)</td>
<td>18-49: 0.48 (+/- 0.14)</td>
</tr>
<tr>
<td>30-39: 0.33 (+/- 0.06)</td>
<td>Females: 0.26 (+/- 0.03)</td>
<td>50-65: 0.46 (+/- 0.17)</td>
</tr>
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<td>40-49: 0.40 (+/- 0.09)</td>
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<td>65+: 0.65 (+/- .41)</td>
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<td>Total sample: 0.36 (+/- 0.10)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Modified Borg Dyspnea Scale

- 0 = Nothing at all
- 0.5 = Very, very slight (just noticeable)
- 1 = Very slight
- 2 = Slight
- 3 = Moderate
- 4 = Somewhat severe
- 5 = Severe
- 6 =
- 7 = Very severe
- 8 =
- 9 = Very, very severe (almost maximal)
- 10 = Maximal
### Dyspnea

<table>
<thead>
<tr>
<th>Age</th>
<th>Dyspnea after 6MWT (m)</th>
<th>Dyspnea after SCT (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>1.45 (+/- 1.38)</td>
<td>3.00 (+/- 1.54)</td>
</tr>
<tr>
<td>30-39</td>
<td>1.88 (+/- 1.33)</td>
<td>3.20 (+/- 1.08)</td>
</tr>
<tr>
<td>40-49</td>
<td>1.81 (+/- 1.29)</td>
<td>3.47 (+/- 1.46)</td>
</tr>
<tr>
<td>50-60</td>
<td>1.52 (+/- 1.21)</td>
<td>3.52 (+/- 1.53)</td>
</tr>
<tr>
<td>Total Sample</td>
<td>1.59 (+/- 1.33)</td>
<td>3.18 (+/- 1.45)</td>
</tr>
</tbody>
</table>

Significant difference between **Dyspnea post 6MWT** and **Dyspnea post SCT**; \( t(137) = 16.29, p = 0.00 \)

### Mean Results for Tests

<table>
<thead>
<tr>
<th>Age</th>
<th>6 Minute Walk Test</th>
<th>Time (s)</th>
<th>Speed (m/s)</th>
<th>Seconds/Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 29 (n=71)</td>
<td>581.13 (+/- 86.46)</td>
<td>22.01 s</td>
<td>0.51 (+/- 0.11)</td>
<td>0.34 (+/- .09)</td>
</tr>
<tr>
<td>30 - 39 (n=25)</td>
<td>619.20 (+/- 99.76)</td>
<td>21.17 s</td>
<td>0.51 (+/- 0.09)</td>
<td>0.33 (+/- .06)</td>
</tr>
<tr>
<td>40 - 49 (n=19)</td>
<td>577.95 (+/- 52.39)</td>
<td>25.42 s</td>
<td>0.43 (+/- 0.09)</td>
<td>0.40 (+/- .09)</td>
</tr>
<tr>
<td>50 - 60 (n=22)</td>
<td>549.67 (+/- 77.45)</td>
<td>28.74 s</td>
<td>0.38 (+/- 0.08)</td>
<td>0.45 (+/- .10)</td>
</tr>
<tr>
<td>Total Sample:</td>
<td>582.85 (+/- 85.89)</td>
<td>23.35 s</td>
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## Pre- and Post- Heart Rate Values

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<tr>
<th>Age</th>
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<th>HR post 6MWT</th>
<th>HR pre SCT</th>
<th>HR post SCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>79.32 (+/- 15.61)</td>
<td>108.18 (+/- 25.45)</td>
<td>84.41 (+/- 16.51)</td>
<td>140.08 (+/- 21.38)</td>
</tr>
<tr>
<td>30-39</td>
<td>75.32 (+/- 8.87)</td>
<td>106.44 (+/- 22.87)</td>
<td>81.44 (+/- 12.64)</td>
<td>133.08 (+/- 14.42)</td>
</tr>
<tr>
<td>40-49</td>
<td>78.26 (+/- 12.42)</td>
<td>109.58 (+/- 27.45)</td>
<td>81.95 (+/- 16.00)</td>
<td>134.84 (+/- 15.89)</td>
</tr>
<tr>
<td>50-59</td>
<td>78.76 (+/- 12.53)</td>
<td>111.19 (+/- 23.78)</td>
<td>86.86 (+/- 12.79)</td>
<td>133.81 (+/- 14.52)</td>
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Significant difference between HR post 6MWT and HR Post SCT; $t(137) = 18.30$, $p = 0.00$