I, Sara M. Tamsukhin, hereby submit this work as part of the requirements for the degree of:
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It is entitled:
The Relationship between Parity and Body Composition in African-American Women

This work and its defense approved by:
Chair: Debra A. Krummel, PhD, RD, LD
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The Relationship between Parity and Body Composition in African-American Women

A thesis submitted to the

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MASTER OF SCIENCE

in the Department of Nutritional Sciences

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By

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Abstract

Objectives. To determine the relationship between parity and body composition in African-American women. To compare different equations for determining body composition in this population.

Design. Cross-sectional

Subjects. Eighteen African-American women (10 previously pregnant, 8 never pregnant women) between 18 and 35 years old were recruited through advertisements.

Methods. Body composition was measured using air-displacement plethysmography (BODPOD®). Percent body fat was calculated using four previously validated equations (by Ortiz, Dioum, Siri, and Brozek).

Main Outcome Measure. Percentage of body fat.

Results. No significant difference in percent body fat was found in women who had ever been pregnant versus women who had never been pregnant. The four equations used to determine percent body fat were perfectly correlated (r=+1.00, p<0.001).

Conclusion. A difference in the percentage of body fat in nulliparous versus parous women was not observed. In this population, the four equations produced equivalent estimates of the percentage of body fat.
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Introduction

In the past ten years, the rate of obesity has continued to rise among all ages, genders, races, and ethnicities. The prevalence of overweight and obesity in the United States has now reached epidemic proportions. Many factors contribute to this trend of increasing adiposity. Lack of physical activity and increased caloric intake are two of the more commonly known factors that play a major role. For women, critical periods for the development of obesity are pregnancy and post menopause. Many researchers have found the relationship between obesity and these time periods to be different among various racial and ethnic groups.

Based on body mass index (BMI), the prevalence of overweight and obesity varies between non-Hispanic white and African-American women. Data from the 2003-2004 National Health and Nutrition Examination Survey (NHANES), shows that the overall rates of overweight and obesity for all women ages 20 years and above were 62% and 33%, respectively.\(^1\) For African-American women of all ages, the rates were 82% overweight and 54% obese compared to 58% overweight and 30% obese for non-Hispanic white women.\(^1\) Moreover, African-American women 20 to 39 years old have a much higher rate of overweight and obesity than non-Hispanic white, with 74% of African-American women being overweight and 50% obese compared to 46% of non-Hispanic white women being overweight and 24% obese.\(^1\) These differences in prevalence among races warrant further examination and research into factors that might help explain these trends.

With such high rates of overweight and obesity occurring during the reproductive years (ages 20 to 39 years), the effect of pregnancy on future BMI and adiposity also requires further research. Prepregnancy weight and BMI can have an effect on current and future pregnancies, maternal outcomes, fetal outcomes, and future health. Studying both the effect of weight and
BMI on pregnancy and, conversely, the effect of pregnancy on weight and BMI will allow us to further understand and improve maternal and child health.

In addition to prepregnancy body weight, weight gained during pregnancy and changes in body composition can also play a role in pregnancy outcomes and future health. The Institute of Medicine offers guidelines for the amount of weight a woman should gain during pregnancy based on her prepregnancy BMI. However, these recommendations are rarely met; weight gain during pregnancy often exceeds the guidelines. Changes in BMI and body composition can also be tracked during pregnancy and provide useful assessment data. However, individuals may fall into the normal BMI category but still have an increased percentage of body fat. The changes in BMI reflect changes in adiposity whereas body composition distinguishes between lean body mass and fat mass accrual and loss. Tracking changes in lean body mass and fat mass is important, especially since fat mass is related to chronic disease risk. Together these three measurements, weight gained during pregnancy, BMI, and body composition, provide a picture of adiposity changes over the lifespan. By following weight gained during pregnancy, BMI, and body composition in women, current and future problems can be reduced or eliminated.

The purpose of this study was to examine the relationship between parity and body composition in African-American women.

**Review of Literature**

The following is a review of the literature related to adiposity during pregnancy, gestational weight gain and pregnancy outcomes, parity-related weight changes, parity and body composition, methods for body composition, and validity of air-displacement plethysmography (BODPOD®) as a tool for body composition measurement.
Adiposity during Pregnancy

Pregnancy is a time of change in body fat stores for both the mother and the fetus. During pregnancy, subcutaneous fat is being deposited while the placenta increases in volume and provides a supportive environment for the growth and nourishment of the fetus. For a healthy woman of ideal body weight, about 25% of weight gained during pregnancy is added to maternal fat stores. This adipose tissue is another source of energy for the mother and may serve as a reserve of energy for the rapidly growing fetus in the last weeks of pregnancy.

The most common method used to determine changes in body fat stores during pregnancy is skinfold thickness measurement. In a prospective study, Forsum et al. measured skinfold thickness in a group of Swedish women before, during, and after pregnancy. They found that early in pregnancy women gained a considerable amount of subcutaneous fat, with skinfold measurements at the subscapular site having the greatest increase in adipose tissue followed by the suprailliac site. In a larger prospective study of healthy women enrolled prior to pregnancy, Sidebottom et al. also measured skinfold thickness at the same time points. Data from this study showed that as early as six weeks after conception subcutaneous fat began to accumulate and continued to increase throughout pregnancy. Specifically, subscapular skinfolds increased by 35%, thigh skinfolds by 30%, and triceps skinfolds by 13% from preconception to 35 weeks gestation.

Although these studies have added to knowledge of adiposity during pregnancy, some limitations should be noted. Skinfold measurements can be difficult to obtain, especially in obese women, and require trained personnel whose technique must be assessed periodically. Secondly, the study by Forsum et al. was conducted on non-Hispanic white women in Europe which limits generalizability to other races and ethnicities. The authors also note that the degree
of hydration of fat-free mass may play a role in the changes of total body fat since hydration is a component of body composition calculations. Additionally, Sidebottom et al. had a population of primarily well-educated Caucasian women (97%) and point out that fat storage during pregnancy may show different patterns based on ethnicity, race, parity, and maternal nutrition status.

Sknfold measurements are a common way to measure body composition in pregnant women and results from available studies show that fat deposition begins early in pregnancy especially at the thigh and subscapular sites. Little evidence is available regarding the racial differences in fat deposition during pregnancy.

**Weight Gain during Pregnancy**

Although weight gain is an essential part of pregnancy, the amount of weight gain and composition of this gain varies greatly among individuals. The Institute of Medicine (IOM) provides recommendations for gestational weight gain based on pre-pregnancy BMI category. These recommendations were created to help ensure optimal fetal outcomes. The recommendations are as follows: women with a pre-pregnancy BMI < 19.8 kg/m² should gain 12.5 to 18 kilograms (kg); women with a BMI of 19.8 to 26.0 kg/m² should gain 11.5 to 16 kg; those with a BMI of 26.0 to 29.0 kg/m² should gain 7 to 11.5 kg; and women with a BMI > 29.0 kg/m² gain at least 7 kg.

One study looked at the amount of weight gained and used underwater weighing and a four-compartment model, which includes total body water in liters, body density in grams/milliliters, bone mineral in kilograms, and body weight in kilograms, to determine body composition in pregnancy. During and after pregnancy, it was determined that if weight is
gained as recommended, underweight women would move to a normal body composition and obese women would have little or no change in body fat.5

In a retrospective study of births registered in North Carolina from 1988 through 2003, the proportion of women gaining the recommended amount of weight steadily decreased from 77% in 1988 to 71% in 2003.6 The same study also showed the percentage of women gaining less than or more than recommended increased from 7% to 10% and from 16% to 19%, respectively. A study of women giving birth in New Jersey, found that one in three of all mothers gained more than 35 pounds during pregnancy.7

Weight gain is essential for a healthy pregnancy. However, the current guidelines for gestational weight gain are rarely followed with many women gaining much more weight than is necessary. This excess weight includes a greater percentage of fat, which can lead to current and future health issues.

Maternal Weight Gain and Pregnancy Outcomes

Many researchers have looked at the effect of weight gain on pregnancy outcomes and fetal outcomes. Placental volume at 14, 17, and 20 weeks gestation was determined to have a direct relationship to maternal BMI in a prospective study of women.8 For every one kg/m² increment in mother’s BMI, a 0.08 unit increase was found in the placental volume at 14 weeks, a 0.07 increase at 17 weeks, and a 0.1 increase at 20 weeks. In addition, maternal weight gain was positively associated to fetal abdominal circumference.

A number of studies have looked at how prepregnant weight status and gestational weight gain can affect the actual pregnancy. In a large cohort study of live singleton births from 1999 to 2000, Rosenberg et al. found that the heaviest women were most at risk for primary cesarean
delivery and that risk of preeclampsia increased as weight increased for all racial/ethnic groups. A retrospective study of women showed similar findings and also found that increased maternal BMI was associated with an increase in hypertension and gestational diabetes for the mother. Vahratian and colleagues also determined that overweight and obese women had a higher proportion of weight gain above the IOM recommendations compared with normal weight women; 47% of obese and 40% of overweight women had to be induced compared to only 31% of normal weight women. In their study, these researchers also confirmed an increased risk of cesarean delivery, with 21% of women who were overweight prior to pregnancy requiring this method of delivery.

In addition to the increased risk of preeclampsia found in the study by Rosenberg et al., a higher prevalence of preeclampsia for obese women was seen in two other studies. In a study by Brennand, Dannenbaum, and Willows, it was determined that obese women with an excessive weight gain during pregnancy had a 15% higher prevalence of preeclampsia than obese women with low (4%) or acceptable weight gain (7%). Another large study of pregnant, obese women found that women with class III obesity (BMI ≥ 40 kg/m²) were more likely to experience preeclampsia, as well as cesarean delivery and large for gestational age (LGA) births, than women with class I (BMI 30.0-34.9 kg/m²) or class II (35.0-39.9 kg/m²) obesity.

The infant can also be affected by the weight status and weight gain by the mother during pregnancy. The study by Rosenberg et al. in 2005, found that obese women were most at risk for giving birth to a macrosomic infant (4000 grams or more), which can lead to future health problems for the child. Furthermore, infants of overweight and obese mothers were 100 grams and 60 grams heavier, respectively, than infants of normal weight mothers. Another research group looked at a large cohort of women and discovered that woman who gained more than the
IOM recommendations were 50% more likely to have an infant with hypoglycemia or hyperbilirubinemia.\textsuperscript{14}

Overall, weight and BMI prior to pregnancy, as well as, weight gain during pregnancy can have an adverse effect on pregnancy outcomes and fetal outcomes. Pregnancy can be affected by increased risk of cesarean delivery, gestational diabetes, and preeclampsia. Infants are at increased risk for being large for gestational age, and having hypoglycemia or hyperbilirubinemia. These issues during pregnancy can also have an effect on the future health of both the mother and baby, including increased risk of obesity for both. With the risk of obesity, there is also the increased chance of cardiovascular disease and type 2 diabetes.

**Postpartum Weight and Fat Retention**

The retention of fat mass in the postpartum period can have a health effect on the mother well into adulthood and older age. Excess fat retention leads to a higher BMI and possibly overweight, obesity, or severe obesity. Much evidence supports a relationship between increased amounts of body fat and the onset of cardiovascular disease, diabetes, and many other chronic conditions.

Several groups reported a positive association between gestational weight gain and postpartum weight and fat retention.\textsuperscript{15,16} Parham, Astrom, and King, studied 158 low-income pregnant women during a two year period from prenatal up to nine months postpartum for weight gain and weight changes.\textsuperscript{15} The 114 women remaining at three months postpartum had an average residual weight of 4.2 kg (+/- 3.4kg).\textsuperscript{15} From three to six months postpartum, 58 women were measured with a mean residual weight of 4.8 kg (+/- 4.7 kg) and during the final six to nine months, 37 women were measured with a residual weight of 3.8 kg (+/- 5.4 kg).\textsuperscript{15}
Similar findings were reported by Butte et al., who assessed body composition in sixty-three women and found a positive correlation between gestational weight gain and weight retention ($r=+0.67$, $p=0.001$).\textsuperscript{16} Finally, Kac et al. found gestational weight gain to be a main predictor of postpartum weight retention in 405 Brazilian women (regression coefficient $=0.3506$, $p<0.001$).\textsuperscript{17}

The fat retention after pregnancy tends to be situated centrally and can lead to maternal obesity. Additionally, race can have an effect on the amount of weight retained. In women who are obese before pregnancy, there is a tendency for a more central obesity to develop in the postpartum period.\textsuperscript{18} Furthermore, Parham et al. confirmed that excessive weight gain in pregnancy can contribute to maternal obesity.\textsuperscript{15} In relation to race, African-American women were found to retain more weight postpartum as compared to Caucasian women.\textsuperscript{19}

Several studies have quantified the amount of weight retained in the postpartum period. The average amount of fat mass retained four to six weeks postpartum was determined to be 1.8 kilograms (~4 pounds) by Kopp-Hoolihan et al. in a study of nine women in the San Francisco Bay area using a four-compartment model, including body density, total body water, bone mineral content, and total body potassium to determine fat mass deposition.\textsuperscript{20} In a large study of healthy adult women who gave birth to a full-term singleton, 26\% of women were at least 4.6 kilograms heavier than their prepregnancy weight at one year postpartum.\textsuperscript{21} Another study of racially diverse women, showed that over 75\% of the women did not return to their prepregnant weight within six weeks postpartum.\textsuperscript{22}

Other factors can also contribute to preventing excess weight retention in the postpartum period. Women who are lactating have different changes in body composition than women who are not lactating during the first six months postpartum.\textsuperscript{23} Furthermore, women who exercised
often, ate less, and were breastfeeding at one year retained significantly less weight than those who did not.\textsuperscript{21} According to a prospective cohort study by Gunderson, Abrams, and Selvin, characteristics related to an increased risk of becoming overweight after pregnancy included race/ethnicity, gestational weight gain greater than the IOM recommendations, age between 24 and 30 years, age at menarche less than 12 years, and having a first ever birth less than 8 years after menarche.\textsuperscript{24}

Parity and Weight Gain

The role of parity in weight gain has not been thoroughly explored. Most studies that are available look mainly at well-educated non-Hispanic, Caucasian women. In women, it appears that parity plays a role in both postpartum weight retention and weight gained over the lifetime.

In relation to postpartum weight loss, primiparas were found to lose more weight in the first three months postpartum than multiparas; however, women who were multiparous lost more weight over a longer period.\textsuperscript{25} A study by Brown, Kaye, and Folsom found that women who had never been pregnant and those women who had three or more births, had a higher mean body weight and BMI and were more likely to be overweight than women with only one or two births during their lifetime.\textsuperscript{26} Overall, parity was associated with an increase of 0.55 kilograms per live birth in women ages 18 to 50 years old.\textsuperscript{26} A prospective study of women randomly selected within specific ages (ages 38, 46, 50, 54, and 60) conducted in Sweden, showed that parity was positively related to central obesity and gradual changes in fat distribution within the body.\textsuperscript{27}

There are some limitations to the aforementioned studies. Most women studied were white and well-educated. Additionally, self-report of weight histories was utilized in the study by Brown, Kaye, and Folsom.\textsuperscript{26}
A positive association between parity and body weight in African-American women has been reported. Similar studies in women from other racial/ethnic groups have not been consistent. In a large retrospective study of live singleton births, the relationship between maternal obesity and risk factors for adverse pregnancy outcomes among four racial/ethnic groups was explored. Findings from this study showed that African-American women were significantly more likely to be in the two heaviest weight categories and were more likely to have excess weight gain during pregnancy than whites or Asians. Additionally, twelve percent of black women had a prepregnancy body weight of 200 pounds or more. Another study found a significant relationship between parity and body weight in African-American women living in metropolitan areas; women studied from metropolitan areas tended to have a higher body weight with higher parity than women from non-metropolitan areas. In this same study, a weak negative relationship was found between parity and body weight in African-American women living in non-metropolitan areas.

The relationship between BMI and childbearing was explored in a prospective study of African-American women over a four year period. This study found that parity decreased with increasing education. Moreover parous women had lower BMIs at age 18 and were less likely than nulliparous women to use hormonal contraceptives or participate in vigorous physical activity. Over the four year follow-up, BMI increased an average of 1.6 kg/m² and the proportion of obese women increased from 24% to 32%.

Lederman, Alfasi, and Deckelbaum also explored the relationship between pregnancy and obesity in a small study of African-American women. The women in the study provided self-reported prepregnancy weight, height, and highest weight attained during pregnancy and
prepregnancy BMI was calculated. Several findings came about from this study related to weight gain during pregnancy. First, during pregnancy, women on average gained more than 38 pounds; only 25% of women gained weight as recommended. Furthermore, excessive weight gain during pregnancy occurred in all women who were obese or overweight prior to pregnancy. At two months postpartum, most women were still approximately 18 pounds above prepregnancy weight and none of this residual weight was lost by six months. Between two and six months postpartum, 44% of the women remaining in the study at six months gained weight.

From these studies, it is apparent that pregnancy plays a role in the future adiposity of women. However, more research is necessary to further understand the distribution of the weight gain and the biological mechanisms that mediate the weight change.

**Parity and Body Composition**

In relation to parity and body composition, there is little research available. In a study by Kirchengast et al., 106 postmenopausal women had body composition measurements using dual-energy x-ray absorptiometry (DXA) and fat distribution was estimated using the fat distribution index (FDI = upper body fat mass divided by lower body fat mass). The authors found that parity was positively related to menopausal changes in fat distribution. For example, there was an inverse relationship between number of births and fat distribution index. Another trial used skinfold measurement data collected from the National Health and Nutrition Examination Survey III (NHANES III) to explore the relationship between body composition and parity. This study found that women tended to gain fat with successive pregnancies and parity was negatively associated to hip and thigh circumference, suprailliac and thigh skinfolds, and body fat estimated
from skinfolds. Furthermore, an increase in parity was related to an increase in waist circumference.\textsuperscript{31}

Body mass index and waist-to-hip ratio have also been used to describe the relationship between parity and body composition. In a study of multiparous, primiparous, and nulliparous Brazilian women by Rodrigues and DaCosta, parity was positively related to central fat distribution as indicated by waist-to-hip ratio ($F = 16.09$, $p=0.0001$).\textsuperscript{32} These results suggested that having a baby was associated with an increase in total body weight, body fat, and central accumulation of body fat.\textsuperscript{32} A second study of Caucasian women who were menstruating, using bioelectrical impedance analysis, found no statistically significant association between parity and change in weight, body composition, or waist-to-hip ratio.\textsuperscript{33} After adjusting for age, nulliparous women retained more lean mass in the 4.5 year interval of the study, i.e. nulliparous women lost 1.4 kg of lean mass whereas parous women lost 2.3 kg of lean mass on average.\textsuperscript{33}

The relationship between parity and body composition needs to be explored further since conflicting results have been found with different studies using different methods of assessment. Some studies determined that body composition or fat distribution was different among parity groups whereas, others found no relationship between parity and body composition or fat distribution indicated by waist-to-hip ratio.

**Differences between African-American and Caucasian Women in Body Composition and Weight Retention**

The fact that African-American women and Caucasian women have distinct differences in body composition is very important when studying parity and body composition. In a study by Ortiz et al. on 28 pairs of black and white subjects matched for height, weight, age, and menstrual status, it was reported that when ethnicity is not taken into account, small, but
important, errors in fat estimates occur in body composition models due to differences in fat-free mass and total body potassium. Furthermore, African-American females were found to have more appendicular skeletal muscle and total bone mineral mass than the matched Caucasian female controls. These findings were supported by another study of nineteen Caucasian females and fifteen African-American females, which concluded that the lean body mass of African-Americans (65.3 kg) was denser than that of Caucasians (62.8 kg).

Another important factor in body composition is weight retention and the difference between African-American women and Caucasian women. Parker and Abrams analyzed data from the 1988 National Maternal and Infant Health Survey and found that African-American mothers were twice as likely to retain at least 20 pounds postpartum as compared to Caucasian mothers (AOR = 2.20, 95% CI, 1.50-3.22). Moreover, analysis of data from the Coronary Artery Risk Development in Young Adults (CARDIA) study found that African-American women gained almost twice as much weight as Caucasian women and that African-American women had greater increases on all measures of adiposity. In relation to fat distribution, primiparas in both groups had significantly greater increases in waist-to-hip ratios independent of weight change than did nulliparous women ($p_{\text{adjusted Caucasian}} = 0.0001, p_{\text{adjusted African-American}} = 0.003$).

**Air-Displacement Plethysmography (BOD POD®) and the Creation of Race-specific Equations**

Many methods have been used to monitor changes in body composition such as skinfold measurements, bioelectrical impedance, and underwater weighing (also known as hydrostatic weighing). Dual energy x-ray absorptiometry (DXA) provides another method of body composition determination, but is used less often in pregnancy due to x-ray radiation exposure.
More recently air-displacement plethysmography (BODPOD®) has been introduced to measure body composition by determining the amount of air displaced by an individual. Currently, the BODPOD® has been determined to be a reliable and valid method to measure percent body fat in non-pregnant women.

The BODPOD® was introduced in 1994 by Life Measurement, Inc. It uses a concept similar to underwater weighing, but instead of water displacement, the BODPOD® uses air-displacement plethysmography to determine body density. Using the body density measurement, percent body fat can be calculated using a variety of equations. Numerous studies have been conducted to determine reliability, validity, reproducibility, and accuracy in various populations including women, men, and different races/ethnicities. Data from a study by Levenhagen et al., also indicates a highly significant correlation between air-displacement plethysmography and both hydrostatic weighing and bioelectrical impedance used to determine body composition (r=+0.92, and r=+0.94, respectively with p=<0.0001).

Trials have also been conducted to determine the effects of increased body temperature, moisture, and amount of clothing on body density measurements. Increases in body heat and moisture or excessive clothing during the test can result in an underestimation of body fat. Hence, these variables should be taken into account and be controlled for during testing.

One important piece to the calculation of body density is lung volume. When using the BODPOD®, lung volume can either be measure or estimated with a standard equation. One study looked at the differences between predicted and measured volumes and found that they do not differ significantly. However, if a participant has erratic breathing, this will create errors in body density with either measured or predicted lung volumes.
As previously discussed, African-American females and Caucasian females have differences in body composition components including total body potassium and fat free mass. Dioum and colleagues took these variations into account and used skinfold measurements to cross-validate the use of air-displacement plethysmography and to create an equation specifically for Africans. Similarly, Ortiz et al., also derived equations that could take into account the differences in body composition of African-American females. These equations use different coefficients and constants determined by mathematical derivation.

Summary

Research has shown that body weight and fat gained during pregnancy are likely to be retained by individuals. Also, the weight gained in the postpartum period needs to be considered. With weight retention from pregnancy and further weight gain in the postpartum period, women are putting themselves at greater risk for overweight, obesity, and the complications that accompany obesity.

The differences in body composition, weight retention, and fat retention in African-American and Caucasian females are apparent from the current literature available. The relationship between parity and body composition in African-American females warrants further investigation since there is little information about this relationship available. While there are many methods for determining percent body fat, air displacement plethysmography is a reliable and accurate way to obtain body composition measurements. The BODPOD® can provide an easy and safe way to obtain body composition measurements in order to explore the relationship of these measurements with parity.
Purpose

The purpose of this study was to look at the relationship between parity and body composition in African-American women using the BODPOD®.

Hypotheses

1) A relationship between percent body fat and parity will emerge in African-American women.

2) Percent body fat estimates determined by four different equations will be significantly correlated.

Methods

Subject Recruitment and Screening

African-American women were recruited through the Ambulatory Care Clinic at University Hospital in Cincinnati, Ohio and through flyers posted on the University of Cincinnati campus. A telephone screening to determine eligibility was completed prior to scheduling the study visit (Appendix 1: Screening form). Eligibility criteria included African-American women ages 18 to 35 years old who were either nulliparous or at least six to nine weeks postpartum and had a BMI between 19 and 40 kg/m². Women could not be currently breastfeeding, have a current or previous diagnosis of diabetes, asthma or respiratory problems, or an eating disorder. Also, women must have had their first pregnancy at 18 years old or later and could not be currently pregnant. During screening women were also asked if they were claustrophobic since the BODPOD® is enclosed. If the woman was determined to be eligible, a study visit was scheduled.
Subjects

The recruitment goal was thirty-two women, sixteen in each category, “ever pregnant” versus “never pregnant” (power at alpha=0.05, beta=0.10). Thirty-three women were screened, eight women were ineligible and seven women did not return messages to schedule a study visit. Eighteen African-American women were enrolled and completed the study; ten “ever pregnant” women and eight “never pregnant” women. These eighteen women were recruited over a one-year period.

Training and Support

The investigator was trained in the use of the BODPOD® during a half-day training session provided by the manufacturer (Life Measurements, Inc) to the University of Cincinnati Nutritional Sciences faculty and students.

The study was supported in part by a College of Allied Health Sciences Interdisciplinary grant and through Millennium funding for Debra Krummel, PhD, RD, LD. Through this support, women were able to receive a small cash incentive for their participation in the present study.

Study Visit Procedures

Study visits were confirmed by phone the day prior to the actual visit. Subjects were advised on directions, parking, and location. Subjects were also advised to avoid eating, drinking, and exercising at least two hours prior to the visit since these can affect the measurement. The BODPOD® was turned on thirty minutes before the visit for warm-up to
prevent errors in readings. Quality control was also performed prior to testing to be sure that equipment was functioning properly.

Upon arrival subjects read the consent form which was approved by the University of Cincinnati’s Medical Institutional Review Board. The consent was reviewed and both parties signed. Any questions from the subjects were addressed prior to beginning procedures. A copy of the signed consent was provided to the subject and another copy was filed by the researcher.

After consent was completed, subjects were asked to empty their bladder. The subjects were then asked to complete a 47-item health questionnaire developed by the researcher that included sections on demographics, general health, weight history, and past pregnancies. (Appendix 2: Study Questionnaire). Next, the women were asked to change into a provided swimsuit and swim cap to minimize air trapped by clothing and hair which can invalidate the measurement. Height was taken using a wall-mounted stadiometer. Weight was taken using the scale attached to the BODPOD® system. Subjects were then instructed to enter the BODPOD® and to sit quietly, hands in lap, and to stay still during the measurement. Individuals were also told to relax and breathe normally. Before the body composition measurement was initiated, women were advised that a release switch was available if they felt uncomfortable.

Body composition measurements were obtained following the BODPOD® procedure manual and prompts from the BODPOD® software. Two measurements of body volume were performed, if they were in agreement, a third measurement was not required. However, if necessary, a third measurement was taken. If none of the three measurements were in agreement, a new test was completed. Predicted lung volume was used in lieu of a measured lung volume. The BODPOD® uses a standardized equation to predict lung volume. The equation for lung volume is as follows:
Lung volume:
Thoracic gas volume = $V_{tg} = \frac{1}{2}$ total volume + functional residual capacity (FRC)

Predicted residual volume (women)$^{53}$:
0.1970*height + 0.0201*age - 2.421

Predicted functional residual capacity (men and women)$^{53}$:
0.0472*height + 0.0090*age - 5.290

The BODPOD® software uses body volume to calculate body density (mass divided by volume). Body density is then used to calculate percent body fat. In this study, the BODPOD® software was set to calculate percent body fat using the Siri equation.$^{54}$ However, for consistency, the number provided by the BODPOD® was not used. Instead body density was entered into the Siri and three other equations for determining percent body fat. These equations are located in Table 1.

<table>
<thead>
<tr>
<th>Table 1 Percent Body Fat Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name of Equation</strong></td>
</tr>
<tr>
<td>Ortiz$^{34}$ (1992)</td>
</tr>
<tr>
<td>Dioum et al.$^{52}$ (2005)</td>
</tr>
<tr>
<td>Brozek$^{55}$ (1963)</td>
</tr>
<tr>
<td>Siri$^{54}$ (1961)</td>
</tr>
</tbody>
</table>

**Statistical Analysis**

Descriptive statistics were calculated for the entire sample group and for the two study groups. The Pearson correlation was conducted to look at the correlation between Dioum, Ortiz,
Siri, and Brozek percent body fat calculations. An independent sample t-test was performed to determine the relationship between percent body fat and pregnancy group. One-way ANOVA was used to look at the relationship between number of pregnancies and percent body fat. Pearson correlations between percent body fat and other variables, including weight, BMI, RMR, LBM, height, and age were also performed. Stepwise regression was performed to look at age, BMI, and weight in kilograms as possible causes of variability with percent body fat. Pearson correlations were performed to determine the relationships between BMI and RMR (resting metabolic rate), between weight (in kilograms) and RMR, and between lean body mass (LBM) in kilograms and RMR. All statistical analyses were completed using SPSS Version 16.0 (Statistical Package for the Social Sciences, 2007).

Results

Study Participants

Data are reported for all 18 women who participated in the study. Ten women had previous pregnancies and were placed in the “ever pregnant” group and eight women had never been pregnant and were considered the “never pregnant” group. The study consisted of all African-American women. All questions on the health questionnaire were completed by all participants, with no missing data. Questions related to pregnancy were marked as not applicable for women in the never pregnant group.

Descriptive statistics are presented in tables 2 and 3. Groups were closely matched for age and BMI. There was no significant difference in mean (+/- standard deviation, SD) age between the two groups, 25.9 years (+/- 4.7) for the ever pregnant group and 26.6 years (+/- 4.6) for the never pregnant group. No significant difference was found between mean (+/- SD)
BMIs for the groups; 27.6 kg/m² (+/- 7.0) for the ever pregnant group versus 28.3 kg/m² (+/- 8.5) for the never pregnant group. Within the ever pregnant group, 50% of the women had one pregnancy and 50% had two or more pregnancies.

Of the total sample, two women (11%) reported being married; both of these women were in the ever pregnant study group. All eight women (100%) in the never pregnant group reported an education level greater than the 12th grade compared to 60% of women in the ever pregnant group. Three women in the total sample reported being smokers, two in the ever pregnant group and one in the never pregnant group. In the ever pregnant group, 70% of women were receiving food stamps and 80% were receiving WIC assistance. Only 40% of women in the ever pregnant group were currently working compared to 88% of women in the never pregnant group.

Distribution of study participants by BMI category can be found in Table 4. Of the total sample population, ten out of 18 women (56%) were overweight or obese. Sixty percent of the women in the ever pregnant group and 50% of the women in the never pregnant group were either overweight or obese.

**Table 2 Participant Demographics**

<table>
<thead>
<tr>
<th></th>
<th>Total N=18</th>
<th>Ever N=10</th>
<th>Never N=8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
</tr>
<tr>
<td>Not married</td>
<td>16</td>
<td>89</td>
<td>8</td>
</tr>
<tr>
<td>Education &gt; 12th grade</td>
<td>14</td>
<td>77</td>
<td>6</td>
</tr>
<tr>
<td>Smoker</td>
<td>3</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Receives Food Stamps</td>
<td>8</td>
<td>44</td>
<td>7</td>
</tr>
<tr>
<td>Receives WIC</td>
<td>8</td>
<td>44</td>
<td>8</td>
</tr>
<tr>
<td>Currently working</td>
<td>11</td>
<td>61</td>
<td>4</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No pregnancies</td>
<td>8</td>
<td>44</td>
<td>--</td>
</tr>
<tr>
<td>1 pregnancy</td>
<td>5</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>2 or more pregnancies</td>
<td>5</td>
<td>28</td>
<td>5</td>
</tr>
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</table>
Table 3 Anthropometrics

<table>
<thead>
<tr>
<th></th>
<th>Total N=18</th>
<th></th>
<th>Ever N=10</th>
<th></th>
<th>Never N=8</th>
<th></th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>26.2</td>
<td>4.6</td>
<td>25.9</td>
<td>4.7</td>
<td>26.6</td>
<td>4.6</td>
<td>0.75</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.0</td>
<td>5.9</td>
<td>166.2</td>
<td>6.4</td>
<td>163.4</td>
<td>5.2</td>
<td>0.33</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75.9</td>
<td>20.4</td>
<td>76.2</td>
<td>19.8</td>
<td>75.5</td>
<td>22.5</td>
<td>0.94</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.0</td>
<td>7.5</td>
<td>27.7</td>
<td>7.0</td>
<td>28.3</td>
<td>8.5</td>
<td>0.85</td>
</tr>
<tr>
<td>LBM (kg)</td>
<td>48.3</td>
<td>5.4</td>
<td>49.2</td>
<td>6.3</td>
<td>47.1</td>
<td>4.3</td>
<td>0.43</td>
</tr>
<tr>
<td>RMR (kcals)</td>
<td>1354.6</td>
<td>189.1</td>
<td>1376.3</td>
<td>204.0</td>
<td>1327.4</td>
<td>178.3</td>
<td>0.60</td>
</tr>
</tbody>
</table>

BMI=Body Mass Index, LBM=Lean Body Mass, RMR=Resting Metabolic Rate; p* from t test between groups, ever versus never (alpha=0.05). "Ever" = women who have been pregnant; "Never" = women who have never been pregnant.

Table 4 Body Mass Index Categories

<table>
<thead>
<tr>
<th></th>
<th>Total N=18</th>
<th></th>
<th>Ever N=10</th>
<th></th>
<th>Never N=8</th>
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<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Underweight (&lt;19.8)</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>20</td>
<td>0</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Normal weight (19.8-26.0)</td>
<td>6</td>
<td>33</td>
<td>2</td>
<td>20</td>
<td>4</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Overweight (26.1-29.0)</td>
<td>2</td>
<td>11</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Obese I (29.1-34.9)</td>
<td>5</td>
<td>28</td>
<td>3</td>
<td>20</td>
<td>2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Obese II (35.0-39.9)</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>20</td>
<td>0</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Obese III (&gt;39.9)</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>--</td>
<td>1</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td><strong>Total obese</strong></td>
<td>8</td>
<td>44</td>
<td>5</td>
<td>50</td>
<td>3</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td><strong>Total overweight + obese</strong></td>
<td>10</td>
<td>56</td>
<td>6</td>
<td>60</td>
<td>4</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Correlation between Percent Body Fat Equations

The mean percent body fat estimates for each equation are presented in Table 5. The four formulas for percent body fat, Dioum, Ortiz, Siri, and Brozek, were strongly correlated at r = +1.00 (p<.001) as seen in Table 6. Since the equations were strongly correlated, only the Ortiz (1992) equation was used for further statistics because this equation is specific to African-American females.
Table 5 Mean Percent Body Fat Estimates

<table>
<thead>
<tr>
<th></th>
<th>Total (N=18)</th>
<th>Ever (N=10)</th>
<th>Never (N=8)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>%Dioum</td>
<td>35.8</td>
<td>10.4</td>
<td>34.9</td>
<td>11.0</td>
</tr>
<tr>
<td>%Ortiz</td>
<td>35.3</td>
<td>10.4</td>
<td>34.5</td>
<td>10.9</td>
</tr>
<tr>
<td>%Siri</td>
<td>34.0</td>
<td>10.7</td>
<td>33.2</td>
<td>11.2</td>
</tr>
<tr>
<td>%Brozek</td>
<td>32.7</td>
<td>9.8</td>
<td>31.9</td>
<td>10.3</td>
</tr>
</tbody>
</table>

*p* t test between groups, ever versus never (alpha=0.05)

Table 6 Pearson Correlations between Percent Body Fat Equations

<table>
<thead>
<tr>
<th></th>
<th>Ortiz</th>
<th>Dioum</th>
<th>Siri</th>
<th>Brozek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ortiz</td>
<td>--</td>
<td>r=1.00</td>
<td>r=1.00</td>
<td>r=1.00</td>
</tr>
<tr>
<td>Dioum</td>
<td>r=1.00</td>
<td>--</td>
<td>r=1.00</td>
<td>r=1.00</td>
</tr>
<tr>
<td>Siri</td>
<td>r=1.00</td>
<td>r=1.00</td>
<td>--</td>
<td>r=1.00</td>
</tr>
<tr>
<td>Brozek</td>
<td>r=1.00</td>
<td>r=1.00</td>
<td>r=1.00</td>
<td>--</td>
</tr>
</tbody>
</table>

P<0.001 for all; alpha=0.01

The Relationship between Parity and Percent Body Fat

No difference in percent body fat between women who have been pregnant and women who have never been pregnant (p=0.72 > alpha=0.05) was found as shown in Table 5. Furthermore, when number of pregnancies (0, 1, or 2+) was used instead of study group (not shown), it was determined that there was no difference between women who had been pregnant versus women who had never been pregnant (p=0.75; alpha=0.05).

Other Correlations with Percent Body Fat

Table 7 shows other significant correlations found with percent body fat. Weight, BMI, and RMR were positively and significantly correlated to percent body fat. BMI had the strongest significant correlation (r=+0.94; p<0.001) followed by weight (r=+0.89; p<0.001), and then RMR (r=+0.67, p=0.002). Additionally, lean body mass (LBM), height, and education were not
significantly correlated to percent body fat. Age was not significantly correlated to percent body fat or BMI.

| Table 7 Pearson Correlations with Percent Body Fat (Ortiz Equation) |
|-----------------|-------------------|------------------|
|                  | r              | p                |
| BMI              | 0.94           | <0.001           |
| Weight (kg)      | 0.89           | <0.001           |
| RMR              | 0.67           | 0.002            |

Percent Body Fat and other Predictors

BMI was determined to explain 88% of the variability in percent body fat (not shown). Age and weight were not significant predictors for percent body fat.

Correlations with Resting Metabolic Rate

BMI and resting metabolic rate (RMR) were found to be strongly correlated in a positive direction (r=+0.83, p<0.001). Similarly, weight was also determined to be strongly correlated with RMR in a positive direction (r=+0.92, p<0.001). Furthermore, lean body mass also had a strong positive correlation to RMR (r=+0.96, p<0.001). Age, however, was not significantly related to resting metabolic rate.

Discussion

With the increasing rates of obesity in the United States, it is important to describe the potential factors that may contribute to the etiology of adiposity. In women, these factors include, but are not limited to, pregnancy and menopause, activity, diet, and lifestyle. Furthermore, race and ethnicity are also variables in the equation for obesity. Research on the relationship between parity and body composition has been minimal and, in the case of African-
American women, is almost nonexistent. The present research study was conducted to explore the relationships between parity and body composition in African-American women.

Before this relationship could be assessed, however, the question of which body fat equation to use for the population in the study was addressed. Four equations were selected based on the population with which they are associated. The Dioum\textsuperscript{52} equation is specific to African females, the Ortiz\textsuperscript{34} equation is specific to African-American females, the Siri\textsuperscript{54} equation was created for the general population, and the Brozek\textsuperscript{55} equation is for use with both lean and obese individuals. In the study by Dioum and colleagues, significant differences were found between their “black-specific” formula and the Siri equation for percent body fat.\textsuperscript{52} In contrast, the present study found a very strong, positive correlation between all four equations. Since the equations were strongly correlated, it was determined that the Ortiz equation\textsuperscript{34} would be used to determine other statistical relationships.

Previous studies on body composition in women have given some insight into the relationship between parity and body composition. The present study found that there was no significant difference in body composition between women who had been pregnant and women who had never been pregnant. Similarly, Sowers and colleagues found no association between parity and body weight or body composition, except that nulliparous women retained more lean mass over a specified time interval.\textsuperscript{33} On the other hand, some studies have shown a positive relationship between pregnancy and body composition or body weight. In a study by Lee et al., significant relationships between parity and body weight were found in black women.\textsuperscript{19} Furthermore, Brown, Kaye, and Folsom also found that parity was associated with an increase in body weight in women from ages 18 to 50 years.\textsuperscript{26} An increase in parity was found to be related
to central fat distribution in two other studies. The CARDIA study also found increases in adiposity for African-American women at each parity level.

Although BMI is widely used as a measure of fatness, there is much controversy over its use. Since BMI shows the relationship between height and weight, many are concerned about other factors that may influence the level of body fat such as physical activity, muscle mass, bone structure, gender, and race or ethnicity. The present study found that BMI is highly correlated with percent body fat and explained a large part of the variability in percent body fat.

In young premenopausal African American women, it was also determined that age was not significantly related to BMI or percent body fat. On the other hand, weight was positively related to percent body fat. This population is more likely to have a higher percent of body fat with a greater amount of weight.

Resting metabolic rate is an interesting factor to look at in the present study. RMR is known to be related to lean body mass which was confirmed by this study. This study also found that RMR was positively related to BMI, percent body fat, and weight. However, age was not found to be significantly related to RMR. This is interesting since it is widely believed that RMR decreases as age increases. Given the narrow range of ages (19-35 years old), the relationship between RMR and age may not have been apparent.

Further research is necessary for increased understanding of the relationship between parity and body composition. The present study has several limitations which could have had an effect on results. The sample size was much smaller than expected due to limited funding for advertising and high rate of people that did not show up as scheduled. The study questionnaire required reliance on self-report of health and weight histories. Also, the study was cross-sectional; a longitudinal study following a larger group of women across several years would
provide better measures for assessment. Lastly, there was a variation in the length of time individuals had been postpartum in the ever pregnant group.

Overall, the present study found no significant relationship between percent body fat and parity. However, the study did find a significant relationship between percent body fat and several other measurements, including weight, BMI, and resting metabolic rate. Interestingly, this study also found that four equations used to determine percent body fat (created by Dioum, Ortiz, Siri, and Brozek) were perfectly correlated.

Determining the effect of pregnancy on the current obesity epidemic could provide a means for prevention and treatment. Women are gaining excess weight during pregnancy and not losing this weight in the postpartum period. Creating interventions to prevent women from gaining excessive weight during pregnancy may provide one piece of the puzzle for decreasing obesity.
References


Appendix 1: Screening Form

Disposition Form/Quick Screen for the Body Changes and Pregnancy Study

*If person is ineligible, please circle the reason for not being eligible.*
*If person is eligible please take their name, telephone number, and best time to contact.*

**Eligible:**
African American women
18-35 years old
Nulliparous OR at least 6-9 weeks postpartum
BMI between 19 and 40 kg/m² (Prefer BMI ≤ 35 kg/m²)
Not lactating

**Ineligible:**
Lactating women
Women with diabetes (including gestational)
Women with asthma or respiratory problems
Women diagnosed with an eating disorder
Women with claustrophobia
First child born *before* woman was 18 years old
Currently pregnant

Name: ____________________ Phone: ____________________

Best time of day to reach: ____________________
Appendix 2: Study Questionnaire

Pregnancy and Your Body Study Survey

**About You:**
1. What type of work have you done most of your life?
   - Clerical
   - Professional
   - Homemaker
   - Technical
   - Physical Labor
   - Other (Please describe):

2. Are you currently employed?
   - Yes
   - No

3. Have you changed jobs in the last 6 months?
   - Yes
   - No

4. How many hours do you work per week on average? _____

5. Are you employed at more than one job?
   - Yes
   - No

6. Are you currently a student?
   - Yes
   - No
   If so, are you:
   - Part time
   - Full time

7. What is the highest level you have completed in school?
   - Less than high school
   - Started, but didn't finish high school
   - High school diploma, GED, or equivalent
   - Some college credit but no degree
   - College degree
   - Course work beyond college degree

8. Do you usually do volunteer work?
   - Yes
   - No

9. What is your marital status?
   - Single, never married
   - Married
   - Living with significant other
   - Engaged
   - Separated
   - Divorced
   - Widowed

10. What is your racial or ethnic background?
    - Asian or Pacific Islander
    - Black, not Hispanic
    - Chicano, Latino, Hispanic
    - Native American, Native Alaskan, Indian
    - White, not Hispanic
    - Biracial
    - Multiracial
    - Other (please describe): ____________________________
11. Do you live with other people?
   - Yes
   - No

12. How many people live with you?
    _____

13. Where do you live?
   - House
   - Apartment
   - Condo
   - Mobile home
   - Trailer
   - Motel, hotel
   - Boarding house
   - Other (Please describe)

14. Has a doctor ever told you that you had any of the following health problems (Mark all that apply)
   - Heart attack
   - Other heart problem
   - Diabetes
   - High cholesterol
   - High blood pressure
   - Kidney problem
   - Gout
   - Lung problems
   - Depression
   - Fluid retention
   - Ulcers or intestinal bleeding
   - Other stomach problems
   - Anemia or low iron
   - Arthritis
   - Osteoporosis
   - Cancer
   - Overweight/Obesity
   - Other (Please describe)

15. Are you currently taking any medications on a regular basis?
   - Yes
   - No

16. Have you smoked 100 or more cigarettes in your life?
   - Yes
   - No

17. Do you smoke cigarettes now?
   - Yes
   - No

18. Do you get shortness of breath that requires you to stop and rest?
   - Yes
   - No

19. Have you ever been pregnant?
   - Yes
   - No

20. Are you pregnant now?
   - Yes
   - No

21. Are you breastfeeding now?
   - Yes
   - No

22. Have you ever lost a baby in the first trimester?
   - Yes --> How many times ___
   - No

23. Have you ever lost a baby in the second or third trimester?
   - Yes --> How many times ___
   - No

24. How many live born children do you have?______

25. How old were you when you had your first child?______

26. How old were you when you had your last child?______
27. Did you ever have a baby that weighed more than 10 pounds?
   □ Yes
   □ No

28. Did a doctor ever tell you:
   a. That you had gestational diabetes or high blood sugar problems during any of your pregnancies?
      □ Yes
      □ No
   b. That you had high blood pressure or toxemia with any of your pregnancies?
      □ Yes
      □ No

29. How old were you when you had your first menstrual period? ______

30. Do you usually have menstrual periods?
    □ Yes
    □ No

31. Have you missed or not had a period within the last 6 weeks?
    □ Yes
    □ No

32. Are you currently using a birth control method that prevents you from having periods?
    □ Yes
    □ No

33. Are you currently using Depo-provera as a method of birth control?
    □ Yes
    □ No
    If yes, how long ________

34. Have you used Depo-provera as a method of birth control previously?
    □ Yes
    □ No
    If yes, how long ________

Your Weight History:

35. What was your weight at:
   Age 16_____
   Age 18_____
   Age 25_____
   Age 30_____
   Age 35_____

36. Does your current weight differ more than 5 pounds than your weight at age 18?
    □ Yes
    □ No

37. What was your weight before your most recent pregnancy? ______

38. How much did you weigh after your:
   First pregnancy ______
   Second pregnancy ______
   Third pregnancy ______
   Fourth pregnancy ______
   Fifth pregnancy ______

39. How much weight did you gain during your:
   First pregnancy ______
   Second pregnancy ______
   Third pregnancy ______
   Fourth pregnancy ______
   Fifth pregnancy ______

40. How difficult or easy is it for you to gain weight?
    □ Extremely difficult
    □ Moderately difficult
    □ Neither easy nor difficult
    □ Moderately easy
    □ Extremely easy
41. How difficult or easy is it for you to lose weight?
   - [ ] Extremely difficult
   - [ ] Moderately difficult
   - [ ] Neither easy nor difficult
   - [ ] Moderately easy
   - [ ] Extremely easy

42. Have you ever tried to lose weight?
   - [ ] Yes
   - [ ] No

43. Are you currently dieting to lose weight?
   - [ ] Yes
   - [ ] No

44. Have you changed your eating habits intentionally to be healthier?
   - [ ] Yes
   - [ ] No

45. Do you receive Food stamps?
   - [ ] Yes
   - [ ] No

46. Do you receive WIC vouchers?
   - [ ] Yes
   - [ ] No

47. Do you receive Meals on Wheels?
   - [ ] Yes
   - [ ] No

__________________________________________________________________________________________
Office Use Only
Subject ID: ___________
BMI: ___________
IOM Pregnancy Weight Category: ___________

BODPOD Data:
Age: _____
Height: _____
Weight: _____
Body volume: _____

Percent body fat:
   - Ortiz equation: _____
   - Dioum equation: _____
   - Brozek equation: _____
   - Siri equation: _____