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Comparison of Body Composition Assessment Techniques in Older
Adult Females

Lauren Yacapraro

HONORS PROJECT

Submitted to the Honors College
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Dr. Mary-Jon Ludy, Family and Consumer Sciences: Advisor

Dr. Amy Morgan, Human Movement, Sport, and Leisure Studies:
Advisor

Comparison of Body Composition Assessment Techniques in Older Adult Females

Obesity has rapidly become a worldwide epidemic as the last several decades have unfolded. According to the National Health and Nutrition Examination Survey, conducted by the Centers for Disease Control and Prevention, more than two-thirds of the adult population aged 20 and older in the United States is considered overweight or obese (Flegal, Carroll, Kit, & Ogden, 2012). From a numerical perspective, in 199 countries, 1.46 billion adults are classified as overweight. More specifically, of these 1.46 billion, 502 million are classified as obese (Wang, et. al., 2011). Obesity is associated with chronic diseases such as cardiovascular disease (CVD), stroke, some cancers, and type II diabetes (www.nhlbi.nih.gov). Chronic disease prevalence has increased significantly since the onset of the obesity epidemic in the 1980s (Mittal, et. al., 2011). A particular concern in this overweight and obese population is adult females since they gain, on average, 2.4% body fat each decade between their twenties and seventies (Meeuwse, Horgan, & Elia, 2010).

In recent generations, a larger elderly population has resulted from increased life expectancy due to medical advances and improved hygiene. It is important to be able to accurately assess obesity in this population to better predict the prevalence of chronic diseases, as the percentage of older adults with two or more chronic diseases has increased from 37.2% to 45.3% in the past ten years. (Freid, Bernstein, & Bush, 2012). More accurate assessment can result in reduced health care costs because prevention and treatment can be better targeted. It is estimated that obesity contributes to approximately 20.6% of health care costs or 190 billion U.S. dollars annually according to data from the Medical Expenditure Panel Survey (Cawley, 2013).

The most common assessment of obesity currently is Body Mass Index (BMI). BMI is a simple ratio of weight to height, calculated by the equation kg/m^2 . BMI, while easy and economical, has several limitations. It was originally meant to be used in larger populations as an assessment tool rather than a technique for individual use. One commonly cited example of the limitations of BMI is athletes. Athletes often have increased weight due to a high percent of muscle mass, which weighs more than fat. Hence, these individuals have a low body fat percentage. However, when BMI is calculated with only height and weight, this population looks to be overweight or obese on the BMI scale (Ode, Pivarnik, Reeves, & Knous, 2007). The reason for this disparity is that BMI does not take actual body composition into account. Body composition is the components that make up the body such as bone, muscle, fluid (high amounts are desirable), and fat (high amounts are undesirable). By taking both desirable and undesirable components of the body into account a better assessment of obesity and its associated health implications can be done.

There are physiological changes that occur in the elderly that can restrict BMI from accurately assessing their risk for chronic diseases and obesity. These include variations in weight, muscle, and bone composition. Weight gain often occurs during the gaining process for

various reasons, such as reduced physical activity. This is sometimes paired with decreased height as spinal issues become more pronounced with age (Lexell, Taylor, & Sjostram, 1988). Sarcopenia is another condition that occurs as individuals age. Sarcopenia is the wasting of muscle mass during the gaining process. This typically occurs because muscles are used less for physical activity during the gaining process. Sarcopenia can result in a skewed BMI measurement since a decrease in muscle mass can result in a lower overall weight and hence a lower BMI, but in reality the body fat percentage, a better determinant of chronic disease, is increased (Chien, Huang, Wu). A third factor that shows prevalence during the gaining process and can potentially skew BMI is osteoporosis, the loss of bone mass. This condition can occur with little to no difference in weight, but with the decreased bone mass and increased fat mass, body composition changes in an undesirable manner (Parfitt, Mathews, Villanueva, Kleerekoper, Frame, & Rao, 1983).

RESEARCH PROBLEM

Even with the debate over the validity and overall usefulness of BMI, this method is still used predominantly over every other method of assessing obesity. The main reason for this is the ease with which it can be calculated and its ability to assess large populations. There are, however, a plethora of other ways body composition can be assessed. While BMI is a prevalent anthropometric measure, there are other anthropometric measures such as waist circumference (WC) and sagittal abdominal diameter (SAD). In addition, there are body compositional methodologies such as bioelectrical impedance analysis (BIA) or air displacement plethysmography (ADP). The purpose of this study is to interpret the overall relevance, accuracy, and appropriateness of these methods in order to determine the preference of using some methods over others in older adult women. In this study, all of the above techniques will be measured. The following sections will detail the techniques being evaluated in this study.

WAIST CIRCUMFERENCE (WC)

Two methods were used in this study when measuring WC, one method was a measurement (cm.) at the narrowest part of the waist and the second method was an umbilicus (belly button) measurement (Figure 1). WC is a good indicator of abdominal obesity, which is associated with health risks such as type II diabetes and metabolic syndrome (Duren, et. a., 2008). Larger WC is suggested to be a better predictor of mortality in elderly adults (aged 51-72) than BMI (Koster et. al., 2008). This study focused on the placement of fat on the body rather than only body fat percentage. As individuals age, fat tends to begin to accumulate around the abdominal area. Accumulated fat in the abdominal area is significantly more related to health complications than fat in the lower regions of the body due this visceral fat surrounding the internal organs, which is one of the reasons WC is more accurate in predicting mortality over BMI. A study of 2080 participants showed an increased likelihood of overall mortality with an increase in WC between 3.1 and 6.9 cm (Hazard Ratio = 1.52; Hollander, Bemelmans & Groot, 2013).

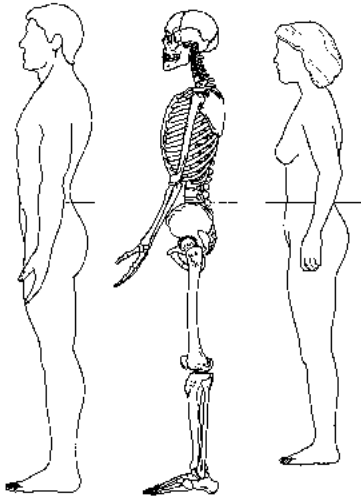


Figure 1. Measuring tape position for waist circumference at narrowest point of waist. High disease risk is >88 cm (> 35 in) for women and > 102 cm (> 40 in) for men. Image from: http://www.nhlbi.nih.gov/guidelines/obesity/e_txtbk/txgd/4142.htm.

SAGITTAL ABDOMINAL DIAMETER (SAD)

SAD is similar to WC, except that a sliding beam caliper is used to take the measurement and the subject is lying in a semi supine position so the subcutaneous fat does not slide to the sides of the waist, as it does when using WC. This technique is arguably better than WC and BMI. SAD is highly correlated with WC, but has a stronger association with hyperglycemia and dyslipidemia. In addition, it was found that in middle-aged adults, SAD had a strong correlation with predicting heart disease risk factors (Pimentel, Moreto, Takahashi, Poreto-McLellan & Burini, 2011). A study in adults 18-87 years of age, determined that SAD correlated six of the nine parameters that indicate risk for developing CVD (Souza and Oliveira 2013). SAD correlated with systolic blood pressure, high density lipoprotein cholesterol (“good” cholesterol), low density lipoprotein (“bad” cholesterol), triglycerides, total cholesterol, and glycemia, whilst BMI only correlated with total cholesterol, triglycerides and systolic arterial blood pressure, and WC correlated with triglycerides, HDL cholesterol, total cholesterol, and systolic arterial blood pressure.

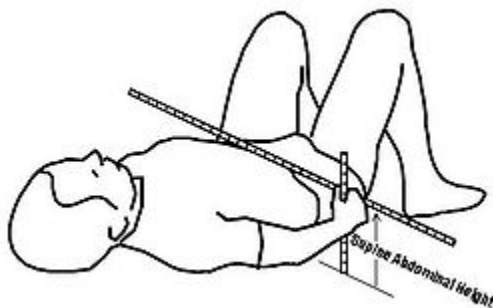


Figure 2. Sagittal abdominal diameter.

Image from: http://www.mashpedia.com/Sagittal_Abdominal_Diameter

BIOELECTRICAL IMPEDANCE ANALYSIS (BIA)

Thus far, the techniques discussed have been anthropometric measurements. Body composition methodologies such as BIA, are another technique for assessing weight status (Figure 3). BIA is measured by sending brief, harmless electric shocks throughout the body to determine body composition. Percent body fat and percent lean mass are measured by assessing how long it takes the shocks to travel through the body, through transmission through adipose tissue requiring more time than lean tissue.



Figure 3. Bioelectrical Impedance Analysis. Image From:

<http://sciengsustainability.blogspot.com/2014/06/body-fat-estimation-using-bioelectrical.html>

A study in India of 276 subjects showed the failure of BMI to accurately assess obesity when compared to BIA (Mittal, et. al., 2011). BMI measurements assessed only 3.9% of men and 5.7% of women to be obese, whilst BIA measured 52.9% of both men and women to be obese when using the same participants for both techniques.

AIR DISPLACEMENT PLETHYSMOGRAPHY

ADP is a two-compartment model that measures percent body fat and percent lean mass using BodPod technology (Figure 4). ADP uses a very precise scale to determine mass and the

BodPod chamber to determine density. Body density is assessed to determine percent body fat and percent lean mass.

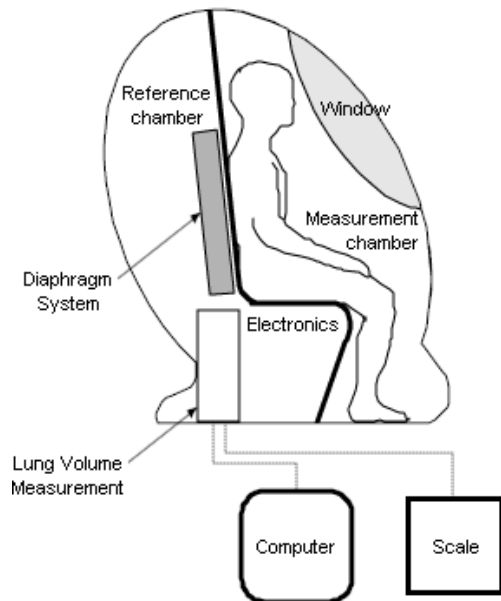


Figure 4. BodPod technology used for ADP. Image from: <http://www.nutritionrx.ca/services-rates/body-composition-testing/>.

ADP was created to be an alternative method in place of underwater weighing (UWW) which is considered the gold standard of body composition measurement. ADP was developed because UWW can be stressful and some individuals are unable to complete the test. This occurs because one is submerged underwater and asked to exhale all the air from their lungs, making the test potentially uncomfortable. There are numerous complications with compliance in UWW such as, fear of water with inadequate expulsion of air, which could be a particular problem when assessing elderly populations (Alemán-Mateo, et. al., 2004). ADP is also less physically taxing on the individual and is quicker in assessing body composition. While ADP does have benefits over UWW, it tend to overestimate density which can lower the measure of percent body fat. However, the same holds true in UWW. The variability between tests for BodPod technology (ADP) and UWW for percent body fat is 0.8% and 1.0% respectively (Alemán-Mateo, et. al., 2004).

METHODOLOGY

Measurements for each of the above described techniques were taken in this study and each method will be analyzed in order to attempt to determine which method(s) would be preferable over the rest. It is exceedingly important to be able to accurately assess an individual as being obese or overweight because this can better predict the risk for chronic disease than weight or BMI alone. By continuing to utilize BMI as the primary assessment technique to determine obesity, the likelihood of disparities in the assessment increases dramatically. The use

of other techniques assessing body composition by practitioners could ultimately result in better health outcomes for patients and lowered health care costs by preventing chronic disease since practitioners would be more aware of the health status of patients.

In this study, BMI, WC, SAD, BIA, and ADP using BodPod technology were assessed on adult females (aged 50+ years). These women were recruited via fliers around Bowling Green State University's campus, fliers in the Bowling Green Community, Campus Updates, and emails.

It was hypothesized that ADP would be the most accurate method to assess body composition as it is the most similar to the gold standard of body composition methodologies, UWW. Due to the variability in body type and fluid content of the participants, it was difficult to determine which of the other methods (WC, SAD, BIA) would be most accurate and relevant next to ADP. It was predicted that BMI would be the least appropriate and accurate amongst the other methods because of the lack of body composition taken into account in the measurement.

Before each day of data collection, the tester arrived approximately 30 minutes prior to the arrival of the participant in order to warm up and calibrate the BodPod. The Analyze Hardware, Check Scale, Autorun, and Volume functions were run in order to effectively prepare and calibrate the equipment. The scale used to weigh the participant whilst using the BodPod was also calibrated every two weeks to ensure the most accurate measurements.

Once the participant arrived, she was seated in the BodPod room and asked to thoroughly read the informed consent form and encouraged to ask any questions she may have. After her questions had been answered and she had read the informed consent form, she could choose to either sign the informed consent form and proceed with testing, or to not sign and not complete the testing. All participants chose to proceed with testing. The informed consent is available in **Appendix A**.

The participant was then asked to fill out a screening and demographic questionnaire. In order to proceed with testing, she had to answer "true" to all ten questions asked on the questionnaire. Answering false to any questions would result in exclusion from the study. After the screening and demographic questionnaire was filled out, the participant was asked to complete a physical activity questionnaire. The screening and demographic questionnaire can be found in **Appendix B** and the physical activity questionnaire in **Appendix C**.

At this point in the visit, the participant had been sitting for approximately five minutes and it was appropriate to now take a measurement of her resting blood pressure. The tester took the measurement via blood pressure via auscultation, using a stethoscope and a sphygmomanometer. The measurement was taken from the participant's non-dominant arm with the arm resting on the table. After blood pressure was taken, the tester took the participant's resting heart rate via the radial artery for one minute. Both measurements were recorded on the participant's data sheet. A blank copy of the data collection sheet can be seen in **Appendix D**.

The participant was then directed to change in preparation for ADP testing. Appropriate clothing for women for ADP testing is a bathing suit or compression shorts, sports bra, and a swim cap. The participant was asked to remove any jewelry, hair accessories, shoes, and socks. This type of clothing is specified for ADP testing in order to minimize the amount of error in the volumetric measurements taken by the BodPod. Appropriate clothing was provided for the participant if she did not bring her own.

Once the participant had changed, the participant's height was recorded using a stadiometer with her back touching the stadiometer and heels together. The head plate was then lowered to touch the participant's head. Height was recorded on the data sheet to the nearest tenth of a centimeter.

The participant was then asked to step away from the stadiometer, stand up straight, and breathe normally. The tester then measured the participant's WC at the narrowest area (WCN) using a Gulick tape. The measurement was taken at the narrowest area of the abdomen between the iliac crest and xiphoid process. The tester ensured the tape was parallel to the floor and was not twisted. The tape was tightened to remove any slack. Another measurement that was taken was the WC at the umbilicus (WCU). This measurement was taken at the participant's transverse plane located at the umbilicus. The tape was tightened again and measurement was recorded. Both measurements were taken at the nearest tenth of a centimeter and were recorded on the data sheet.

Next, the participant and the tester moved to the BIA room. The tester asked the participant to step onto the BIA machine once the machine was on and functioning. The tester entered the participant's information (height, age, and gender) into the BIA machine and switched the mode to read in kilograms and centimeters. The BIA machine weighed the participant and the participant was instructed to then hold onto the upper extremities of the BIA machine with her thumbs placed on the silver recording panels. The BIA machine performed the analysis of the participant and the results were printed off. The results sheet was placed in the participant's file and the percent body fat of the participant was recorded on the data sheet.

The participant and tester then moved back into the BodPod room to complete SAD measurements. The participant was asked to lie in a supine position on the examination table. The tester placed the SAD caliper under the lumbar the participant's lumbar spine and in line with the participant's umbilicus. The participant was asked to breathe normally and then the measurement taken while the participant exhaled and held her breath for approximately three seconds. The top of the caliper was then lowered to touch the participant's skin and a measurement was taken to the nearest tenth of a centimeter. This was performed three times for three separate measurements which were all recorded on the data sheet.

The last test performed was ADP via BodPod technology. The basic demographic information of the participant was input into the BodPod computer by the tester. This

information included the participant's date of birth, height, and identification number. The BodPod was then calibrated one more time using a standardized volumetric cylinder. Meanwhile, the participant was asked to don a swim cap in order to further minimize error in the volumetric measurements performed by the BodPod. The participant was asked to step onto the scale that is associated with the BodPod for a weight measurement. The participant was asked to minimize movement and her weight was measured. She was asked to step off of the scale and into the BodPod after the volumetric cylinder was removed from the chamber. The BodPod performed two measurements of the participant's volume and if the variability between the two tests was beyond the accepted threshold, a third measurement was taken. Each test lasted approximately 45 seconds. Once the volumetric measures had been successfully completed, the participant changed back into her own clothing, was thanked for her time, and escorted to the exit.

RESULTS

Data was collected from 36 Caucasian females (aged 57.9 ± 6.84). Descriptive statistics are listed in the table found below.

Table 1: Descriptive Statistics of the Sample Population. Means and Standard Deviations.

| | Mean | Standard Deviation | % Classified as Obese | N |
|-------------------------------|-------------|-------------------------------|----------------------------------|----------|
| Age (years) | 57.4 | 6.8 | | 36 |
| BMI (kg/m²) | 26.4 | 6.2 | 25% | 36 |
| WCN (cm) | 83.5 | 12.9 | 36.1% | 36 |
| WCU (cm) | 90.8 | 12.8 | 52.8% | 36 |
| SAD (cm) | 20.4 | 4.5 | 66.6% | 36 |
| BIA (%BF) | 33.5 | 9.5 | 22.2% | 36 |
| ADP (%BF) | 35.9 | 8.7 | 36.1% | 36 |

Further, risk stratification is identified in the figures found below.

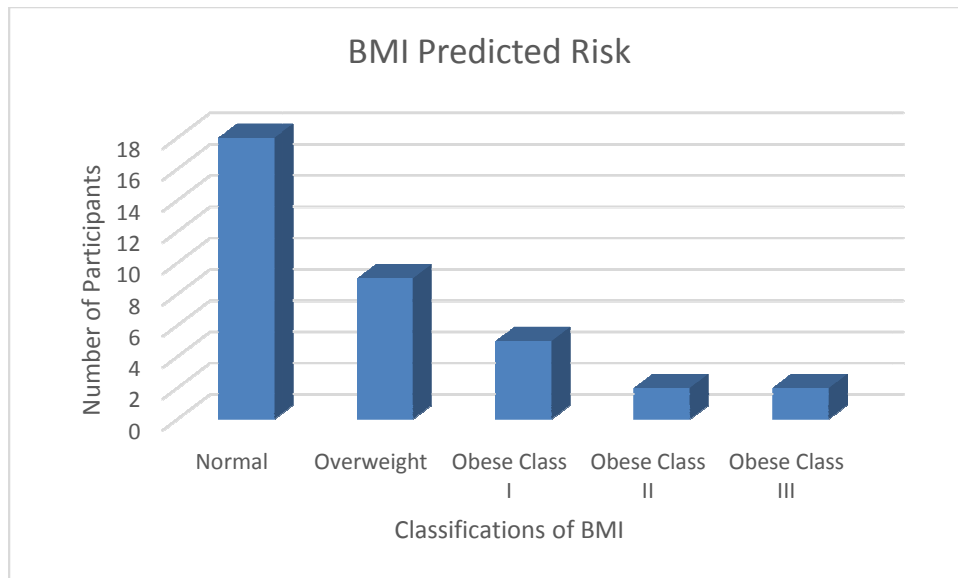


Figure 5: Risk stratification based on body mass index (BMI).

BMI risk can be classified as normal with values of 18.5-24.9 kg/m², overweight (25.0-29.9 kg/m²), obese class I (30-34.9 kg/m²), obese class II (35-39.9 kg/m²), and obese class III (40-45 kg/m²) (Centers for Disease Control and Prevention, 2011). BMI classified 18 females as normal BMI, nine as having an overweight BMI, five as having an obese class I BMI, and two females each as obese class II and obese class III. For the sake of this study, obesity health risk, (i.e., BMI \geq 30) was looked at primarily. Overall nine participants were classified as obese (25%).

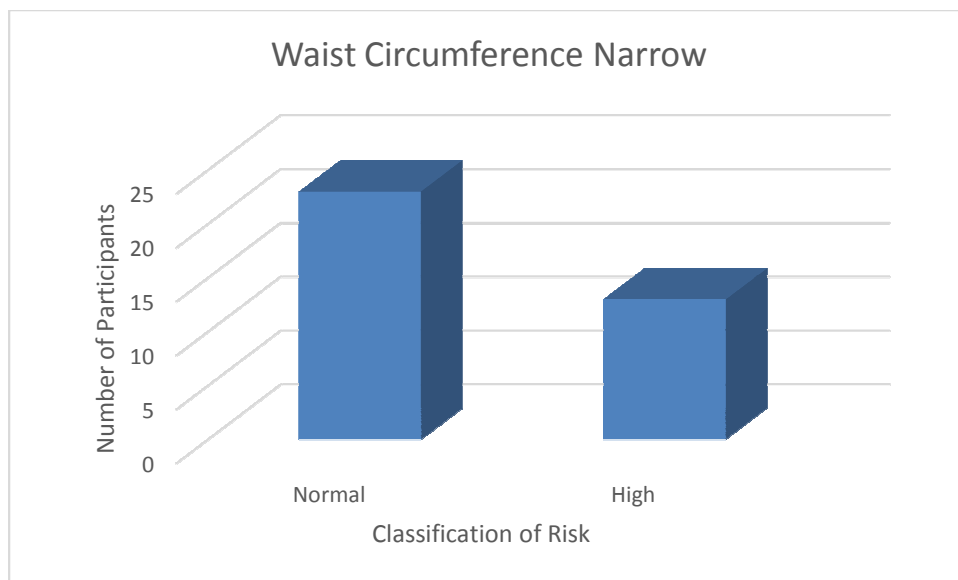


Figure 6: Risk stratification based on waist circumference taken at the narrowest area of the abdomen (WCN).

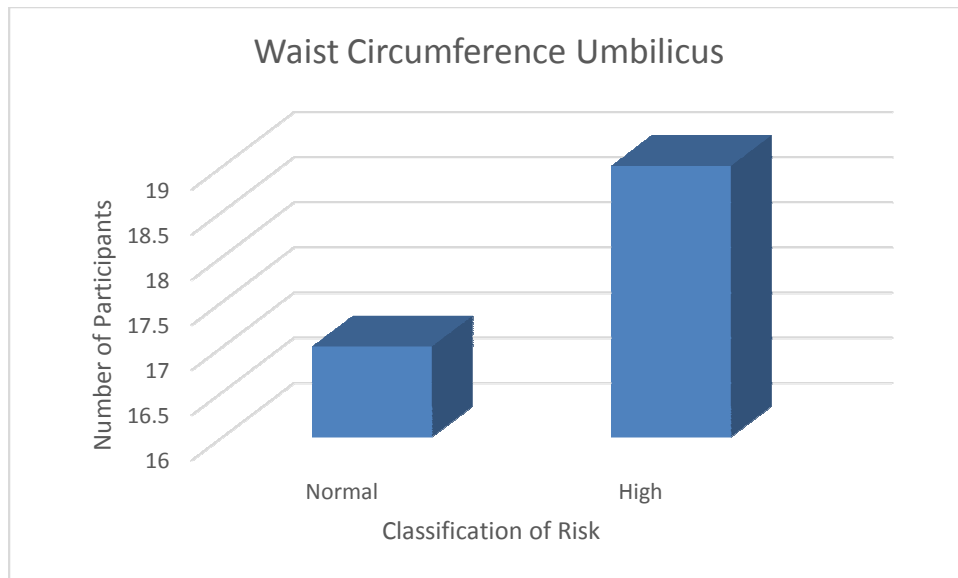


Figure 7: Risk stratification of waist circumference measured at the umbilicus area of the abdomen (WCU).

WC is broken up into classifications of normal and high risk for negative health consequences and or chronic disease. WC measured at both the umbilicus and the narrowest areas of the abdomen is identified as high risk if WC is above 88 cm for females (National Heart, Lung, and Blood Institute, 2000). WCN classified 13 participants (36.1%) as having high risk and 23 participants as having normal risk. WCU classified 19 participants (52.8%) as having high obesity-related risk and 17 as having normal risk.

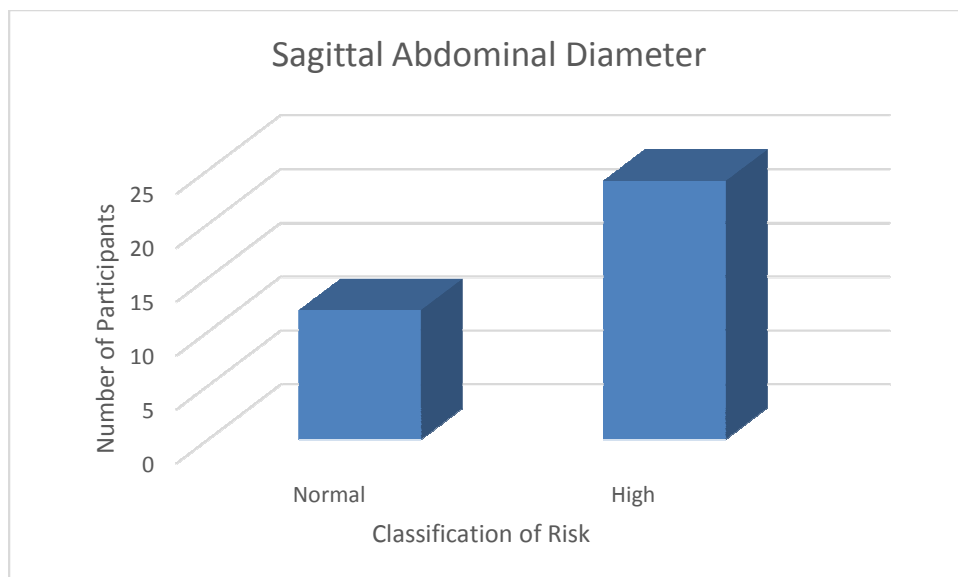


Figure 8: Risk stratification of sagittal abdominal diameter (SAD).

Risk classification for SAD is broken down into normal or high health risk for negative health consequences. There is no current standardized cut off point for what is considered normal or high obesity-related health risk. For this study, an SAD of above a 19.3 was determined to be the cut off for obesity-related health risk for women (Sampaio, Simoes, Assis, & Ramos, 2007). Obesity-related risk was found in 24 females (66.6%) using SAD while 12 were found to have normal risk using SAD.

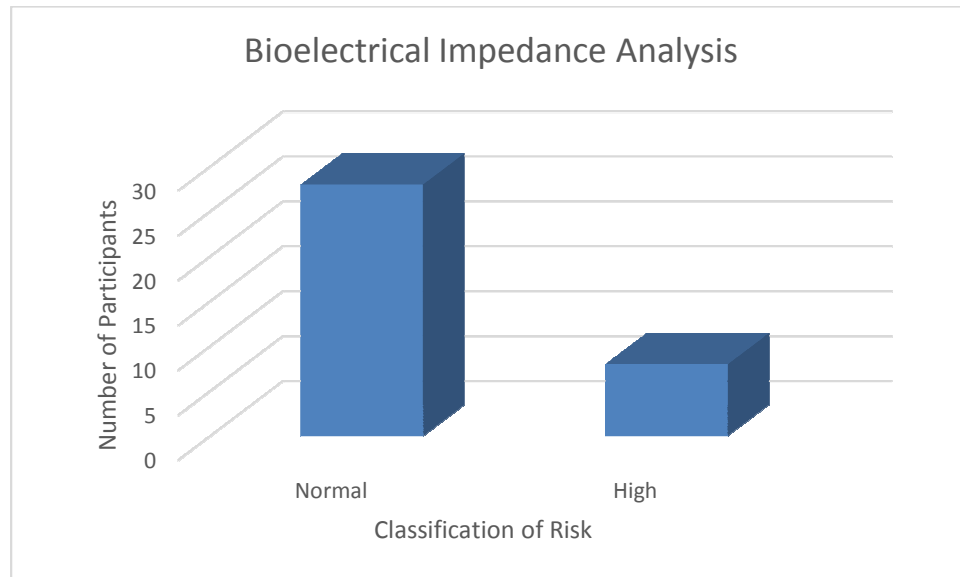


Figure 9: Risk stratification of bioelectrical impedance analysis (BIA).

According to the American College of Sports Medicine (Thompson 64), having a body fat percentage of above 42% is considered to be risky high body fat. BIA measured eight females (22.2%) to have risky high body fat and 28 to be at a normal risk for body fat percentage.

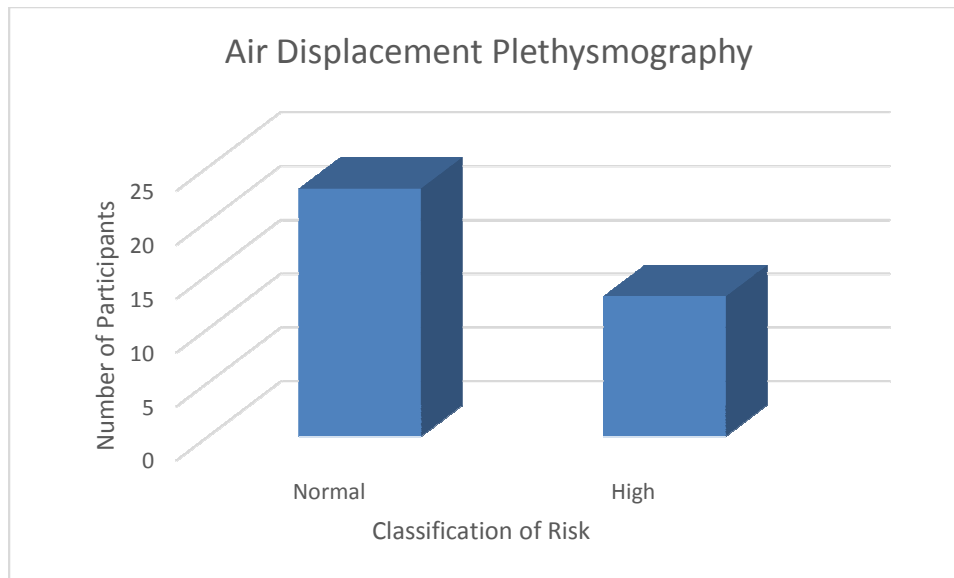


Figure 10: Risk stratification for air displacement plethysmography (ADP) .

The risky high body fat range is considered to be the same for ADP as it was for BIA. However, when using ADP 13 females (36.1%) were found to have risky high body fat and 23 females were found to have a normal risk body fat.

When using ADP as a criterion method, all measurements were found to be significant at $p < 0.001$ with high correlation values. The correlation values were as follows; WCN ($r=0.713$), WCU ($r=0.740$), SAD ($r=0.753$), BMI ($r=0.726$), and BIA percent body fat (%BF; $r=0.878$). In addition, in all adiposity measures 19.4% and 22.2% of participants were classified as obese and healthy consistently, respectively and variable results were found in 58.3% of participants.

DISCUSSION

Several conclusions can be drawn from the results above. First, the most accurate body composition measures in comparison with ADP were WCN, BMI, and BIA. This can be concluded as these measures were highly correlated without overestimating adiposity and had the highest numbers of participants as either consistently obese or healthy. BIA was expected to be highly correlated with ADP as both are body composition methods that measure fat mass and lean mass. BIA did underestimate adiposity at 22.2% of participants compared with 36.1% of participants being classified as obese by ADP. This discrepancy could be attributed to the amount of fluids in the participant's body at the time of testing as this could skew results. The amount of body fluids can influence the results in a negative manner if a participant consumed any food or drink less than two hours prior to the time of testing.

Conversely to what was expected, BMI was one of the most accurate anthropometric measures when compared with ADP. It should be noted, however, that BMI, like BIA, did tend to slightly underestimate adiposity at 25.0% of participants being to be at a predicted obesity-

related health risk whereas ADP classified 36.1% of participants as having a predicted obesity-related health risk. This is the inverse of the traditional argument against BMI. The traditional argument argues that BMI overestimates adiposity and obesity-related risk in young athletes with high muscle mass. The inverse was found in this study and should be taken into consideration when using BMI on an older adult female population. Overall, when using WCN and BMI, these can be considered reliable and “ballpark” measurements and should be used when anthropometrics are the main methodology in determining obesity-related risk while looking at adiposity. For the most accurate results, BIA and ADP should be used in tandem with WCN and BMI when assessing body composition.

WCU and SAD, however, had high correlations with ADP as well. ADP classified 36.1% of participants as obese whereas WCU and SAD classified 58.6% and 66.6% of participants as obese. This is a significant discrepancy between the two results. Despite the high correlation values associated with ADP, these measurements tended to overestimate adiposity as they classified some participants as obese who were not obese by any other measurement, causing much of the variable results. This meaning, WCN, BIA, BMI, and ADP did not classify specific participants as obese, but SAD and WCU did, causing variable results. The overestimation of adiposity can be equally as detrimental to one’s health as underestimation of adiposity. Overestimation of adiposity can cause a change in lifestyle habits that are unnecessary and can become potentially dangerous, such as disordered eating patterns and excessive exercise.

As was mentioned above, there was also a high amount of variable results found in this study. Much of this can be attributed to the overestimation of adiposity by SAD and WCU, but not all of it. This emphasizes the need for standardization among adiposity assessment techniques.

CONCLUSION AND RECOMMENDATIONS

Conversely to what was expected in this pilot study, it was determined that BMI was one of the most accurate anthropometric measurements in assessing obesity-related risk along with WCN. Whenever possible, BIA and ADP should be used in tandem with these anthropometric measures for the most accurate results. However, this is not always feasible as ADP and BIA technology is expensive and not always readily available. When using BMI, it is important to consider that a slight underestimation may be possible when assessing adiposity. In addition, the high amount of variable results indicate a need for standardization in assessing adiposity in relation to obesity-related risk in order to implement appropriate interventions.

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Appendix A

Informed Consent for “Senior Health Study”

Introduction: You are being invited to participate in the “Senior Health Study.” This project is collaboration between Dr. Amy Morgan, an associate professor of kinesiology, Dr. Mary-Jon Ludy, an assistant professor of clinical nutrition, Edward Kelley, a graduate student completing a master’s degrees in kinesiology. We are interested studying the body composition status of older community members.

Purpose: The purpose of this study is to explore body composition measures in older populations. In general, the study will help to assess the need for better obesity classification standards in older Americans.

Benefits of being a participant include:

- A comprehensive body composition analysis testing session.
- Access to results and expert feedback after data is collected. This will include your testing results, which would cost approximately \$200 at a health club.

Testing Date:

1. *Arrive at laboratory.* - You will arrive at Eppler South 124 at least 2-hours after exercise and eating/drinking anything other than water.

a. *Sign informed consent document.*

a. You will read the informed consent document.

b. You will ask any questions about participating in this study.

c. After all your questions have been answered, you will have the option of:

Signing the informed consent (meaning that you agree to participate in this study), or

Deciding not to participate.

b. *Screening and demographic questionnaire.*

You will complete a questionnaire asking about: Your sex, age, ethnic/racial background, height, weight, phone number, and email.

(If applicable we will ask if you are claustrophobic)

Upon completion of informed consent and pre-testing questionnaires testing will begin.

Test Visit Procedures (45 minutes):

1. You will arrive at Eppler South 124 at least 2-hours after exercise and eating/drinking anything other than water.
2. You will sit while completing informed consent, demographic, and physical activity questionnaire.
3. Your blood pressure will be measured by placing a cuff around your upper arm.
4. You will dress in a swimsuit or tights shorts with sports bra (if applicable), swim cap, and nose plugs for your body composition measurements.
5. You will have your waist circumference measured by placing a measuring tape around your waist.
6. You will have your height measured while standing against the wall.
7. You will have your sagittal abdominal diameter measured while laying supine.
8. You will have your body composition measured using 2 methods.

Method 1 (BOD POD): You will sit in an airtight chamber for 2-3 brief measurements lasting approximately 45 seconds. *You should not participate in this measurement if you are claustrophobic.*

Method 2 (bioelectrical impedance): You will stand on an electronic scale and place your hands around handgrips. *You should not participate in this measurement if you have a pacemaker or other artificial electrical medical device/electrical system.*

9. You will dress in your own clothes.

After Data Collection

You will have access to your testing results. Your testing results will be available to you and research team members can answer any questions regarding your results.

Voluntary nature: Your participation is completely voluntary. You are free to withdraw at any time. You may decide to skip questions (or not do a particular task) or discontinue participation at any time without penalty. Deciding to participate or not will not affect your relationship with Bowling Green State University.

Confidentiality: Your participation in this study will remain confidential. Hard copies of all data will be stored in a locked filing room. The principal investigator, co-investigators, and graduate student assistants will be the only people with access to the data. The hard- copies will be retained for 3 years after the project ends, after which they will be destroyed by shredding. Electronic files will be stored on a portable flash

drive in password-protected documents and will not be destroyed. The study will not be anonymous because it will be necessary to identify participants before each test, as well as track and analyze results. Your name will be used when signing consent forms, at the screening visit, and when entering data into computer hardware for body composition testing. You will receive a “subject ID” number, which will be used on all paper documents after screening.

Risks: Risk may be encountered during body composition assessments and alcohol reporting.

a. BOD POD: There is a risk that participants will experience anxiety and/or uneasiness when placed in the confined windowed chamber. This procedure, involving 2-3 measurements of approximately 45 seconds, will be monitored by laboratory staff and can be discontinued at any point as necessary. The BOD POD also has a “panic button” that the subject may press at any point during the assessment to stop the test. To minimize this risk, potential participants reporting claustrophobia will be excluded at screening.

b. Bioelectrical impedance analysis: There is a risk that the small electrical signal transmitted through bioelectrical impedance analysis (to measure resistance of body tissues to the electrical flow, and thus estimate body fat and muscle mass) will interfere with implanted electrical devices. To avoid

this risk, potential participants who report having a pacemaker or other artificial electrical medical device/electrical system will be excluded at screening.

Contact information: If you have any questions about this research or your participation in this research, please contact the study investigators.

Principal Investigator: Dr. Amy Morgan, Associate Professor
School of HMSLS amorgan@bgsu.edu 419-372-0596

Co-Investigator: Dr. Mary-Jon Ludy, Assistant Professor School
of FCS mludy@bgsu.edu 419-372-6461

Co-Investigator: Edward Kelley, Graduate Student School of
HMSLS etkelle@bgsu.edu 419-372-0212

You may also contact the Chair, Human Subjects Review Board
hsrb@bgsu.edu, if you have any questions about your rights as
a participant in this research.

Thank you for your time.

I have been informed of the purposes, procedures, risks and
benefits of this study. I have had the opportunity to have all my
questions answered and I have been informed that my
participation is completely voluntary. I agree to participate in
this research.

_____ Participant Signature

Appendix B

Name: _____

Subject ID: _____

Visit Date: _____

PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities students do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person.

Please think about the activities you do on campus, at work, to get from place to place, and in your spare time for recreation, exercise, or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

No vigorous physical activities Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. Moderate activities refer to activities that take **moderate** physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

No moderate physical activities Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

Think about the time you spent **walking** in the last **7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? _____ days per week

No walking Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

The last question is about the time you spent **sitting** on **weekdays** during **the last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ hours per day

_____ **minutes per day**

_____ Don't know/Not sure

Thank you for completing the physical activity questionnaire!

Appendix C

Name: _____

Subject ID: _____

Visit Date: _____

SCREENING AND DEMOGRAPHIC QUESTIONNAIRE

Please circle TRUE or FALSE for the following questions.

TRUE FALSE 1. I am not claustrophobic.

TRUE FALSE 2. I do not have a pacemaker or artificial electrical medical device(s)/electrical system(s).

TRUE FALSE 3. I am willing to attend 1 test visit lasting about 45 minutes each.

TRUE FALSE 4. I am willing to answer questions about my physical activity.

TRUE FALSE 5. I am willing to have my blood pressure measured.

TRUE FALSE 6. I am willing to have my weight measured.

TRUE FALSE 7. I am willing to have my height measured.

TRUE FALSE 8. I am willing to have my waist size measured.

TRUE FALSE 9. I am willing to have my abdomen measured.

TRUE FALSE 10. I am willing to wear a swimsuit or tight shorts with a sports bra (if applicable) to have my muscle and body fat measured.

Please fill-in or circle your answers to the following questions.

11. Sex: _____ male; _____ female

12. Age: _____ years

13. Birthday (month/day/year):

14. Ethnic/Racial Background

1. White/Caucasian (non-Hispanic)

2. Asian/Pacific Islander

3. Hispanic

4. Black/African American

5. American Indian/Alaskan

6. Other (name): _____

7. Prefer not to answer

15. Height: _____ inches

16. Weight: _____ pounds

17. Phone Number: _____

18. Email: _____

Thanks for completing the screening and demographic questionnaire!

Appendix D

Senior Health Study Data Collection Sheet Participant

ID: _____

Resting Blood Pressure: _____

Height (cm): _____

Waist Circumference (Narrow): _____

Waist Circumference (Umbilicus): _____

Bioelectrical Impedance Analysis (% fat): _____

Sagittal Abdominal Diameter (cm): Trial 1 _____ Trial 2 _____ Trial 3 _____

BodPod: Fat Mass (kg) _____ Lean Body Mass (kg) _____