INTRODUCTION
In recent years, obesity rates have continued to steadily increase. In 2009-2010, more than 35% of adults in the United States were obese, with obesity being more prevalent in adults over the age of 60 [1]. With obesity comes an increased risk of developing health conditions, such as type 2 diabetes and hypertension [1]. The prevalence of excessive body fat and the associated health risks have created a demand for simple and effective ways of measuring a person’s obesity risk.

Various anthropometric measurements, such as circumference and ratios, are thought to be simple, inexpensive tools capable of diagnosing obesity. If accurate, these measurements would provide an easy way to monitor a patient’s percent body fat and risk of obesity.

Previous studies have compared several anthropometric measurements to obesity and mortality risk in adolescents, adults, and older adults in various ethnic populations. Common measurements evaluated include body mass index (BMI), waist circumference, and waist-to-hip ratio. A study of older adults, age ≥75 years, from the United Kingdom concluded that relative abdominal obesity and increased mortality risk were best measured using waist-to-hip ratio; additionally, waist circumference still predicted obesity and mortality risk better than BMI [2]. The Honolulu Heart Program, a study involving elderly Japanese-American men, showed consistent results that waist-to-hip ratio was positively correlated to mortality [3]. However, these studies determined mortality and obesity risk by evaluating measures such as BMI, smoking, heart rate and death rather than comparing to an accurately calculated percent body fat.

METHODS
Eighty-three adults (75.5 ± 5.0 years) were recruited as study participants. The adults were divided into four subgroups based on gender (41 male, 42 female) and obesity (42 non-obese BMI < 30, 41 obese BMI > 30). Each subject underwent a whole body DXA scan (Hologic QDR 1000/W, Bedford, MA) from which mass and percent body fat (%BF) were calculated on a total and per segment basis.

Hip and waist circumferences were measured by a trained technician using a cloth measuring tape. Waist-to-hip ratio was calculated.

Associations between each circumference and waist-to-hip ratio with %BF were explored using a correlation analysis. Statistical analysis was done to compare %BF to the measured circumferences for each of the four subgroups with an alpha value of 0.05.

RESULTS AND DISCUSSION
A positive correlation was found between waist circumference and %BF (Table 1).
Table 1. Correlation Values (r) between Percent Body Fat (%BF) and Anthropometric Measurements

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th></th>
<th>Male</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-obese</td>
<td>Obese</td>
<td>Non-obese</td>
<td>Obese</td>
</tr>
<tr>
<td>Waist Circumference</td>
<td>0.7227*</td>
<td>0.4983*</td>
<td>0.3917</td>
<td>0.7603*</td>
</tr>
<tr>
<td>Hip Circumference</td>
<td>0.8215*</td>
<td>0.8536*</td>
<td>0.5134*</td>
<td>0.7802*</td>
</tr>
<tr>
<td>Waist-to-Hip Ratio</td>
<td>0.2200</td>
<td>-0.2471</td>
<td>0.0552</td>
<td>0.2945</td>
</tr>
</tbody>
</table>

*denotes significant with p-value <0.05

This relationship was strongest for non-obese females and obese males; however, a lesser positive correlation was still observed for obese females and non-obese males (Figure 1). All conditions, except non-obese males, were significant.

Figure 1: Waist circumference [cm] vs. body fat (%) for obese and non-obese males and females. As body fat increases, waist circumference increases.

Again, a positive relationship was found between hip circumference and %BF (Figure 2). This relationship was significant for both males and females, and independent of whether or not they were obese.

Figure 2: Hip circumference [cm] vs. body fat (%) for obese and non-obese males and females. As body fat increases, hip circumference increases.

No significant correlation was found between the waist-to-hip ratio and %BF (Figure 3).

Figure 3: Waist-to-hip ratio vs. body fat (%) for obese and non-obese males and females. No significant correlation was observed.

The results shown do not support previous research suggesting that waist-to-hip ratio is a useful predictor of obesity in older adults. Of the three measurements examined, waist-to-hip ratio was least correlated to %BF. Waist and hip circumference were both positively correlated with %BF; however, hip circumference correlation values suggest it is a better measure in obese subjects, both male and female. For this reason, hip circumference has the potential to act as a better measure of %BF in elderly Americans.

Although more analysis is needed, initial findings suggest the waist-to-hip ratio should be avoided as an obesity determinant in older adults and, instead, waist or hip circumference should be used as an indicator until further methods are developed.

REFERENCES

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