CORRELATION OF BODY COMPOSITION, GRIP STRENGTH, AND CORE STABILITY WITH BALANCE IN OLDER ADULTS

BECCA MOOS, LINDSAY HEMMRRICH, NIKKI BROMELKAMP, KELSEY MOORE

ABSTRACT

Becca Moos, Lindsay Hemmrich, Nikki Bromelkamp, Kelsey Moore. Correlation of Body Composition, Grip Strength and Core Stability with Balance in Older Adults; Journal of Undergraduate Kinesiology Research 2012; 8(1): 16-22. Purpose: Balance is important to everyday functioning in older adults. The purpose of this study is to determine the correlation between body composition, grip strength, and core stability with balance. Methods: 30 subjects, (17 males, 13 females) age 55 to 75 years, were assessed for fall risk via Biodex Balance System, body composition, grip strength, and core stability. Results: The strongest correlation to balance was observed in the waist-to-hip ratio \( r = .78, n = 29, p < .001 \); this was stronger in females than in males. Overall core stability was also associated with better balance \( r = -.43, n = 28, p = .023 \). For body fat percent there was a weak association to balance for females but virtually no association for males. Similarly grip strength had no clear association with balance. Conclusion: The correlations in this population suggest better balance is associated with lower waist-to-hip ratio and higher core strength, but is not associated with higher grip strength and lower body fat. Core stability and decreasing waist-to-hip ration should be focal points when working towards decreasing fall risk in older adults.

Key Words: Older adults, Balance, Waist-to-Hip Ratio, Skin Fold

INTRODUCTION

Balance is important in preventing falls and maintaining an independent lifestyle (1). Factors that can affect balance and thus a risk of falling include core stability, muscular strength, body composition, and psycho-motor dimensions. Most studies to date have focused on a single factor of balance, such as core strength, body composition, or cognitive ability. Balance is multifactorial; therefore, there is a
need to identify relationships between balance and its predictors. This study will be looking at multiple factors that together may give a better understanding of balance.

Studies show that an increased amount of adipose tissue may lead to increased fall risk. Greve et al.(2) found decreasing stability with an increase in BMI. Using older, obese individuals Menegoni et al.(3) found that increased mass produced instability along the antero-posterior axis in both genders and medio-lateral axis in males.

Other studies of balance have assessed overall leg strength, coordination, and age. Ringsberg et. al. (4) has demonstrated that younger adults have significantly better balance than older adults. The loss of muscular strength with age impacts balance in older adults and therefore increases risk of falling presumably due to lack of adequate and timely muscle contraction (1). According to Wolfson (5) there is up to a 40% decrease in muscular strength between ages 20 to 70 years. Handgrip strength testing is the simplest form of strength testing; it correlates well to overall strength, and is a strong predictor for morbidity and mortality in elderly subjects (6,7).

Another dimension of balance is core stability. This is an important factor because better core stability will provide a more stable platform, from which the arms and legs can function to catch the body during an unstable time. Suri et.al. (1) reported a significant correlation between trunk extension endurance and increased balance. Suri et.al. (1) also found that improvements in trunk extension endurance are considered a clinically meaningful change in balance based on the Berg Balance Scale. Additionally, other studies have shown improved core endurance was associated with enhanced activities of daily living (7,8).

Although several studies have suggested that there are multiple factors contributing to balance, it remains unclear the relationship each factor has with balance. Thus, the purpose of the present study is to determine the relative contributions of body composition, grip strength, and core stability that may impact fall risk in older adults. Based on previous research, we hypothesize that both muscular strength and core stability will improve balance while higher fat percent will increase risk of falls.

METHODS

Subjects:
Table 1 shows the characteristics of the thirty subjects, recruited from the Eau Claire community. Subjects were included if they fit the age range 55-75 years and were physically able to stand on the Biodex machine and perform strength and core stability exercises. Potential subjects were provided a cover letter and verbal explanation of the study and then signed an informed consent before participation.

Procedures & Instrumentation:
Body Composition:
This study consisted of 4 different measurements to help determine body composition. The first test conducted was height. Each participant's stature was measured using a wall stadiometer. Second, each participant was weighed to the nearest ½ pound using a Detecto Beam Balance scale. The third test was skin folds, using a Lange skinfold caliper (Bets Technology, Cambridge, Maryland). Three sites were measured specific to gender. For men, sites included subscap, triceps, and chest. For women, the sites were triceps, suprailliac, and abdomen. Each site was measured three times to the nearest mm for consistency. Body fat was estimated using the Jackson Pollock 1985 equation(8). The last test conducted was waist to hip ratio using a flexible measuring tape. The waist was
measured above the iliac crest but below the ribs at the narrowest diameter. The hip was measured at the widest protrusion of the buttocks.

Grip strength:
Grip strength was assessed using a handgrip dynamometer (Takei, Japan). Participants held the device relaxed at their side. Once instructed, the participant squeezed the device as hard as they could. This was done 3 times alternating each hand. The best trial of both left and right side were recorded and their percentile ranking was found.

Balance:
Balance was assessed using the Biodex Balance System SD (Shirley, New York), following the Fall Risk Assessment Protocol as described in the Biodex operation/service manual. The participants kept their shoes on and stepped onto the platform. The participant completed 3 trials of 20 seconds each, during which time the platform decreased in stability from a level 6 to level 2, with a 10 second rest period in between the trials. Participants were instructed to do their best to stay as stable as possible, with keeping the dot in the middle of the circle as visual feedback. The movement of the dot away from the center provided an average score of the three trials and a standard deviation.

Core Stability:
Core stability was assessed using 4 tests. Each test was completed in the same order for each participant: side bridges, trunk flexion, and trunk extension. Side bridges were performed on both the right and left sides. The participant lay with the side being tested on the floor. Their feet were stacked on top of each other, their arm on the side being tested was at a 90 degree angle with the floor, and their other hand was placed on their hip. The participant began the test by lifting their hip off the ground and keeping their shoulders back, holding their body in a neutral side bridge position with head, shoulders, hips, knees, and feet in alignment. When this position was reached, the timing was started with a stopwatch. The participant was given one warning to adjust body alignment. The test ended and time was stopped once the participant went out of neutral alignment or became too fatigued to continue.

Trunk flexion endurance was assessed by how long the participant could hold their trunk in a 60 degree flexed position. The participant sat with buttocks and shoulders relaxed against a large triangle shaped box built at a 60-degree angle from a padded table where the participant sat (See Figure 1.). At the start, the box was pulled 4 inches away from the participant and the timer started the stopwatch. Another person was present to hold the participants feet down. Subjects had to hold their position with their hands across their chest and knees bent and were encouraged to maintain the position as long as possible up to five minutes. Subjects were given one warning if the distance between their back and the box was getting small. The test ended when the participant's back touched the box.

Trunk extension endurance was assessed by how long the participant could hold their trunk in a neutral extension while the whole body was at a 45 degree angle from the floor. Feet and legs were held in place by the pads on a back extension station, and neutral position was determined by measuring extension with a goniometer. The participant had to hold their neutral position with hands across the chest, and was encouraged to maintain the position as long as possible up to five minutes. Participants were given one warning when they started to lose their neutral position. Time was kept by using a stopwatch, and the test was over when the participant could no longer maintain neutral position.
An overall core stability score was calculated for each subject by summing the time to failure for each of the 4 tests.

**Figure 1.**

**Statistical Analyses:**
All data was assessed using SPSS Version 19 software to determine the correlation of the three factors to fall risk. A Pearson product-moment coefficient correlation was conducted to establish the association of each variable against fall risk scores. Gender differences were compared using independent samples T-test.

**RESULTS**

The participant descriptive statistics and mean measurement scores for body composition, strength, core, and Biodex are shown in Table 1. The only significant difference between male and female subjects was the Biodex score for balance in which the lower score for females represents better balance.

**Table 1. Descriptive Statistics of Participants**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total N=30</th>
<th>Female N=13</th>
<th>Male N=17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>61.53±4.43</td>
<td>61.77±4.82</td>
<td>61.35±4.26</td>
</tr>
<tr>
<td>Body Fat %</td>
<td>22.7±4.82</td>
<td>26±4.06</td>
<td>20.29±3.84</td>
</tr>
<tr>
<td>Waist to Hip Ratio</td>
<td>.89±1</td>
<td>.79±.04</td>
<td>.96±.04</td>
</tr>
<tr>
<td>Strength</td>
<td>78.8±23.1</td>
<td>55.62±7.76</td>
<td>96.53±12.29</td>
</tr>
<tr>
<td>Trunk Extension</td>
<td>164.49±83.14</td>
<td>214.95±82.49</td>
<td>125.89±61.41</td>
</tr>
<tr>
<td>Trunk Flexion</td>
<td>121.96±109.04</td>
<td>162.10±122.23</td>
<td>91.27±89.63</td>
</tr>
<tr>
<td>Right Side Bridge</td>
<td>67.87±43.03</td>
<td>69.27±34.13</td>
<td>66.88±49.37</td>
</tr>
<tr>
<td>Left Side Bridge</td>
<td>69.03±38.06</td>
<td>69.12±34.22</td>
<td>68.97±41.60</td>
</tr>
<tr>
<td>Overall Core</td>
<td>428.36±235.65</td>
<td>535.10±228.8</td>
<td>363.14±218.75</td>
</tr>
<tr>
<td>Biodex score</td>
<td>3.12±1.90</td>
<td>1.77±.70*</td>
<td>4.14±1.90*</td>
</tr>
</tbody>
</table>

*p<0.05 Female to Male Comparison*
Balance in Older Adults

Body composition, strength, and core endurance were correlated with balance using the Pearson product-moment correlation coefficient. The strongest correlation to balance was observed in the waist-to-hip ratio (overall $r = .78$, $n = 29$, $p < .001$), meaning lower waist-to-hip ratios were associated with better balance. As shown in Table 2, when broken down by gender there is still a significant association for females, however this was not quite significant for males. For the association between body fat percent and balance, females had a weak correlation and males had virtually no correlation.

Table 2. Correlations by Gender to Balance Score

<table>
<thead>
<tr>
<th>Variables correlated to Biodex score</th>
<th>Female N=13</th>
<th>Male N=16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist to Hip Ratio</td>
<td>$r = .57$, $p = .04$</td>
<td>$r = .44$, $p = .09$</td>
</tr>
<tr>
<td>Body Fat Percent</td>
<td>$r = .38$, $p = .21$</td>
<td>$r = .12$, $p = .66$</td>
</tr>
<tr>
<td>Strength</td>
<td>$r = -.23$, $p = .46$</td>
<td>$r = .13$, $p = .64$</td>
</tr>
</tbody>
</table>

Higher grip strength was weakly associated with balance for females, but there was virtually no correlation for males between strength and balance.

The core stability variables were correlated to balance using all the subjects together because the trends by gender were in the same direction. The overall core stability score was significantly associated with better balance ($r = -.43$, $n = 28$, $p = .023$). When looking at the separate core variables, there was a correlation for trunk flexion ($r = -.44$, $n = 29$, $p = .018$) and trunk extension ($r = -.41$, $n = 29$, $p = .027$), but no significant correlations for right side bridge ($r = -.19$, $n = 28$, $p = .332$) or left side bridge ($r = -.10$, $n = 28$, $p = .620$).

Thus, these correlations in this population suggest a better balance score (based on Biodex scoring) is associated with lower waist-to-hip ratio and higher core strength, but is not associated with higher grip strength and low body fat.

**DISCUSSION**

The purpose of this study was to determine the correlations of body composition, muscular strength, and core stability with balance. Regarding body composition, our findings showed a strong correlation ($r = .78$) between waist-to-hip ratio and balance for all subjects combined however, when broken down by gender, this association was stronger in females than in males. One possible explanation for this finding can be that the lower an individual’s center of gravity, the easier it will be for them to maintain balance (9). Our findings of the gender differences in balance related to waist-to-hip ratio are consistent with the gender/balance findings of Menegoni et.al (3).

Our results showed that the lean and fat tissue proportion has less of an effect on balance than does distribution of fat based on waist-to-hip measurements. There were no significant associations between balance and body fat percent for either gender. Heavier Individuals (body mass index > 30) have previously been shown to have poorer balance (2). In the current study, there were no participants with a BMI greater than 30 and fat percents for both genders were in the average range. This likely limited our ability to find correlations between body fat percent and balance.

According to Suri et.al. (1) trunk extension is a significant factor contributing to balance. Our findings agreed with this and showed that balance scores were significantly correlated with both trunk extension and trunk flexion. These two correlations were strong enough that when combined with the
insignificant correlations of the side bridges to make an overall core stability score, there was still significant association with balance. Thus, stronger core stability should improve balance.

Our results showed little to no association between grip strength and balance; this suggests that strength alone does not help balance. Previous studies have also found little correlation between lower limb strength and balance (1, 4,10). We did find differences between the two genders; our women actually had an inverse association between muscular strength and balance, while males had a very weak, but positive correlation. Women tend to be overall weaker than men, however they typically have better balance (9).

Limitations of this study include one outlier whose data was removed from analysis because he had a balance score far out of the range of the other subjects. One participant had no data for core due to medical diagnoses limiting her ability to perform the tests at their full capacity. Grip strength, while easier to use than a 1 RM test, may not be best suited as the sole measurement of strength in application to balance. Assessing lower body strength may have been more directly relevant to an individual who begins to fall. Although not assessed in this study, other factors that could affect balance include cognitive decline with age, reaction time and muscle recruitment/coordination.

CONCLUSION

In sum, these findings provide interesting information on balance and its predictors. We found that core stability, especially trunk extension and flexion, is an important factor contributing to balance. Waist-to-hip measurements showed that body fat distribution has a stronger influence on balance than the fat percent itself. Grip strength was surprisingly not a good indicator of balance. Some of these findings can be attributed to the fact that women had overall better balance than men though men tend to be stronger. Balance programs including core exercises should be helpful for older individuals to improve balance and in turn decrease fall risk.

ACKNOWLEDGEMENTS

We would like to thank all of the participants who volunteered their time to make this study possible. We would also like to extend thanks to Dr. Don Bredle and Dr. Sue Myhre for their guidance in completing this research study. We would also like to recognize the University of Wisconsin Eau Claire for allowing us to use their workspace and equipment necessary for this study.

Address for correspondence: Donald Bredle M.S., 105 Garfield Avenue, Department of Kinesiology, University of Wisconsin - Eau Claire, Eau Claire, WI, United States 54701. (715)836-3953; Fax: (715)836-4074 Email: bredledl@uwec.edu

REFERENCES


Disclaimer
The opinions expressed in the Journal of Undergraduate Kinesiology Research are those of the authors and are not attributable to the Journal of Undergraduate Kinesiology Research, the editorial staff or the University of Wisconsin - Eau Claire.