ABSTRACT

Dissertation Title: THE RELATIONSHIP OF LOW BIRTH WEIGHT AND CURRENT OBESITY TO DIABETES IN AFRICAN-AMERICAN WOMEN

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Aims: (1) To test *the fetal origins of chronic disease* by examining birth weight, current obesity, and odds of developing type 2 diabetes (T2DM) in African-American women 38-57 years. (2) To assess birth weight and obesity in relation to fasting plasma glucose (FPG).

Background: African-American women suffer disproportionately in prevalence and complications of T2DM. According to the fetal origins of chronic disease, T2DM is related to low birth weight with subsequent adult obesity. Several studies have substantiated this hypothesis; none have focused on African-American women.

Outcome Measure: Self-reported physician diagnosis of T2DM.

Exposure Measures: Birth weight, an indicator for fetal growth; waist-to-hip ratio, a marker for abdominal obesity. Other factors: physical activity, body mass index (BMI), history of gestational diabetes, blood pressure.

Design: Retrospective, case-control observational study.

Method: Convenience sample of urban African-American women. Cases (*n*=95) reported a physician diagnosis of T2DM. Controls (*n*=186), matched on race and age, reported no T2DM diagnosis. To verify control status, participants were screened for elevated FPG (cut-point, <126 mg/dL, as defined by the American Diabetes Association). Vital and family records were sources for birth weight. Current weight, height, and waist and hip circumferences were measured; BMI and waist-to-hip ratio were calculated. Confounding factors were collected on a 68-item questionnaire. Logistic regression analysis tested the proposed model for the odds of having T2DM. Multiple linear regression analysis was employed to assess FPG. Sample size was estimated.

Results: The odds ratio for T2DM increased as waist-to-hip ratio increased (*OR*=1.13, 95% *CI*=1.08, 1.19, *p*<.0001). Birth weight did not contribute independently to the model's ability to examine T2DM (*OR*=0.92, 95% *CI*=0.74, 1.14, *p*=.4409). Birth weight and waist-to-hip ratio each contributed independently to assessing FPG.

Conclusions: This study found an interaction between birth weight and abdominal obesity when examining T2DM in African-American women: those born small and who subsequently developed abdominal obesity had a greater odds for T2DM. Abdominal obesity, but not birth weight, was independently associated with T2DM. FPG significantly increased with increasing abdominal obesity and decreasing birth weight. African-American women are cautioned to maintain healthy body measures (waist-to-hip ratio $\leq$0.80 and BMI <25) to address T2DM.

THE RELATIONSHIP OF LOW BIRTH WEIGHT AND CURRENT OBESITY TO DIABETES IN AFRICAN-AMERICAN WOMEN

by

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
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Dedication

I dedicate this dissertation to my beloved husband, Mycheal Qieth McQureerir, who encouraged me to begin my journey towards earning a Ph.D. in Nutrition. His unwavering support helped me to sustain the enthusiasm and focus I needed to fulfill the requirements for this degree.

I also dedicate this dissertation to my mother, my sisters and brother, and all my other relatives who were very understanding of the years I needed to take time away from important family events.

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Chapter 1: Introduction

Statement of the Problem

Diabetes is a growing problem in the United States and is costly in terms of treatment, lost work productivity, decreased quality of life, and premature death.[1-5] African-American women suffer disproportionately from this disease in terms of prevalence and complications.[6] When examining results from a nationally representative sample of African-American women between the ages of 40 and 55, the prevalence of combined diagnosed and undiagnosed diabetes exceeded 14%[7] Type 2 diabetes has reached near-epidemic proportions in African-American women over the age of 55 where 55% live with type 2 diabetes.[6] African-American women between the ages of 40 and 55 were selected for the current study because of the need for practical interventions in this age group due to the sharp increase in the prevalence of diabetes that occurs after the age of 55.

Type 2 diabetes is associated with low birth weight[8,9-14] and abdominal obesity.[9,13-22] It is important to prevent fetal under-nutrition to reduce the risk for developing diabetes and other related disorders later in life.[8] The fetus may experience structural and functional adaptations that could make it more susceptible to diabetes once the individual reaches adulthood.[8] Low birth weight, defined as less than 2,500 g (5 pounds, 8 ounces),[23-24] has been shown to increase the risk for type 2 diabetes.[8-9,11-12] In 2002, low birth weight deliveries among African Americans was 13.4% compared to 6.9% for European Americans and 7.8% for the general population of the United States.[23]

A distinction must be made between low birth weight due to fetal under-nutrition and low birth weight due to prematurity.[14] By including gestational age as a study variable, an investigator can account for prematurity status in the analysis and improve the interpretation of the data as they relate to fetal under-nutrition. The present study focuses on low birth weight due to under-nutrition as opposed to prematurity. Prematurity and macrosomia (heavy at birth) were assessed through a brief interview by the investigator within the one-hour enrollment session. Women who were born premature and women who had macrosomia at birth were included in the study if they met the study criteria.

Macrosomia, defined as high birth weight or as birth weight >4,100 g (approximately 9 pounds), represents the other extreme of birth weight and, like low birth weight, has been implicated as a factor that increases the risk for the development of type 2 diabetes.[25] Therefore, high birth weight has been examined as a possible confounding factor for predicting type 2 diabetes.

Abdominal obesity, like low birth weight, has been shown to be another independent predictor for type 2 diabetes and for various precursors of type 2 diabetes, including glucose intolerance, insulin deficiency, and insulin resistance.[13-22] Abdominal obesity, estimated by waist-to-hip ratio >0.80, has been shown to be a better predictor for chronic diseases in African-American women than has overall obesity.[26-27] Body mass index (BMI) is an indicator for overall obesity.[26-27] African-American women have a greater tendency of having excessive accumulation of fat in their abdomen than do European-American women.[17] This may be a contributing

factor to the excess risk experienced by African-American women compared to European-American women for developing type 2 diabetes.[26-27]

Low birth weight and abdominal obesity may be different expressions of the same phenomenon: fetal under-nutrition that results in exposure of the fetus to chronic hyperinsulinemia in response to maternal hyperglycemia.[28] Maternal hyperglycemia is a consequence of uncontrolled diabetes during pregnancy. The current study did not address the question of the maternal glycemic status of the participant's mother while the mother was pregnant with the participant because maternal diabetes status was not routinely captured in vital records before the 1980s.[29] Consequently, the current study focused on participant birth weight as an indicator for fetal under-nutrition.

The objective of this study was to test the fetal origins of chronic disease in African-American women. This was accomplished through examining the relationship between the risk for developing type 2 diabetes and birth weight and current abdominal obesity status.

Hypotheses

The main hypothesis for this study was: Birth weight and abdominal obesity interact to increase the odds ratio of type 2 diabetes among cases versus controls in African-American women 38 to 57 years of age, controlling for potential confounders. There were three other hypotheses: (1) Birth weight is independently associated with type 2 diabetes in African-American women; (2) Abdominal obesity is independently associated with type 2 diabetes in African-American women; and (3) Among African-American women without a physician diagnosis of type 2

diabetes, there is an association among birth weight, abdominal obesity, and fasting plasma glucose level.

For the first three hypotheses, type 2 diabetes was the outcome variable of interest. The *interaction* between participant birth weight and current abdominal obesity status was the primary covariate of interest. In addition, birth weights of the study participants and current abdominal obesity status, as defined by waist-to-hip ratio, were examined as independent variables. History of gestational diabetes, family history of diabetes, smoking, highest level of education attained, physical activity, body mass index, self-reported weight at age 25 years, blood pressure, and menopausal status were covariates whose associations with type 2 diabetes were examined.

Significance

This current study was the first to address the interaction of low birth weight and abdominal obesity when examining type 2 diabetes in African-American women. It was also the first to include verified birth weights to test this hypothesis in African-American women, as opposed to being limited to self-reported birth weights. The current study helped address knowledge gaps in what is known about risk factors for type 2 diabetes[17,30-31]

Studies conducted in Europe,[13-14] India,[21,32] and, to a more limited extent, the United States,[17,33] have examined the combined effects of low birth weight and abdominal obesity in predicting the development of type 2 diabetes using documented birth weights. However, no studies have been found that examined the combined

effects of low birth weight and abdominal obesity specifically in African-American women, using documented birth weights.

Unlike the majority of industrialized countries that maintain national registries of birth data linked to individual births, the United States has over 50 registry systems, including those of the 50 states, and the District of Columbia, New York City, and the U.S. Territories. The current study was designed with the intent of collecting documented birth data on nearly every participant. However, it was more difficult than anticipated to collect this information, matching data from birth records of individuals born in various states with anthropometrical and biological data collected directly from these individuals during their middle adult years. In contrast, researchers who used cross-sectional data from the Third National Health and Nutrition Examination Survey (NHANES III)[34] could not examine birth weight and abdominal obesity and their relationship to type 2 diabetes for this age range because relevant birth data for study participants, ages 38 to 57 years, were not collected in that survey.

Delimitations and Limitations

The current study targeted U.S.-born African-American women in the Washington, D.C., Metropolitan Area. Restricting participant selection to U.S.-born women not only facilitated the procurement of birth data from vital records offices, but also helped reduce variability due to environmental factors, including prenatal and child care practices, long-term dietary practices, and public policy factors that might have influenced the life-long health status of the participants. In addition, standard procedures set forth by the National Center for Health Statistics (NCHS)[29] for the

collection of data for specific birth variables are followed by the various vital records offices of the United States.

Churches and other faith-based organizations with large congregations of African-Americans were the primary sources for the recruitment of study participants. Self-selection of participants for the study limited the generalizability of the study compared to random sampling; nevertheless, convenience sampling is frequently used in studies where random selection and random assignment are not feasible due to ethical, cost, and time considerations. These considerations held true for the current study.

Indicators for fetal under-nutrition (birth weight), overall obesity (BMI) and abdominal obesity (waist-to-hip ratio) were used in the current study. Birth certificates are considered accurate sources for birth data, including birth weight. For anthropometric data, the accuracy of the data is a function of the accuracy of the measurements and of the recording and data transmission processes.[35] Computed tomography[36-37] and dual energy x-ray absorptiometry (DEXA), more accurate indicators of abdominal fat, were not available for the current study. Waist circumference and waist-to-hip ratio were used instead.

The current study incorporated verified self-reported birth weights when vital records data were not available. Participants verified their birth weights from copies of birth certificates or hospital records they had on hand or through obtaining their birth weights from their mothers. Obviously when official birth weight data are not available, self-reported birth weight may be used, as was done for the Nurses' Health Study (NHS).[33] In studies where self-reported birth weights are used, the investigator

is advised to assess the accuracy of these self-reports compared to birth reports from official records.[38-40] The reliability of self-reported birth weights was assessed for participants in the current study by running correlations and paired *t*-tests between birth weights obtained from vital records (*n*=63) and those obtained through verified self-report for the same participants.

Serum high-density lipoprotein cholesterol (HDL-C), an independent risk factor for type 2 diabetes[41] and the preferred measure of cholesterol status, was not collected because it is expensive and invasive. Instead, for the current study, self-reported hypercholesterolemia status was determined through a questionnaire to assess the associations between total serum cholesterol and type 2 diabetes.

Assumptions

The current study assumed there were no significant differences in demographics and health behaviors assessed in the study for African-American women in the Washington, D.C., Metropolitan Area who were members of churches or other faith-based organizations and those who were not members. Church-going women represent a wide range of health status and health behaviors that reflect those of the general population of African-American women.[42] Thus, findings from this community-based study may be more generalizable than if study participants had been recruited from clinics or hospitals where uninsured and underinsured African-American women might not be reached.

It was assumed that documented birth data would be available for the majority of the study sample. Before the current study was launched, vital records offices of all 50 states and New York City and the District of Columbia were contacted to

confirm that birth weight data for women 40 to 55 years of age would be available. Contact information for each state was obtained through the website of the NCHS.[43] Once these state offices were contacted, it was learned that the availability of birth weight was dependent on both the year and the state or county in which participants were born. However, at that point, it was believed that birth weight data would be available for the majority of the study participants.

Chapter 2: Literature Review

This review of the literature covers the following topics: (1) Overview of diabetes, its prevalence and the pathophysiology of type 2 diabetes; (2) assessment of type 2 diabetes; (3) the metabolic syndrome; (4) non-genetic transmission of type 2 diabetes; (5) fetal programming; (6) abdominal obesity; (7) interaction between low birth weight and abdominal obesity and; (8) confounding factors.

Overview of Diabetes

Diabetes is a disease characterized by elevated levels of blood glucose that, if not controlled, may lead to long-term, irreversible macro- and microvascular damage that can result in renal failure, cardiovascular disease, blindness, and amputations.[41] There are three main categories of diabetes: type 1, type 2, and gestational. According to the Centers for Disease Control and Prevention (CDC),[44] type 1 diabetes represents approximately 10% of the cases of diabetes in the United States and is caused by an absolute deficiency of insulin secretion from the pancreas and is usually accompanied by evidence of pancreatic autoimmune pathology. Most cases of type 1 diabetes are diagnosed during childhood and adolescence.

In contrast, type 2 diabetes, which represents the majority (~90%) of the cases of diabetes, is generally diagnosed in adulthood.[41] However, the median age for onset of this form of diabetes is decreasing dramatically.[37-38,128,130] The increased prevalence of diagnosis of type 2 diabetes in childhood and adolescence corresponds to the increasing prevalence of obesity and reduced levels of physical activity in the U.S. population.[45-49] Obesity and low physical activity levels are two significant correlates for type 2 diabetes. Other correlates for type 2 diabetes are a family history

of type 2 diabetes, low levels of high-density lipoprotein cholesterol, being older than 45 years of age, belonging to a high-risk ethnic group, abdominal obesity, and fetal under-nutrition.[41,50]

The third category of diabetes is gestational diabetes, defined as diabetes that is first diagnosed during pregnancy and that usually disappears immediately upon delivery. Gestational diabetes is an important risk factor in women for the development of type 2 diabetes later in life.[41]

The American Diabetes Association (ADA) and the World Health Organization (WHO) changed the terminology of diabetes to reflect etiology. The old system of referring to type 1 diabetes as "juvenile diabetes" and type 2 diabetes as "adult-onset" diabetes is obsolete. Likewise, ADA and WHO have abandoned the use of Roman numerals (I, II) and now use Arabic numerals (1, 2) to avoid confusion among patients.[41] Focusing on etiology in nomenclature also avoids confusion when treatment regimens vary over time. Finally, an emphasis on etiology can assist in identifying factors that can reduce the risk for diabetes in individuals and in populations.[41]

Prevalence of Diabetes

In the year 2000, 17 million people in the United States were estimated to be living with diabetes (6.2% of the population).[44] Of this number, 11.1 million people had been diagnosed with diabetes and 5.9 million had not been previously diagnosed and, thus, were considered "undiagnosed cases." In 2005, the prevalence of diabetes had increased to 20.8 million people (7% of the population) in the United States. Of this number, 14.6 million had been diagnosed with diabetes and 6.2 million (9.6% of

the population) were undiagnosed cases. Among all adults ≥20 years of age (20.6 million cases), it is estimated that 30% of all cases of diabetes are undiagnosed.[51]

In the United States, type 2 diabetes accounts for about 90% of all cases of diabetes. Certain ethnic groups are at greater risk for developing type 2 diabetes.[41,50] Prevalence figures for diabetes in adults 20 years of age or older in these high-risk ethnic groups include African Americans (13%),[41] Hispanic Americans (10%),[44] Asian Americans and Pacific Islanders (11%) and Native Americans,[44] with prevalence rates for the Pima Indians of Arizona among the highest levels (age-adjusted rate in men, 49%; in women, 51%).[52-53] Native Americans who receive health care through the Indian Health Services have an overall prevalence of 15% for diabetes.[44] These figures are in contrast to the lower prevalence for European Americans (7.8%).[44]

National prevalence data for diabetes come from various data sources.[44,52-56] Depending on the source, reported prevalence may or may not include undiagnosed cases of diabetes. The Third National Health and Nutrition Examination Survey (NHANES III)[55-56] provides data on diagnosed and undiagnosed cases of diabetes among a national sample of non-Hispanic whites, non-Hispanic Blacks, Hispanics, Mexican Americans, Native Americans/Alaskan Natives, and Asian Americans/Native Pacific Islanders. Again, about one out of three persons with diabetes has not been diagnosed with the disease.[44]

The Behavioral Risk Factor Surveillance System (BRFSS),[54,56] a state-based survey conducted by telephone, collects data on self-reported diagnosed cases of diabetes for the same populations surveyed in NHANES. Information on

undiagnosed diabetes is not collected for this telephone-based survey where, in contrast to NHANES, glucose testing is not conducted. In essence, the BRFSS collects information on self-report of a physician diagnosis of diabetes.

Pathophysiology of Type 2 Diabetes

The pathophysiology, or derangement of function, of type 2 diabetes can be divided into two major areas. The first mechanism for the pathophysiology of type 2 diabetes is dysfunction of the β-cells of the pancreatic islets where an insufficient amount of insulin is secreted in response to elevated levels of glucose in the bloodstream. The second mechanism is insulin resistance (insulin insensitivity) where the action of insulin is impaired, even in the presence of elevated levels of insulin in the bloodstream (called hyperinsulinemia). Long-term hyperglycemia leads to many of the toxic effects of type 2 diabetes. Both β-cell dysfunction and insulin resistance contribute to hyperglycemia.

Insulin resistance generally plays the more significant role in the development of type 2 diabetes, especially early in the course of the disease and even before the disease is diagnosed. Some individuals can compensate for an impaired ability to maintain glucose homeostasis through enhanced insulin secretion by pancreatic β-cells. Over time, when the pancreas can no longer compensate, these individuals may develop glucose intolerance, and ultimately, type 2 diabetes.[57-58] Figure 1 is a schematic depiction of the development of type 2 diabetes.[59]

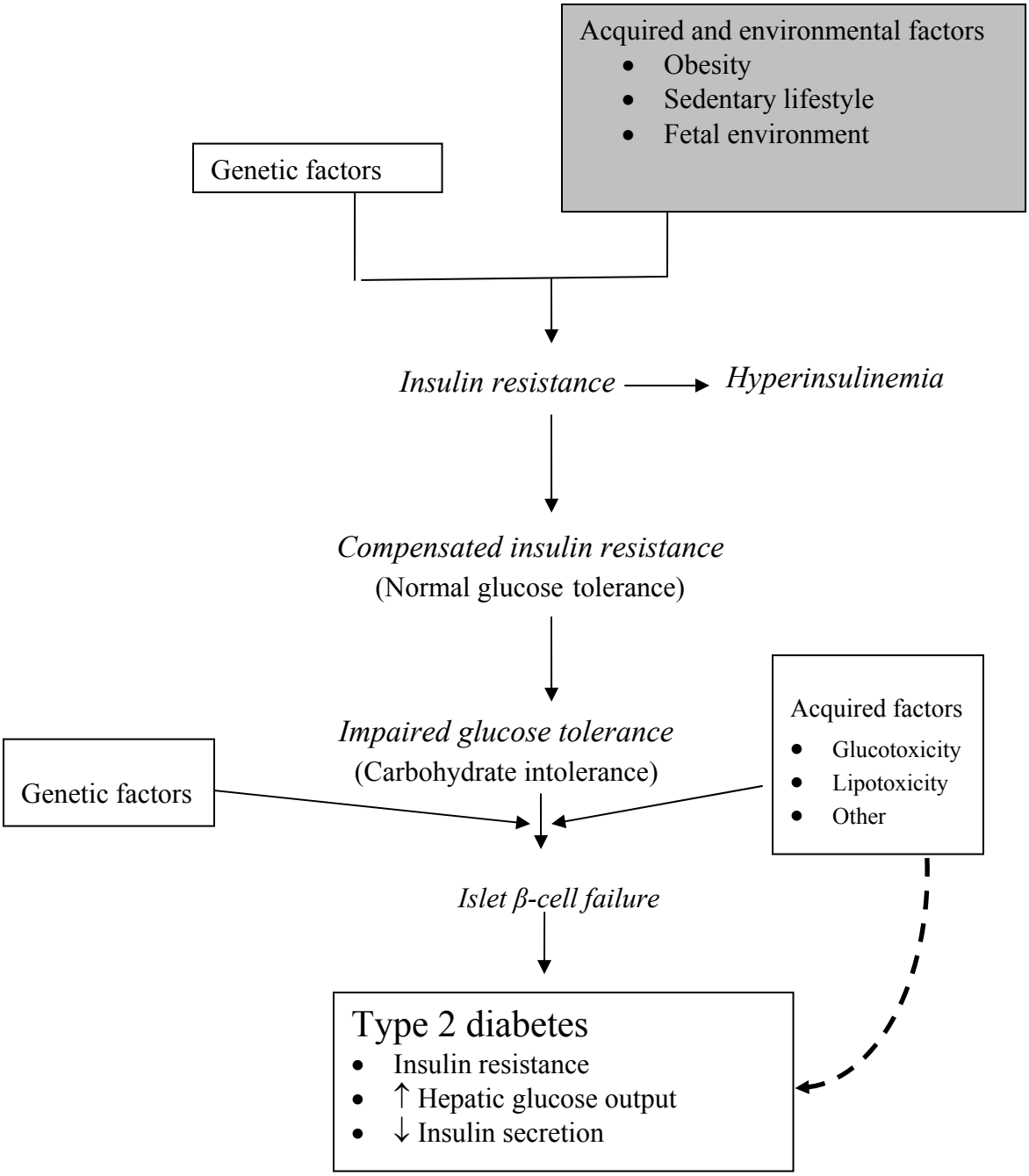

Figure 1. The pathophysiology of type 2 diabetes. (Adapted from Olefsky and Kruszynska 2003, "Insulin Resistance"[59])

Insulin resistance may be genetic, acquired, or both. Much is still unknown about the role genetics plays in the development of type 2 diabetes. Although the genetic markers for type 2 diabetes have not been well defined, they appear to be heterogeneous. Frayling and Hattersley[60] presented their "fetal insulin hypothesis" which states that low birth weight and type 2 diabetes are two phenotypes of the same genotype. They suggested that gene variants that result in differences in insulin resistance or insulin secretion within the normal population may also affect birth weight and birth length through effects on insulin-mediated fetal growth.

Studies that focused on twins[61-62] or on multi-racial, multi-ethnic, or immigrant populations[60] have provided data on the genetic components of type 2 diabetes. In addition, animal studies have provided data for much of what is known about the genetic component of type 2 diabetes.[8,63] Molecular studies also have contributed to what is known about the genetics of type 2 diabetes.[64-65]

Frayling and Hattersley[60] noted that insulin plays a central role in both fetal growth and carbohydrate regulation and, thus, may share a common pathway for the influence of genes. This team of researchers discussed specific gene defects that (1) alter fetal insulin secretion or fetal insulin resistance or (2) alter growth. Acquired conditions may be more important to the development of type 2 diabetes than are genetic factors alone. These acquired, or environmental, conditions include obesity, a sedentary lifestyle, and a less-than-optimal fetal environment (Figure 1). Abdominal obesity is an indicator for visceral adiposity and has been shown to be superior to overall obesity as a predictor for chronic disease outcomes in African-American women.[26-27] Sedentary lifestyle, as indicated by a low physical activity

level, is an additional risk factor for type 2 diabetes.[45] An environment that compromises the growth and development of the fetus has been shown to be an important acquired risk factor for type 2 diabetes. In fact, much of the risk that previously had been attributed to genetics has been explained by the prolonged exposure of the fetus to elevated levels of glucose and insulin.[8] Theories that focus on fetal under-nutrition and on cross-generational exposure to elevated levels of glucose and/or elevated levels of insulin in utero have been proposed to explain the higher incidence of type 2 diabetes in certain families and populations.[8]

Elevated blood glucose levels characterize diabetes mellitus. Hormonal factors that work to increase blood glucose levels include glucagon, growth hormone, epinephrine, and the corticosteroids (glucocorticoids). Insulin is the only hormone that functions to counterbalance the effects of all the hormonal factors that increase blood glucose concentration. Therefore, insulin is critical to the regulation of glucose metabolism. Insulin is secreted by the β-cells of the pancreas and functions to lower rapidly the amount of glucose in the blood after the consumption of a meal so that the concentration of glucose is maintained within the normal physiological range. During the postpandrial (fed) state, insulin also catalyzes reactions in the liver to reduce the amount of glucose that the liver releases into the bloodstream by causing the reduction of hepatic gluconeogenesis. This reduction in gluconeogenesis occurs because high concentrations of glucose in the portal vein overshadow the counterregulatory effects of glucagon, a hormone that, in the fasting state, triggers the liver to produce glucose and to release it into the bloodstream.

The roles of insulin are (1) to stimulate glucose oxidation and (2) to stimulate non-oxidative glucose storage in insulin-sensitive tissues such as muscle and adipose tissue.[66] In utero, insulin is an important anabolic factor and promotes fetal growth, a role taken over postnatally by growth hormone.[67]

Assessment of Type 2 Diabetes

There are several ways to assess diabetes status. According to the American Diabetes Association, for the purpose of the assessment of diabetes status, plasma blood is preferred over whole blood and venous blood is preferred over capillary blood, the latter of which is sensitive to hydration status.[41] Analysis of fasting blood glucose is preferred over that of casual (random) blood glucose because the former gives less variable results than the latter. However, fasting plasma glucose (FPG) used as a single test for detecting the presence or absence of diabetes is widely accepted for screening in place of the gold standard post-load value[68] (Oral Glucose Tolerance Test, OGTT) which is not appropriate for most epidemiological studies because it involves multiple collection times and typically requires two hours to complete. In addition, fasting plasma glucose results are more reproducible than results from the OGTT.[41]

Based on data from NHANES III for the U.S. population aged 40-74 years, the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus[41] reported that using only the FPG test to diagnose diabetes in persons without a medical history of diabetes would result in a lower prevalence of diabetes than would be obtained using the OGTT (4.35% versus 6.34%). The Expert Committee noted that these prevalence estimates refer to results of testing on one occasion and that the

prevalence of diabetes confirmed by a second test would be lower regardless of which criterion were used.

An important limitation with using capillary blood for determining FPG status is that both hematocrit and hydration status can affect the results. Poirier and associates[69] evaluated self-monitoring blood glucose meters. They noted that ideally, hematocrit as a confounder should be addressed through screening controls for hematocrit levels at the same time as the FPG screening. Due to the physiological difference between capillary whole-blood glucose and venous plasma glucose levels, Poirier and associates corrected their results for hematocrit according to the equation where whole blood glucose = plasma glucosex [1 – (0.0024) (hematocrit)]. The Expert Committee of the American Diabetes Association[33] does not address hematocrit status as a priority for screening for diabetes. In addition, pricking the fingers of participants more than once for a study might adversely affect recruitment efforts and might result in a dataset that is incomplete in terms of hematocrit and/or FPG.

Incorrectly classifying study participants as cases can be reduced by not including cases of undiagnosed diabetes in the study. The incorrect classification of study participants as controls can be limited by excluding from the study any participant who is without a previous diagnosis of diabetes and whose FPG is $\geq$126 mg/dL (7.0 mm/L). Many studies do not use medical records to verify self-reported diabetes. Studies that use data from the Behavioral Risk Factor Surveillance System are based on a self-reported physician diagnosis of type 2 diabetes.[54,56] However, the Nurses' Health Study (NHS) study reported by Manson and associates[70] revealed that

self-reported diagnosis of diabetes in study participants was valid, based on a blinded review of medical records by an endocrinologist.

Plasma glucose levels are assessed clinically through blood extracted intravenously. For research performed in non-clinical settings, blood is often drawn from a finger prick. *The advantages of obtaining blood through finger pricks versus through intravenous blood draws are as follow:*[71-73]

1. It is less invasive and less burdensome to the participants.
2. It may result in a higher participation level by prospective study participants.
3. It is safer with a lower risk of provoking injury or harm to the participant.
4. There is no need for highly specialized training as a phlebotomist, nurse, or physician.
5. It is less expensive.
6. It is faster to collect and to analyze blood obtained from finger pricks because fasting blood can be measured immediately for glucose with a glucometer.
7. There is lower risk for blood coagulating while awaiting analysis.

According to various researchers, *the disadvantages of obtaining capillary blood samples through finger pricks are as follow:*[71-73]

1. It provides a static measure of blood glucose concentration. It gives information on current glucose levels and reveals nothing about glucose tolerance or insulin sensitivity. These latter two functional assessments require multiple collections of blood.
2. It is not as accurate as laboratory analyses conducted on intravenous blood.

3. Standards are set for the analyses of intravenous blood; therefore, results for capillary blood must be adjusted for interpretation. However, the Hemocue 201 glucometer automatically converts whole blood glucose values to plasma glucose equivalents.[74]
4. It does not distinguish between those who do not have diabetes and those who have diabetes but whose blood glucose levels are under good control.

Given that the purpose of the assessment of glucose levels is to screen for diabetes and not to make a diagnosis, the capillary plasma glucose screening is sufficient.[41] Generally, glucose screening for epidemiological studies involves determining fasting whole blood glucose levels and not plasma glucose levels, the latter of which is the standard set by the American Diabetes Association.[41] Again, the Hemocue 201 glucometer provides the investigator with plasma glucose equivalents.[74]

The glucometer, a device that measures glucose levels in whole blood, is an acceptable method for analyzing blood in epidemiological studies. The Hemocue 201 is a glucometer calibrated by the manufacturer to reflect the standard cut-point for elevated plasma glucose. Fasting plasma glucose $\geq$126 mg/dL (7.0 mm/L) is the American Diabetes Association's standard for categorizing an individual as having diabetes.[41]

The Metabolic Syndrome

The metabolic syndrome, also referred to as syndrome X, metabolic syndrome X, or insulin resistance syndrome, manifests itself as type 2 diabetes, insulin resistance, hypertension, coronary heart disease, obesity, or a combination of these

conditions. Though the symptoms of these diseases often do not present themselves until a person reaches adulthood, it is theorized that the origins of type 2 diabetes and several other chronic diseases lie in fetal or early postnatal development. The "thrifty phenotype theory," as proposed by Barker and others,[75-76] links the diseases of the metabolic syndrome to fetal under-nutrition where the fetus responds to severe malnutrition by favoring the metabolic demands of the growing brain and heart at the expense of other tissues, including the pancreas, liver, somatic muscle, and bones.

Nathanielsz[77] proposed that the effects of fetal programming might cross generations through mechanisms that may not involve changes in genes. In contrast, Neel[78] hypothesized with his "thrifty genotype theory" that type 2 diabetes is a consequence of genetic adjustments to inter-generational starvation conditions over the course of human existence where those who carried this "thrifty gene" were more likely to survive in times of limited food resources, but in times of abundance, were more likely to develop chronic diseases such as type 2 diabetes. In addition to fetal under-nutrition (theorized to be the result of non-genetic intrauterine factors) and genetics (thrifty genotype), postnatal environmental factors such as diet, low physical activity level, and obesity, have been proposed to explain the higher prevalence of type 2 diabetes among certain populations, most notably, the Pima Indians of Arizona,[57] Asian Indians who migrated to urban settings,[9] and African Americans in the United States.[44,55]

The term "metabolic imprinting" was introduced in recent years and was used by Waterland and Garza[79] to describe the basic biology that might underlie relationships between nutritional experiences of early life and later diseases.

According to these investigators, metabolic imprinting is a more precise definition than is fetal programming. Metabolic imprinting encompasses adaptive responses to specific nutritional conditions early in life that are characterized by a narrowly defined critical developmental window, a time when the organism is susceptible to an altered metabolic state whose effect persists through adulthood. In addition, there exist specific and measurable outcomes and a dose-response or threshold relationship between a particular exposure and an outcome. Waterland and Garza[79] noted that although fetal programming addresses the effects of early nutrition experiences, it does not highlight the concept of a narrowly defined "critical window" period. Holness and associates[80] discussed the "critical periods" of growth. Similarly to Barker and others,[75] these investigators proposed that early adaptation to an adverse intrauterine environment may ensure survival in the presence of a restricted nutrient supply, but may lead to persistent, and even lifelong, changes in the physiology and metabolism of tissues because the development of certain organs, such as the brain, are favored over the development of other organs, including the pancreas, liver, bones, and skeletal muscle.

A major problem with the fetal programming hypothesis is that the mechanisms of fetal programming are not yet fully understood. These mechanisms may operate at the organ, cellular, or molecular level to store information over a lifetime, and thus, can affect the organism throughout life. Waterland and Garza[79] added that experiments involving animal models support the epidemiologic evidence for fetal programming and may elucidate the underlying biology (mechanisms) that

links low birth weight to an increased risk for adult chronic diseases. Animal models for type 2 diabetes include rats, mice, sheep, and baboons.[63]

There are alternate hypotheses that relate fetal under-nutrition and its concomitant low birth weight to the outcome of a specific or a constellation of chronic diseases. Ben-Shloma and Smith[81] put forth one such alternative hypothesis. They proposed that the same impoverished environment that leads to a high prevalence of perinatal mortality at later ages may act to predispose a population to elevated coronary heart disease mortality as individuals grow older. Hattersley and Tooke[82] also proposed an alternative hypothesis to fetal programming in response to maternal malnutrition. They postulated that "genetically determined insulin resistance results in impaired insulin-mediated growth in the fetus as well as insulin resistance in adult life." They explained how low birth weight, insulin resistance, glucose intolerance, type 2 diabetes, and hypertension are phenotypes; that is, these conditions are observable characteristics of the same insulin-resistant genotype.

Hattersley and Tooke[82] added that fetal insulin-related growth reflects both maternal glycemia and fetal genetic factors that regulate the secretion of insulin by the pancreas and the sensitivity of fetal tissues to insulin. These authors proposed that experiments be carried out to test whether the insulin resistance of the father shows an inverse correlation with the child's birth weight, specific measures of insulin-mediated growth, and endothelial function. They concluded that "a large component of variation in fetal weight may be explained by genetic control in the fetus of glucose sensing, insulin secretion, and insulin resistance." In addition, Gluckman and Liggins[67] noted that the paternal contribution to birth weight is

expressed only through a father's contribution to the fetus's autosomal genes and sex while the maternal contribution to birth weight is expressed both through genes and through the effect of the mother's own genotype on the fetal environment. These authors concluded that the fetal environment is as important as the fetus's genotype when it comes to birth weight. They stated that during the first half of pregnancy, genetics predominate while in the second half, the importance of environmental constraints and stimuli increase.

Evidence concerning the metabolic syndrome is supported by animal studies[63] and by human epidemiological and experimental studies (clinical trials).[66] Experimental animal studies with rats, mice, pigs, chickens, sheep, and guinea pigs revealed that animals that experienced under-nutrition during the fetal period were more likely to develop diabetes-like syndromes later in life. The same has been shown for protein or caloric restrictions during the neonatal and later infancy periods. However, the strongest associations between under-nutrition and diabetes-like syndromes in animals are for the fetal period.

Poulsen and associates[61] and Bo and associates[62] revealed through their human twin studies' that there is an inverse association between size at birth and type 2 diabetes. The prevalence of type 2 diabetes was greater among the smaller twin of the pair (homozygous or dizygous) than for the larger twin. These twin studies supported the hypothesis that fetal size, irrespective of genetic influences, is a powerful predictor for type 2 diabetes. However, Bennett[57] pointed out that twin studies do not provide information as to whether type 2 diabetes is caused by one or many genes. Bennett added that twin studies also fail to reveal the mode of

inheritance of type 2 diabetes. Phillips and associates[66] showed that the metabolic syndrome is strongly associated with resistance to the metabolic actions of insulin and suggested that insulin insensitivity (insulin resistance), and consequently, type 2 diabetes, may be consequences of reduced fetal growth.

Figure 2 outlines a proposed pathway between fetal under-nutrition and the metabolic syndrome. The theorized mechanism starts with fetal malnutrition that is caused by either maternal malnutrition or by a reduced flow of nutrients to the fetus as a result of placental or maternal abnormalities. Fetal malnutrition can then proceed

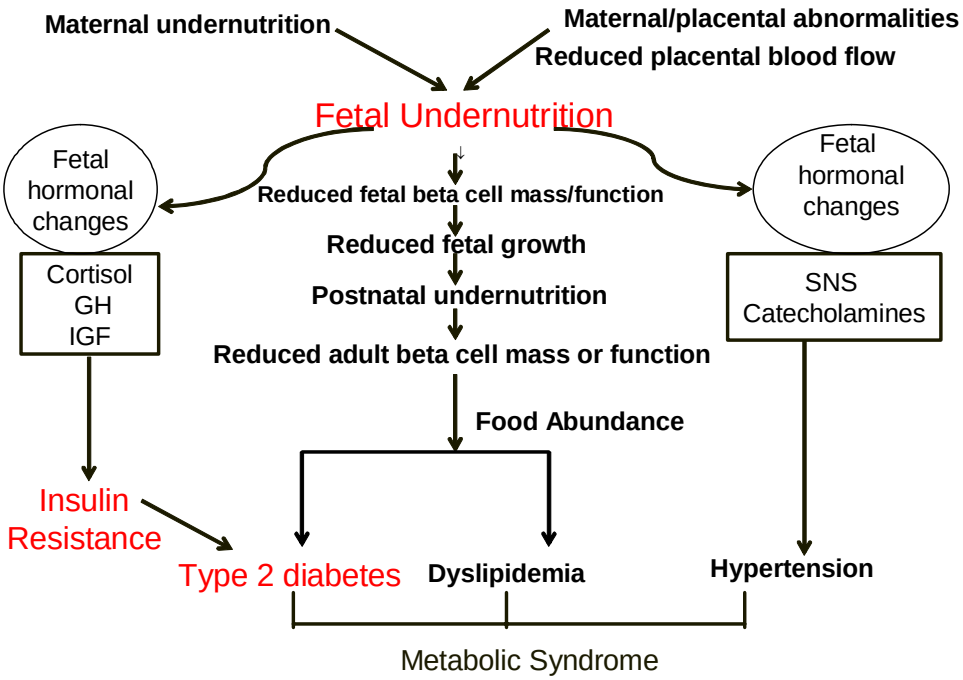

Figure 2. Theoretical model for early under-nutrition and type 2 diabetes and the metabolic syndrome (Adapted from "Syndrome-X in Type 2 Diabetes" by Murthy and Sargur, 2003).[83] GH, growth hormone; IGF, insulin-like growth factor; SNS, sympathetic nervous system.

in one (or more) of three sub-pathways. The first sub-pathway from fetal malnutrition is thought to lead to fetal hormonal changes in the production of cortisol, growth hormone, and insulin-like growth hormone. From there, insulin resistance may develop which may ultimately lead to type 2 diabetes in later life. The second sub-pathway that is postulated to originate from fetal malnutrition initially produces a reduction in fetal β-cell mass and function. This may lead to reduced fetal growth and possibly to early postnatal malnutrition. The reduced mass and function of the β-cells persist through adulthood. In the presence of food abundance, type 2 diabetes and/or dyslipidemia may occur in adulthood. The last of the three proposed sub-pathways for the metabolic syndrome arising from fetal malnutrition involves hormonal changes; however, in this case, the hormones in question are catecholamines and factors that involve the sympathetic nervous system. This sub-pathway is postulated to lead to hypertension. The endpoints of these three pathways—type 2 diabetes, dyslipidemia, and hypertension—are only a few of the conditions that collectively comprise the metabolic syndrome. Other proposed major components of this syndrome are coronary heart disease and obesity.

Non-Genetic Transmission of Type 2 Diabetes

It has been shown that women who experience hyperglycemia and the accompanying hyperinsulinemia during pregnancy have a greater risk for delivering offspring who will develop type 2 diabetes during adulthood. Aerts and associates[8] referred to this as "non-genetic transmission" of type 2 diabetes. Based on findings from rat studies, these investigators defined the transmission of impaired glucose tolerance, insulin resistance, gestational diabetes, and type 2 diabetes as the

transmission of a diabetetogenic tendency over consecutive generations, without any genetic interference. These investigators added that non-genetic transmission of type 2 diabetes can be prevented by normalizing maternal glycemia during pregnancy. They noted that this is true, not only for women who have been diagnosed with having gestational diabetes or type 2 diabetes during or prior to their pregnancies, but also for women who were assessed as being insulin resistant.

Hyperinsulinemia is one mechanism proposed to explain why type 2 diabetes tends to be more prevalent in families where the mother had type 2 diabetes. This relationship has not been shown to hold where the father had type 2 diabetes, especially in light of the intrauterine mechanism proposed by Aerts and associates.[8]

Fetal Programming: Fetal Under-Nutrition and Macrosomia

Figure 2 outlines a proposed pathway between fetal under-nutrition and type 2 diabetes, the latter of which is one component of the metabolic syndrome. Fetal under-nutrition has been found to be an independent risk factor for type 2 diabetes. Fetal under-nutrition has been defined in several ways: low birth weight;[61] small-for-gestational age (to control for prematurity);[84] shortness at birth, defined as a high ponderal index [birth weight (g)/birth length (cm^3)]; thinness at birth (low ponderal index);[66,85] low (or high) placental weight and; small head circumference. In addition, maternal height and maternal weight gain during pregnancy have been used as predictors for size at birth.[28]

The indicators listed above indirectly measure fetal growth. In animal studies, fetuses were measured directly at various points in gestation. Cardel's seminal 1955 study[86] is one of the few that directly measured hypertrophy and hyperplasia of

pancreatic islets in humans. His subjects were fetuses of infants who were born stillborn or who died within 48 hours of birth. In Cardel's investigation, pancreatic tissues of infants who were born to mothers who had diabetes during the pregnancy in question were compared to pancreatic tissues of infants who were born to mothers without diabetes. This investigator found an increase in the size of islet tissues of infants whose mothers had diabetes. This suggested that the fetus compensated for increased exposure to glucose in their prenatal environment.

In their review of the literature, Holness and associates[80] showed that there are competing mechanisms to explain poor early growth and type 2 diabetes. On the one hand, type 2 diabetes may take the form of impaired pancreatic β-cell function, while on the other hand, type 2 diabetes may be the result of impaired insulin action. These authors noted that malnutrition in utero may retard islet functional maturation. Jackson[28] also discussed how the achieved size of an organ is a crude marker for metabolic capacity and that the enzymatic capacity of a larger liver is greater than that of a smaller liver. Thus, the larger liver and larger muscle mass have a greater capacity to remove glucose from the circulation and at a faster rate.[28] Likewise, a pancreas that has reached its full potential size, and therefore its maximal metabolic capacity, would be able to maintain glucose homeostasis better than a pancreas that had been subjected to fetal under-nutrition.

The influence of childhood size on the relationship between fetal under-nutrition and type 2 diabetes, fetal under-nutrition and glucose intolerance, or fetal under-nutrition and insulin resistance have been presented in the literature. Parallel to fetal under-nutrition and its concomitant low birth weight, macrosomia at birth has

been shown to be an independent risk factor for the development of type 2 diabetes later in life. Babies born large for gestational age are most frequently born to mothers who had gestational diabetes.[87] In her review of the role of insulin in prenatal growth, Fowden[25] noted that insulin in utero has anabolic effects. Infants born of mothers who have diabetes tend to have excessive secretion of insulin, and consequently, these infants tend to have increased amounts of body fat and to weigh more than normal newborns of similar gestational age. Fowden[25] noted that the anabolic effects of insulin on the fetus combine with those of insulin-like growth factor (IGF) and peptide-based growth factors to produce a macrosomic infant.

In the United States, birth weight is the most available indicator of fetal under-nutrition. Again, ponderal index and weight-for-gestational age are two alternative proxies for fetal under-nutrition. Ponderal index is a ratio that is comprised of birth weight divided by the cube of birth length. In the United States, data on birth length are more difficult to obtain than birth weight. For the current study, ponderal index could not be assessed because of the unavailability of birth length.

Abdominal Obesity

Abdominal obesity has been identified as an important risk factor for the development of type 2 diabetes. Measures of abdominal obesity include waist circumference and waist-to-hip ratio. Based on their experimental study with 27 participants, Phillips and associates[66] proposed a mechanism to explain how obesity, especially abdominal obesity, can affect glucose metabolism. They concluded that in obese participants, the expanded fat mass may supply an excessive amount of oxidizable lipid substrates. These lipid substrates, in turn, compete with glucose

metabolism in peripheral tissues and interfere with the ability of insulin to suppress hepatic glucose output. The Phillips group hypothesized that decreased insulin sensitivity (increased insulin resistance) could be a "programmed" response to early growth restrictions.

Lundgren and associates,[20] Folsom and associates,[22] Kohrt and associates,[88] and Björntorp[89] examined the relationship between abdominal obesity and glucose tolerance, insulin resistance, and/or type 2 diabetes. Obesity has been shown to have a significant impact on health status, particularly for chronic diseases, including type 2 diabetes, coronary heart disease, hypertension, and hypercholesterolemia. These conditions are components of the metabolic syndrome, also referred to as insulin resistant syndrome, discussed above.

For numerous years, excess body weight, in terms of BMI, has been considered a strong risk factor for many chronic diseases.[22] Stevens[26] noted, that a high BMI, however, does not result in an increase in overall mortality for African-American women as it does for European-American women.

Stevens and associates[90] questioned whether a single cut-point for obesity should be applied to all ethnic groups. They studied the effects of four health outcomes (mortality, type 2 diabetes, hypertension, and hypertriglyceridemia) and three different measures of effect (incidence rate, rate ratio, and rate differences) in African-American and European-American women aged 45 to 64 years. These investigators concluded that there was no significant association between BMI and mortality in African-American women.

At 48%, African-American women have the highest prevalence of overweight in the United States while European-American women have a prevalence of 32.9%.[90] In addition, the distribution of body fat among African-American women tends to be more central and abdominal than for European-American women.[26] This translates into a higher prevalence of abdominal obesity among African-American women than among European-American women in the United States.

Abdominal obesity has been found to be an independent risk factor for type 2 diabetes and other chronic diseases among various populations.[22,89] Abdominal obesity is also referred to as visceral obesity. Little and Byrne[91] concluded that abdominal obesity, measured either by waist circumference or by waist-to-hip ratio, is a better predictor for chronic diseases than is BMI. Byrne stated that focusing on abdominal obesity can help to target those who are at greatest risk for developing type 2 diabetes.

Folsom and associates[22] noted that waist circumference was accepted by an expert panel on obesity as the superior anthropometric measure of abdominal obesity because it is easier to measure and to interpret than is waist-to-hip ratio. In addition, waist circumference correlates well with visceral fat measured by computerized tomography. However, Folsom[22] and associates concluded that waist-to-hip ratio is a better predictor for health outcomes given that waist circumference highly correlates with BMI and therefore reflects both overall and abdominal obesity.

Folsom and associates[22] reported findings from the Iowa Women's Health Study where they focused on older women and considered multiple health outcomes, including type 2 diabetes and coronary heart disease, in terms of overall obesity and

in terms of abdominal obesity independent of overall obesity. These investigators concluded that abdominal obesity is well reflected anthropometrically by either an increased waist-to-hip ratio or waist circumference for a sample of predominantly European-American women. Relative risk based on BMI seemed comparable to measures of abdominal obesity for predicting risk for type 2 diabetes for the Iowa Women's Health Study. Relative risk results for this European-American population were measures of the strength of association between various measures of obesity and type 2 diabetes.

Again, the Folsom study[22] involved a population of predominantly European-American women. In contrast, Okosun[17] measured waist circumference to determine abdominal obesity among American women of African Americans, European Americans, and Latin Americans ethnicity. Both studies showed that abdominal obesity contributed more to African-American women's risk for developing type 2 diabetes than to the other two ethnic groups' risks: 40, 24, and 16 percent of type 2 diabetes could have been avoided in African-American, European-American, and Latin American women, respectively, if abdominal obesity were absent.

Bennett[57] showed that abdominal obesity is associated with an increased risk for type 2 diabetes. He noted that hyperinsulinemia, (insulin resistance) may be the central feature of the cluster of abnormalities related to abdominal obesity. Again, these metabolic disorders include type 2 diabetes, coronary heart disease, high serum triglycerides, low high-density lipoprotein (HDL) cholesterol, and hypertension.

Figure 3 is a theoretical model that depicts how obesity, specifically abdominal obesity, can lead to type 2 diabetes. This postulated mechanism suggests

that fat, most notably abdominal (visceral) fat, leads to an elevated blood level of free fatty acids. These excess free fatty acids are deposited in muscle and liver tissues and contribute to the resistance of muscle and liver tissues to the action of insulin. As a consequence of insulin resistance, type 2 diabetes may develop.

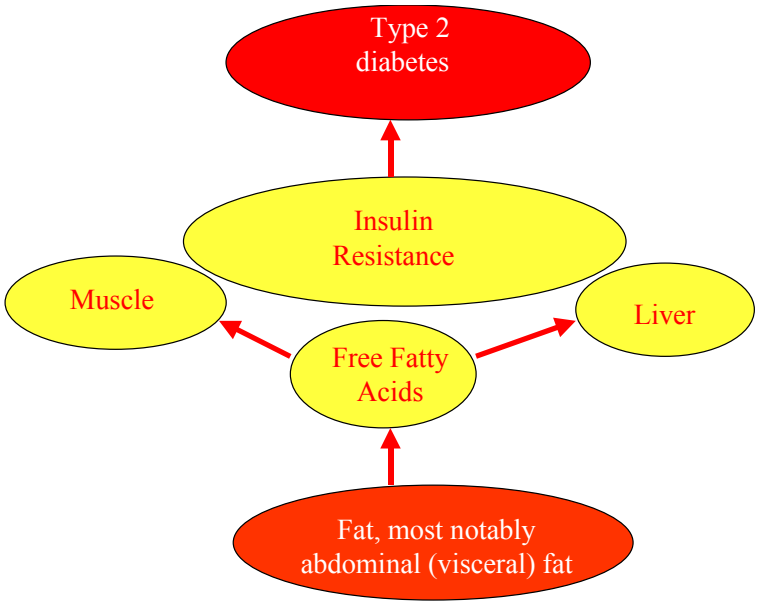

Figure 3. Theoretical model for type 2 diabetes and abdominal obesity (Adapted from Boden, p. 980)[92]

Interaction Between Low Birth Weight and Abdominal Obesity

Studies reported in the literature show a relationship between low birth weight and type 2 diabetes.[66,85] Phillips and associates[66] hypothesized that the pathogenesis of type 2 diabetes begins in utero where fetal under-nutrition results in the development of reduced insulin sensitivity of peripheral tissues, especially skeletal muscle. The infant is born small and tends to develop diabetes in adulthood, especially if insulin sensitivity is further impaired by obesity. These investigators

used thinness at birth (low ponderal index) as the indicator for smallness at birth. Smallness at birth is the proximate surrogate for fetal under-nutrition. Phillips and associates[66] showed that reduced fetal growth is associated with an increased risk for developing type 2 diabetes. They proposed that this relationship is mediated through insulin resistance and not through β-cell function and that it depends on an interaction with obesity in adult life. Given that the incidence of low birth weight among African-American infants at 13.4% in 2002 was much higher than for the general population of the United States at 7.8%, and European Americans at 6.9%,[23] the risk for developing type 2 diabetes as a consequence of fetal under-nutrition may be elevated for African Americans.

It is now accepted that there is an association between abdominal obesity and type 2 diabetes. This is a significant issue for African-American women who comprise the most obese segment of the U.S. population. The obesity of African-American women tends to be abdominal.[26] This propensity for abdominal obesity further elevates this population's risk for developing type 2 diabetes and other chronic diseases. The proposed model for the interaction of birth weight with abdominal obesity to cause type 2 diabetes is shown in Figure 4. Insulin resistance and food overabundance are common denominators for the separate models shown in Figures 2 and 3. Food overabundance can lead to abdominal obesity that, in turn, may lead to type 2 diabetes in those who had experienced fetal malnutrition.

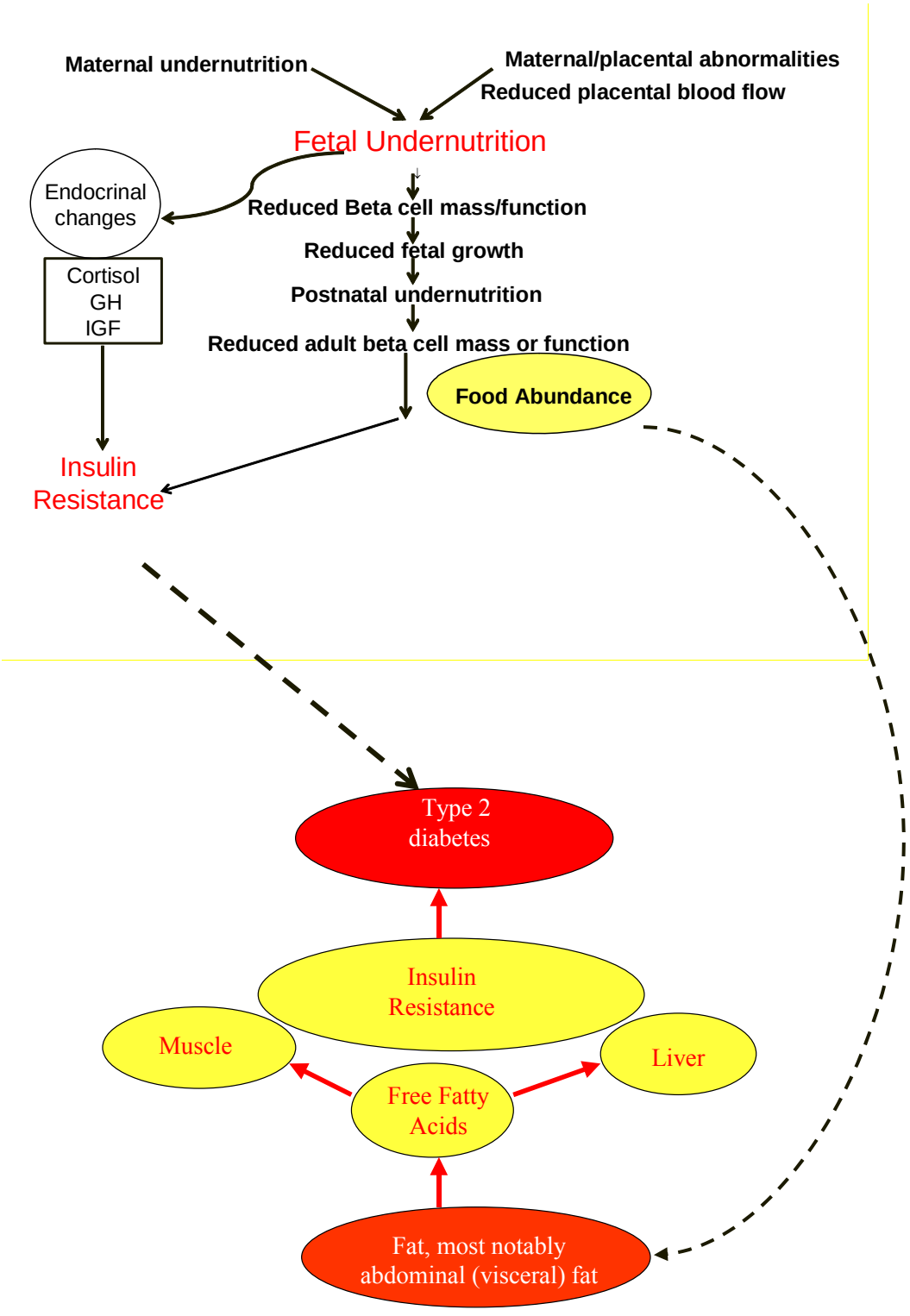

Figure 4. Combined model for interaction of early under-nutrition and abdominal obesity with type 2 diabetes[83,92]

Confounding Factors

The literature revealed several confounders for the relationships among birth weight, abdominal obesity, and type 2 diabetes.[6,22,70,93-102] With the exception of BMI, all the potentially confounding variables examined in the current study were collected using a 68-item validated questionnaire (Appendix A; the screeining questionnaire is located in Appendix B). These factors included age, menopausal status, smoking, physical activity, personal history of gestational diabetes, and family history of diabetes.

Halter[93] wrote that aging has been shown to have an effect on glucose homeostasis and, consequently, an effect on the incidence and prevalence of type 2 diabetes. Clark[94] reported that the prevalence of type 2 diabetes is positively associated with age. Clark noted that prevalence among people over the age of 65 years is eight times greater than the prevalence among people 20 to 40 years of age. The relatively narrow age range (~20 years) covered by the current study helped to reduce the confounding of age on the results. Item 1 of the Birth Information section of the current study's questionnaire was used to collect birth data.

A high BMI was shown by Keyserling[6] and Folsom[22] to be associated with type 2 diabetes.[6,22] Overall overweight, defined as BMI 25.0 to 29.9, and overall obesity, as BMI $\geq$30.0, have been used as covariates to examine the effect of abdominal obesity on type 2 diabetes.[26] However, BMI was not the focus of this. Abdominal obesity was one of the two main exposure variables examined. Abdominal obesity is defined for women as waist-to-hip ratio >0.80 or waist circumference >88 cm (approximately 35 inches).

A large, randomized clinical trial conducted by the Diabetes Prevention Program (DPP) Research Group[95] found that lifestyle changes, namely increased physical activity and weight loss, significantly reduced the incidence of diabetes in persons at high risk compared to those high-risk persons who received only the drug Metformin. Boulé and associates,[103] in their meta-analysis of controlled clinical trials, found that exercise training reduced glycosylated hemoglobin (HbA_{1c}) despite finding no significantly greater change in body mass in the exercise group compared to the control group. It should be noted that HbA_{1c} is a measure of long-term (three-month) blood glucose control.

A study by Helmrich and associates[96] involving middle-aged men showed that total energy expenditure during leisure time had a protective effect against the development of type 2 diabetes. Wei and associates[97] reported that physical inactivity and low physical fitness are modifiable risk factors that contribute to the development of type 2 diabetes. They noted in their review of the literature, however, that physical activity also has been shown to be inversely associated with obesity and central fat distribution. Physical activity was measured in the current study because of its likely role as a confounder for abdominal obesity.

Another study that demonstrated the need to measure physical activity as a possible confounder was conducted by Manson and associates.[70] These investigators utilized data from the Nurses' Health Study (NHS) to document prospective evidence of the association between physical activity and subsequent incidence of diagnosed type 2 diabetes among 87,253 women aged 34 to 59 years of age who were followed for eight years.

The majority of questionnaires used for major epidemiological studies measure leisure-time physical activity. However, leisure activity has been found to underestimate physical activity for women, particularly for women of color.[104] The Lipid Research Clinics (LRC) physical activity instrument[105] was adapted for the current study because, in addition to leisure activities, it measures non-leisure time activities that may play a significant role in energy expenditure for African-American women. These non-leisure activities specifically include activities performed during the course of employment, household chores, and in childcare, family care, volunteer, and church activities. Even though the physical activity items in the questionnaire did not provide information on specific activities, they implicitly measured intensity and duration, as interpreted by the study participant.

The physical activity items in the current study's questionnaire may be more appropriate for African-American women than are those used in the Behavioral Risk Factor Surveillance System (BRFSS)[104] or in NHANES III[104] because the latter two instruments are limited to leisure-time activities. The article by Kriska and Caspersen[106] addressed important aspects that should be considered when creating or adapting physical activity questionnaires. Items 1 to 4 of the Personal Lifestyle section of the current study's questionnaire addressed physical activity.

Dietary assessment through food frequency questionnaires, 20-four hour recalls, or food diary may be time-consuming and burdensome for study participants. However, abdominal obesity, BMI, and physical activity are distinct proxies for dietary intake, especially in terms of the macronutrients—carbohydrates, fats, and

proteins. Gillman and associates[107] and Albanes and Conway and associates [108] found that physical activity and diet quality are associated behaviors.

Gestational diabetes is known to increase the risk for subsequent development of type 2 diabetes. Items 6 and 7 of the Personal Health History section of the current study's questionnaire addressed gestational diabetes. Family history of diabetes is another strong predictor for type 2 diabetes. Twelve items (1 to 12) of the Family Diabetes History section of the questionnaire addressed this risk factor. The questionnaire items that were used to assess family history of diabetes were adapted from a surveillance instrument developed by the National Health Service of the United Kingdom.[109]

Hypertension and hypercholesterolemia are two components of the clustering of diseases and disorders that comprise the metabolic syndrome. Items 1 and 2, respectively, of the Personal Health History section of the current study's questionnaire were designed to collect self-reported data on these variables. In addition, blood pressure was measured by the investigator.

Smoking and alcohol consumption are lifestyle factors proposed to affect the onset of complications of type 2 diabetes. Smoking has been examined for its possible association with type 2 diabetes.[100-101] For the current study, smoking was categorized as "never smoked," "former smoker" (smoked more than 100 cigarettes in lifetime), or "current smoker." Items 5 to 7 of the Personal Lifestyle section of the current study's questionnaire addressed smoking. Alcohol intake was examined by Johnson and associates,[101] Lee and associates,[102] Wei and associates,[110] and Ajani and associates.[111] Items 8 and 9 of the Personal Lifestyle section of the questionnaire

solicited self-reported data on alcohol consumption. The reliability of recalled physical activity, cigarette smoking, and alcohol consumption was examined by Lee and associates.[102] They found that self-report of these lifestyle behaviors were reliable.

In summary, the literature revealed that separately, low birth weight and abdominal obesity increase the risk for type 2 diabetes for certain populations. However, a search of the literature did not reveal any studies that examined whether low birth weight increases the risk for type 2 diabetes in African-American women. It also did not reveal any studies that examined the interaction of low birth weight and abdominal obesity in African-American women, a population whose risk for each of these factors is high. The current study investigated whether the interaction of low birth weight and abdominal obesity is associated with type 2 diabetes for African-American women.

Chapter 3: Method

This chapter describes the design, recruitment and exclusion criteria, sample size determination, survey instruments, data collection procedures and statistical analyses used to address the study hypotheses. In addition, the pilot study and limitations of birth data used in the study are addressed.

Study Design

This retrospective case-control, non-intervention observational study examined the relationships among birth weight, current weight status, and type 2 diabetes in a convenience sample of 281 African-American women. In addition, the relationship between type 2 diabetes, abdominal obesity, and birth weight was assessed. A self-reported physician diagnosis of type 2 diabetes was the outcome measure. Explanatory variables were birth weight and current waist-to-hip ratio. Covariates included body mass index (BMI), physical activity, family history of diabetes, personal history of gestational diabetes, blood pressure, self-reported weight at age 25, and smoking. See Codebook (Appendix C) for collected and calculated variables.

Recruitment and Participants

A large-scale community outreach campaign was implemented to recruit participants. Recruitment sites included, but were not limited to churches, a mosque, and other faith-based organizations, health clinics, worksites, recreation centers, social service and employment service centers, literacy programs, libraries, health fairs, beauty shops, private homes, public housing resident council offices, public and parochial schools, health food complexes and supermarkets (including the posting

and distribution of flyers inside and outside the facilities), parked cars, and university facilities. Printed and electronic media were utilized, including newspaper articles and advertisements, newsletters and church bulletins, printed flyers, radio interviews and announcements, and the Internet. Word-of-mouth was a major recruitment tool. See Appendix D for selected recruitment materials and resources.

The initial sample was a convenience sample of 376 African-American women, 38 to 57 years of age, who were born in the United States between 1945 and 1970 and recruited from the Washington, D.C., Metropolitan Area. Race and birth date data were by self-report. Age was based on last birthday completed at the time of enrollment. (See Figure 5 for enrollment and categorization of study participants.) It was proposed that it would take five to eight months to enroll study participants. However, due to unanticipated recruitment challenges, the recruitment period lasted 17 months (August 9, 2004, to January 14, 2006). Recruitment challenges included the need for additional time to build relationships among the various faith-based organizations. Women above the age limit of 57 years were generally very receptive to the idea of participating in the study; however, they did not meet the study protocol and could not be enrolled. In addition, initially requiring that at least four to five women be available to enroll within one session that was scheduled outside of the university resulted in some lost opportunities for enrolling women in the study. Beginning around the ninth month of the study, a woman eligible for the study who had a self-reported physician diagnosis of type 2 diabetes would be enrolled at the site of her choice, including home, jobsite, or church, even if she

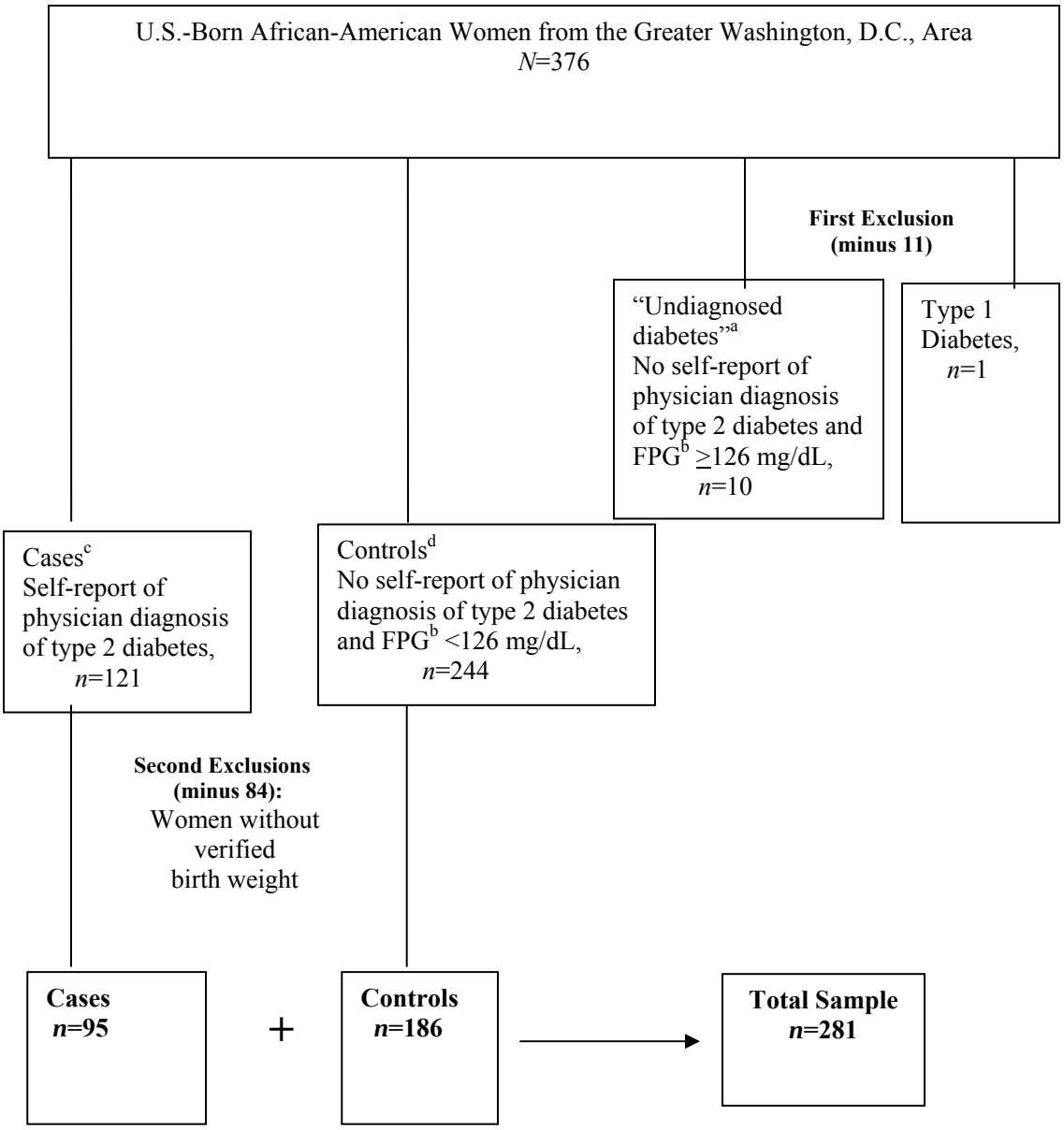

Figure 5. Enrollment and categorization of study participants

[a]*Undiagnosed diabetes,* FPG greater than or equal to 100 mg/dL and less than 126 mg/dL

[b]FPG, fasting plasma glucose

[c]Cases (those with a self-reported physician diagnosis of type 2 diabetes) could have a non-fasting plasma glucose in place of a fasting plasma glucose. The plasma glucose for cases could be any value for the purpose of categorization.

[d]Each control had a fasting glucose test to determine whether she might have undiagnosed diabetes.

were the only enrollee scheduled for the session. Finally, having one observer collect all the measurements slowed down the enrollment process for this study.

Of the 376 women initially enrolled, 121 (32%) reported having a physician diagnosis of type 2 diabetes while 244 reported not having a physician diagnosis of diabetes and had fasting plasma glucose levels of <126 mg/dL. Participants with prediabetes (fasting plasma glucose levels from 100 mg/dL to less than 126 mg/dL) were classified as controls because their fasting plasma glucose levels were less than the cut-point for diabetes (fasting plasma glucose ≥126 mg/dL).

Only women for whom birth weight could be verified through official records or through verified self-report (95 cases, 186 controls) were retained for the study. Verified self-reported birth weights were obtained through asking participants to report the birth weights found on personal copies of their birth certificates, hospital or clinic records, crib cards, entries in family Bibles, or through getting reports of their birth weights from their mothers. Eighty-four women were excluded from the study because verified birth weight could not be obtained for them. Correlations and paired *t* tests analyses were conducted on the different sources of birth weights to determine whether verified self-reported birth weights and vital records birth weights could be pooled. These results can be found in Chapter 4 of this dissertation.

Eleven enrollees could not be categorized as cases or controls and were not included in the study. Of the 11 enrollees excluded based on inability to be categorized as cases or controls, ten could not be classified because they presented as not having had a physician diagnosis of type 2 diabetes, but their fasting blood glucose levels measured ≥126 mg/dL. However, a few hours after enrolling in the

study, one of these participants was diagnosed by a physician as having diabetes. She reported visiting a hospital emergency room after feeling lightheaded because she then was able to recognize the symptoms of diabetic hyperglycemia. (Note: Cognitive and motor impairment have been shown to be symptoms for hyperglycemia as well as for hypoglycemia.[112]) This participant was reclassified as a case after she contacted the study investigator two days after her hospitalization.

A second participant was diagnosed with type 2 diabetes after making an appointment with her health care provider upon the advice of the study investigator. This participant returned six months after her diagnosis to have new study measurements collected. Data collected on her at her first enrollment appointment were not used in the study. Nine of the 11 participants who could not be classified as cases or controls at the time of enrollment could not be reclassified as cases later. None of these participants were included in the study because they did not meet the study protocol's definition of cases or controls.

One participant reported that although she had lived for years believing that she had type 2 diabetes, her physician informed her two years ago that she actually has type 1 diabetes based on a genetics assessment. No details were collected regarding the nature of the genetics assessment. This woman was not included in the study.

Written informed consent (Appendix E) was obtained from each participant. New York State required that participants who were born there sign a state-specific informed consent form. Regulations pertaining to the Health Insurance Portability and Accountability Act (HIPAA)[113-115] and appropriate state laws were followed

regarding data collection and storage. Approval was granted from the Institutional Review Board (IRB) of the University of Maryland (Appendix E) and from IRBs of various vital records offices or State Centers for Health Statistics, where applicable.

Exclusions

Known cases of type 1 diabetes were excluded from the study. Women who were pregnant at the time of enrollment or who had delivered a child within nine months preceding the scheduled enrollment date were also excluded given the possibility that these conditions could influence blood glucose and body measurements. Potential participants who reported that they had major diseases such as cancer, liver or renal disease, myocardial infarction, or stroke within six months prior to their enrollment were excluded to avoid enrolling participants whose altered glucose metabolism or body measurements might be secondary to these diseases or treatments. Two women who had recovered from these conditions more than six months before screening were eligible to enroll (one from a heart attack and one from cancer). Women who reported major infections, including HIV and AIDS, were excluded from the study given that these infections might significantly alter plasma glucose results and current body measurements. One recruit reported that she was HIV-positive. She was not enrolled in the study; however, she received all the benefits that were provided to those women who were enrolled.

Sample Size Determination

Before the study was launched, an *a priori* sample size estimation was performed to determine the number of participants needed to conduct this case-control study. Initially, the sample size was estimated based on a power of

approximately .80; however, due to difficulty in obtaining birth weight data, the final power for the current study was .56. A detailed description of the sample size estimation can be found in Appendix F. The actual power of the current study was based on sample size (95 women with type 2 diabetes and 186 women without diabetes) and prevalence of low birth weight, defined as birth weight <2,500 g. The prevalence of low birth weight for the sample was .13 among controls and .19 among cases. For case-control studies, sample size estimations and power analyses are based on the prevalence estimates of the outcome of interest (for the current study, low birth weight) in persons without the condition (controls: women without diabetes).

Instruments

Tools used in the current study included equipment and materials for direct measurements (Appendix G), a 68-item questionnaire developed and validated by the investigator (Appendix A), a screening questionnaire (Appendix B), and official birth records obtained through vital records offices and State Centers for Health Statistics. These instruments are described below.

Equipment and Materials

Blood pressure was measured using the American Diagnostic Corporation (ADC) Model 6014 digital blood pressure device. Blood pressure readings for various individuals were compared with readings from health center sphyngometers to access the accuracy of the blood measurements collected on study participants. Waist and hip circumferences were measured to the nearest 0.1 centimeter using a flexible measuring tape. Height was measured to the nearest 0.1 centimeter using the

Seca Model 214 Road Rod stadiometer. Weight was measured to the nearest 0.1 kilogram using the self-zeroing Seca Model 770 digital scale.

Hemocue provided training on the use of the Hemocue 201 glucometer. In addition, the investigator received training from experts on the proper procedures for measuring blood pressures in research settings. A videotape provided by the National Center for Health Statistics was used for body measurements training.[116] In addition, the *Anthropometric Standardization Reference Manual,* edited by Lohman and associates,[117] was consulted.

The investigator participated in a university-based certification training course on the safe handling of biohazardous materials. The investigator was certified by several sponsors of programs for human subjects protection in research, including that of the National Institutes of Health Clinical Center. The investigator received training and certification for HIPAA through the District of Columbia Department of Health.

Questionnaires and Data Collection Forms

A 68-item self-administered questionnaire (Appendix A) was developed. A panel of experts, focus group participants, and pilot study volunteers assessed the questionnaire for ease of understanding. The panel of experts, comprised of nine researchers and practitioners in the area of nutrition and health, reviewed the questionnaire items for face validity. That is, the panel assessed whether the questions were relevant to the study and if they were likely to adequately measure the characteristics of interest.

In addition, the investigator conducted five focus groups to assess the content of the questionnaire and its flow in order to increase the likelihood that the questionnaire would be completed by the participant and that accurate responses would be obtained. Background information on focus group participants and selected findings are presented in Appendix H. The first focus group (*n*=11) involved African-American women from an urban area in the Midwest region of the United States. The remaining four focus groups (*n*=4, 6, 5, and 10, respectively) involved women in the Washington, D.C., Metropolitan Area. In total, 36 women completed the questionnaire and reported their suggestions and comments verbally and/or in writing. Suggestions and comments were incorporated in the questionnaire after each focus group interview in preparation for subsequent focus group sessions. Using the SMOG readability formula,[118] the readability of the survey instrument was determined to be at the eighth grade level.

A data form for recording direct measurements, including height, weight, blood pressure, and blood glucose was developed by the investigator (Appendix I). This form was tested for clarity and flow during the pilot study. In addition, a personal measurements form on which the investigator recorded height, weight, waist and hip circumferences, blood pressure, and plasma glucose was developed (Appendix I). Participants could then share this information with their health care providers. This personal measurements form also served as a tool for participants to learn to convert metric-scale measures to U.S. equivalent measures.

Data Collection Procedures

Participants were measured by the investigator. In addition, they completed Items 1 to 11 of the Birth Information section of the 68-items questionnaire. They were then interviewed to provide self-reported health and birth data. In addition, vital records birth data were requested from vital records offices and State Centers for Health Statistics for each participant. The investigator collected all primary measurements with the exception of current weight for one morbidly obese participant for whom body weight was collected at a clinic visit two days before the enrollment session. The following is a summary of the data collection procedures used for the current study. Given the sensitive nature of birth certicate data, a detailed data protection protocol was developed. This protocol can be found in Appendix J.

Primary Data: Blood Pressure, Plasma Glucose, and Body Measurements

Primary data, including blood pressure, fasting blood glucose, height, and weight were collected by the investigator who held sessions at various enrollment sites, including churches, private homes, public housing resident council offices, job sites, and a university lab. Privacy was maintained for each participant during measurement procedures through using free-standing screens or locked rooms or offices. To minimize observer and participant bias, the study protocol was strictly followed. The sequence of data collection was as follows: after screening, informed consent was obtained. Next, one drop of blood from a finger prick was collected and the plasma glucose level was analyzed immediately using the Hemocue 201 glucometer. Women with a self-reported physician diagnosis of type 2 diabetes

(cases) were allowed to provide a non-fasting blood sample, if preferred, to comply with the recommendations of their health care providers. Controls were required to have fasted for at least eight hours before providing a drop of blood for analysis. Universal precautions were followed for the collection of blood and for the disposal of biohazardous materials.

Diabetes, blood pressure, physical activity, and healthy eating were discussed with each participant. Blood pressure was measured using the American Diagnostic Corporation (ADC) Model 6014 digital blood pressure device after the participant had been seated for at least five minutes, the time used in standard protocols for obtaining blood pressure readings.[119] Waist and hip circumferences were measured to the nearest 0.1 centimeter using a flexible measuring tape. Height was measured to the nearest 0.1 centimeter using the portable Seca Model 214 Road Rod stadiometer. Weight was measured to the nearest 0.1 kilogram using the portable self-zeroing Seca Model 770 heavy duty floor digital scale. With the exception of the plasma glucose test, all measurements were taken in duplicate. Measurements were written directly on a data collection form and were later typed into a text file. Standard procedures were followed for the collection of all measurements.[116-119] The guidelines of the manufacturers of the scales, glucometer, and blood pressure device were strictly followed.

Collection of both primary and secondary data (not including follow-up self-reported birth weights and vital records birth weights) took less than one hour for the average participant. Within this one-hour time frame, nutrition education and

referrals were shared with participants. Secondary data and nutrition education are discussed below.

Secondary Data: Self-Report and Official Reports

Participants completed a questionnaire that included items that addressed menopausal status history of being breastfed, physical activity level, and cigarette smoking. Fourteen out of 376 women who presented for enrollment in the study required that the investigator or someone else (including volunteers of a church-based food pantry) to read all or some of the questionnaire items due to low literacy levels, poor eyesight, or for their convenience. For the majority of participants, the questionnaire seemed clear, with only a few seeking clarification and most not skipping any responses. Participant responses to questionnaire items were reviewed for completeness and accuracy.

The investigator requested birth data for each participant from the appropriate vital records office and/or State Center for Health Statistics (*n*=32 states), including those of the District of Columbia and New York City. Data were requested for the following birth variables: birth weight, length of gestation, prematurity status, plurality of birth, and whether or not the participant's mother had diabetes during her pregnancy with the participant. The section that follows gives a more detailed description of birth data collection.

Access to Birth Data

Requests for birth data variables on each participant were made to the appropriate state vital records office and/or State Center for Health Statistics. Procedures for requesting birth data varied among states. These procedures were

strictly followed with the assistance of the National Center for Health Statistics website (www.cdc.gov) and/or with the appropriate contact person of the state-specific vital records office or State Center for Health Statistics. Six months were allocated for the request and receipt of birth data. Extensive follow-up was required for vital records offices or State Centers for Health Statistics where personnel responsible for granting approval for and/or for processing birth data requests had experienced recent turnover.

In addition, participants were asked to self-report their birth weights at the time of enrollment. Self-reported birth weights were verified with birth weights from official sources or from a second report by participants when they were able to obtain their birth weights from a document or from a relative or some other source. The verified self-reported birth weights were obtained through follow-up telephone calls, e-mails, or letters mailed through the U.S. Postal Service. Participants were contacted through more than one method when available and if necessary.

Once it was discovered that obtaining vital records birth weights was more difficult than had been anticipated, the investigator examined other documents to determine if she could abstract birth weights for any participants. An attempt was made to obtain birth weights for District of Columbia-born participants from birth announcements in microfilm files of *The Washington Post, The Evening Star, The Washington News, The Washington Times-Herald* and *The Washington Afro-American,* located in the Washingtonian collection and other collections of the Martin Luther King Memorial Library in the District of Columbia. This met with no success. Birth announcements for the years reviewed listed only the names of parents and the

gender of the infant. Thus, these records could not be used to obtain birth weights for participants.

Likewise, attempts to access birth data from hospitals located in the District of Columbia were unsuccessful. Hospitals are not required to maintain records for patients after a given time. None of the targeted District of Columbia hospitals reported having birth records for participants born between 1946 and 1964 when the investigator requested birth records from these hospitals. Records maintained by hospitals and by a public library in the city where the majority of the study participants were born was not part of the original study protocol. However, investigating them as possible sources of birth data indicated that the investigator was willing to go the extra mile to obtain birth data.

In summary, the procedures for collecting birth data involved (1) collection of a self-reported birth weight at study enrollment, (2) re-contact of participants to obtain a second, presumably more accurate, self-reported birth weight and, (3) request for official birth data from vital records offices or State Centers for Health Statistics. Women without verified birth weights were not included in the study.

Nutrition Education and Referral

Within the one-hour data collection session, each participant received a brief individual nutrition consult and nutrition education from the investigator, a Registered/Licensed Dietitian. In addition, they received two brochures on physical activity and healthy eating.[120-121] Finally, each participant was given fact sheets on diabetes[122] and high blood pressure.[123] Participants were informed of how they could obtain additional copies of nutrition education materials, both study-related and non-

study related, for themselves, their families, friends, church members, and others for free or at nominal cost from various government agencies.

Participants received a copy of a form with their enrollment session measurements (Appendix I) and were encouraged to share these results with their health care providers. Participants were encouraged to discuss their diabetes and high blood pressure risk levels with their health care providers. For the 12 women who had no previous physician diagnosis of diabetes but whose fasting blood glucose levels were ≥126 mg/dL, the urgency of their visiting a health care provider was emphasized. Women already diagnosed with diabetes, but with elevated fasting or non-fasting blood glucose levels were encouraged not to delay following up with their health care providers. All participants with a physician diagnosis of type 2 diabetes received an explanation of why current recommendations for treatment of diabetes includes the aggressive treatment of patients with diabetes for hypertension and pre-hypertension. The concept of prediabetes was explained to all participants whose fasting blood glucose levels were greater than 100, but less than 126 mg/dL.

Participants with high blood pressure levels were encouraged to visit their health care providers immediately. Referrals were made to health care providers of free or low-cost care, as needed. Information on local departments of health was also shared with participants, where indicated. Nutrition education brochures and fact sheets were promoted as benefits and incentives for participation in the study.

Pilot Study

Before the launching of the study, a pilot study was conducted with 21 women. A description of the pilot study participants are presented in Appendix K.

This pilot study allowed the investigator to test the questionnaire for clarity and to assess the flow of procedures and the adequacy of the data collection processes and locations. Two weeks were needed to conduct the pilot study with 21 volunteers while 17 months were needed to enroll 376 women in the full study. Through the pilot study, it was ascertained that 40 to 60 minutes were required to enroll each participant. In addition, information gathered during the pilot study resulted in the improvement of the data collection forms and enrollment procedures. An example of this improved flow was that for the actual study, fasting blood glucose levels were collected before blood pressures. This allowed participants to remain seated after the nutrition education session was conducted. In addition, the order of the fasting question on the measurements form was changed to improve data entry flow.

Statistical Analyses

Logistic regression analysis tested the hypothesized model for assessing the odds ratio for type 2 diabetes. Preliminary statistics were conducted to generate descriptive statistics and to run the appropriate diagnostics on the data. A summary of the relationships of the study variables in statistical terms is as follows: outcome variable (type 2 diabetes), exposure variables (birth weight and waist-to-hip ratio), and covariates (including age, BMI, physical activity, history of gestational diabetes, family history of diabetes, hypertension, and weight at 25 years). See Appendix C for the study codebook and the list of variables for which data were collected for the current study.

Logistic regression analyses allowed adjustment for possible confounding variables. Logistic regression analyses were used to test the proposed model for

measuring the odds for having type 2 diabetes using birth weight, abdominal obesity (waist-to-hip ratio >0.80), and the interaction of birth weight and abdominal obesity as explanatory variables. The proposed logistic regression equation, without covariates, was:

Natural log of (DIABETES/1-DIABETES) = (β_1*birth weight) + (β_2*WHR) + [β_{12}*(birth weight * WHR)].

Multivariate logistic regression models were constructed using birth weight and waist-to-hip ratio, both singularly and in combination, to determine which set of anthropometric variables had the greatest explanatory power. In addition, covariates were considered, including a diagnosis of high blood pressure, family history of diabetes, physical activity level, and smoking. Multiple linear regression analyses were conducted to investigate the relationship between fasting plasma glucose and low birth weight and abdominal obesity. The Satterthwaite *t* test was used for groups of unequal sample sizes to test the differences between cases and controls on various measures. Alpha for all test statistics was set at the .05 level for two-sided tests. All statistical analyses were conducted using SAS version 8.2 (SAS Institute, Cary, North Carolina).[124]

Variability was reduced in several ways. First, the investigator was the sole collector of current body measurements. This eliminated inter-observer variability. Second, limiting the study participants to a single racial/ethnic group, one gender, and a narrow age range decreased variabilty. Third, limiting blood pressure, blood glucose, and current anthropometric collection to morning hours reduced intra-subject

variation secondary to diurnal cycles. Finally, the current anthropometrics and blood pressure were collected in duplicate to reduce variability.

Hypotheses

The current study addressed four research hypotheses.

Hypothesis 1: Birth weight is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

Hypothesis 2: Abdominal obesity is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

Hypothesis 3: Birth weight and abdominal obesity interact to increase the odds ratio of type 2 diabetes among cases versus controls in African-American women 38 to 57 years of age, controlling for potential confounders.

Hypothesis 4: Among African-American women without a physician diagnosis of type 2 diabetes, there is an association among birth weight, abdominal obesity, and fasting plasma glucose level.

Chapter 4: Results

Part one of this chapter presents descriptive statistics for the entire sample and is divided into the following eight sections: (1) demographics and lifestyle indicators; (2) birth weight; (3) current body weight and height measurements and body mass index; (4) self-reported physician diagnosis of high blood pressure versus measured systolic blood pressure; (5) health history; (6) fasting plasma glucose and prediabetes; (7) waist and hip measurements and waist-to-hip ratio and; (8) participants with a self-reported physician diagnosis of type 2 diabetes. In part two, results from logistic regression analyses that address the study hypotheses are presented. Logistic regression model-testing is presented in detail, followed by a presentation of the final model. Part three presents results of additional analyses that further elucidate the data including, (1) fasting plasma glucose by birth weight and abdominal obesity; (2) a focus on low birth weight participants; (3) highlighting participants for whom vital records birth weights were obtained and; (4) fasting plasma glucose among cases: use of hypoglycemic agents; pre-menopausal status and body mass index, waist-to hip ratio, age, and fasting plasma glucose among cases and controls. This chapter ends with a summary of the central findings (part four).

Demographics and Lifestyle Indicators

The sample consisted of 281 women for whom verified self-reported and/or vital records birth weights were collected, a retention rate of 77% (281/365). Ninety-five of the participants (cases) reported a physician diagnosis of type 2 diabetes and 186 participants (controls) reported that they did not have a physician diagnosis of type 2 diabetes. All controls had fasting plasma glucose levels <126 mg/dL.

Mean reported age of study participants was 49 years, *SD*=6.0 years. Table 1 presents the full sample of African-American women by decade of birth. Twenty-one percent of the study participants were born in the 1940s (Table 1). A majority (52%) were born in the 1950s, while 27% were born in the 1960s. Those with diabetes (*n*=95; *M*=51 years, *SD*=5.4 years) were slightly older than the control group (*n*=186; *M*=48 years, *SD*=6.0 years), *p* =.0003. A larger percent (27% versus 17%)) of cases than controls were born in the 1940s. In contrast, more controls (32%) than cases (18%) were born in the 1960s. These birth cohort differences were statistically significant between cases and controls, $\chi^2(2)=8.1$, *p*=.0175. On the one hand, the availability of birth certificates was related to the decade in which the woman was born. On the other hand, vital records data were more likely to be obtained for those who were born in the 1960s than for those born in earlier decades.

Table 1. Decade of Birth for U.S.-Born African-American Women 38-57 Years of Age

Decade	All		Cases		Controls	
	n	%	*n*	%	*n*	%
1940s	58	21%	26	27%	32	17%
1950s	146	52%	52	55%	94	51%
1960s (and 1970 where *n*=1)	77	27%	17	18%	60	32%
Total	281	100%	95	100%	186	100%

Note. All information in this table based on women for whom pooled vital records and verified self-reported birth weights were obtained.
χ^2 was employed when comparing decades born for cases and controls.
$\chi^2(2)=8.1$, *p*=.0175. Bolded figures are significant.

Table 2 presents the region of birth for women in the sample. The majority of the participants reported being born in the southern region of the United States (85%) and delivered in hospitals (84%). (See Table 2.) Table 3 presents the educational background of the women in the sample. Based on self-reported levels of educational attainment, this sample was highly educated. The majority (77%) had attended

college (Table 3). Cases (67%) were significantly less likely than controls (82%) to have attended college, p=.0070.

Table 2. Frequencies of Background Characteristics: Locations of Birth
U.S.-Born African-American Women 38-57 Years of Age

Location	All		Cases		Controls	
Region of Birth[a,b]	*n*	(%)	*n*	%	*n*	%
Northeast	22	8%	2	2%	20	10%
Midwest	14	5%	4	4%	10	5%
South	240	85%	88	93%	152	82%
West	3	1%	1	1%	2	1%
State Unspecified (but born in U.S.A.)	2	<1%	0	0%	2	1%
Specific Location of Delivery[b,c]		%	--	--	--	--
Hospital Births	232	83%	--	--	--	--
Home Births	34	12%	--	--	--	--
Doctor's Office	1	<1%	--	--	--	--
Not Specified	14	5%	--	--	--	--

Note. All information in this table was by self-report. Rounding resulted in totals different from 100%.
[a]Region was categorized according to U.S. Census standards.[125]
[b]Total sample includes only women for whom vital records and verified self-reported birth weights were obtained, N=281.
[c]Hospital birth status of participants was not analyzed by diabetes status.

Table 3. Frequencies of Background Characteristics: Education Attainment of
U.S.-Born African-American Women 38-57 Years of Age

	All		Cases		Controls	
	n	%	*n*	%	*n*	%
Level of Education Attained						
Attended College[b]	216	77%	64	67%	152	82%
Highest Year of School Completed[c]						
Grades 1-8 (elementary)	2	<1%	2	<1%	2	1%
Grades 9-11 (some high school)	8	3%	8	3%	4	2%
Grade 12 or GED (high school diploma/equivalency)	38	14%	38	14%	21	11%
Technical/trade/vocational school	17	6%	17	6%	7	4%
Attended college, but did not graduate	67	24%	67	24%	41	22%
Associate degree	16	6%	16	6%	10	5%
Bachelor degree	61	22%	61	22%	44	24%
Graduate or advanced professional degree	72	26%	72	26%	57	30%

Note. All information on education was by self-report. Total sample, n=281, with 95 cases and 186 controls.
[a]Total sample includes only women for whom vital records and verified self-reported birth weights were obtained, N=281. Information in this table was obtained for all of the study participants.
[b]$\chi^2(1)=7.28$, p=.0070
[c]$\chi^2(7)= 15.96$, p=.0254
p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Lifestyle indicators such as smoking, physical activity, and alcohol consumption are presented in Table 4. In terms of lifestyle indicators, the majority of

the participants reported being non-smokers (89%) (Table 4). There was no significant difference in the percentage of current smokers between controls (8%) and cases (16%), p=.0530. Forty-two percent of the sample reported engaging in regular strenuous physical activity, with controls (47%) being significantly more likely than cases (30%) to have engaged in regular strenuous physical activity, p=.0083 (Table 4). The majority of participants (81%) reported having a history of drinking alcohol during their lifetime. Twenty-eight percent reported drinking within the past seven days, 34% between 8-30 days and 45% within the past 31-90 days. Significant differences between cases and controls on alcohol consumption variables were observed only for drinking within the past seven days: 16% of the cases reported drinking within the past seven days, compared to 35% of the controls, p=.0008. No data on quantity of alcohol consumed were collected for the current study.

Table 4. Frequencies of Lifestyle Indicators: Smoking, Physical Activity, Alcohol Consumption U.S.-Born African-American Women 38-57 Years of Age.

Lifestyle Indicator	All[a]		Cases[b]		Controls[c]		χ^2	p
	N	(%)	*n*	(%)	*N*	(%)	*(df)*	
Current Smoker	30	(11%)	15	(16%)	15	(8%)	3.75 (1)	.0530
Regular Strenuous Physical Activity/Hard Labor[d]	**117**	**(42%)**	**29**	**(30%)**	**88**	**(47%)**	**6.97 (1)**	**.0084**
Alcohol Consumption								
Ever drank	225	(81%)	74	(80%)	151	(82%)	0.06 (1)	.8117
Drank within 7 days	**80**	**(28%)**	**15**	**(16%)**	**65**	**(35%)**	**11.3 (1)**	**.0008**
Drank between 8 and 30 days	96	(34%)	27	(28%)	69(	37%)	2.10 (1)	.1458
Drank between 31 and 90 days	125	(45%)	37	(39%)	88	(48%)	1.89 (1)	.1695

Note. All information on smoking and drinking was by self-report.
[a]N=278-281; [b]n=92-95; [c]n=185-186. Responses to these questionnaire items were not given by up to three women.
[d]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?" *df* = degrees of freedom; p is significant at $\alpha<.05$, 2-sided test.
Bolded figures are significant.

Birth Weight

As of July 21, 2006, official birth weights were obtained for 63 (22%) of the 281 participants. (Note: To date, a total of 84 birth certificates were obtained;

however, birth weights were missing from 21 of these certificates. Hence, these 21 birth certificates could not be used.) Participants were born in 32 states. Each of these states was contacted for vital records birth data. Seventeen states (53%) were able to provide birth weights for all or some of the participants born within their jurisdiction. Although 11 states with small numbers of study participants were able to provide birth weights for 100% of the study participants born there, the state where the majority of the participants were born could not provide vital records birth weights for any of them as of March 2007. Table L1 (Appendix L) shows the percentages of birth weight records obtained for participants, by state of birth. Chapter 5 includes a discussion of birth weight collection challenges.

Self-reported birth weights at enrollment were verified using two methods: (1) birth weight obtained from vital records/State Centers for Health Statistics and/or (2) self-reported birth weight that participants verified from other sources, such as birth weights that participants obtained from their mothers or from self-reports from hospital and other family records that participants possessed.

Of the 281 study participants, 75 reported that they verified their self-reported birth weight from hospital or family records, 112 reported that they obtained their birth weight from their mothers, 62 from other sources (including other relatives), one did not know her birth weight, and 31 could not be reached through a follow-up contact. Note that for some participants, birth weights were obtained from both official records and from verified self-report. When both sources were available for a participant, birth weight from the official source was used. Participants without vital

records birth weights were included in the study if their self-reported birth weight was verified by another source, such as hospital or family records.

Comparisons between birth weights obtained from vital record and verified self-reported birth weights by source of self-reported birth weight are presented in Tables 5 to 9. While Table 5 displays the mean, minimum, and maximum values of birth weights by source of birth weight data, Table 6 displays the correlations among birth weight data sources. There was a significant positive association between verified self-reported birth weight and vital records birth weight, r =.70, p<.0001, n=32 (Table 6).

Table 5. Means, Standard Deviations, and Minimum, Maximum Birth Weight Measurements U.S.-Born African-American Women 38-57 Years of Age

Birth Weight Source	Mean g	*SD* g	Minimum g	Maximum g
Birth weight, Enrollment Self-Report	3,063 n=200	621.8	1,020	4,564
Birth weight, Verified Self-Report	3,054 n=250	622.7	1,020	4,705
Birth Weight, Vital Records	3,301 n=63	470.1	2,183	4,507

Note. 2,500 g = 5 pounds, 8 ounces;
1,020 g ~ 2.25 pounds; 3,200 g ~ 7 pounds; 4,100 g ~ 9 pounds

Table 6. Correlations Among Birth Weight Data Sources
U.S.-Born African-American Women 38-57 Years of Age

Birth Weight Source	Enrollment Self-Report	Verified Self-Report	Vital Records
Enrollment Self-Report			
r	1.00		
p			
n	200		
Verified Self-Report			
r	**.91**	1.00	
p	**<.0001**		
n	**179**	250	
Vital Records			
r	**.75**	**.70**	1.00
p	**<.0001**	**<.0001**	
n	**42**	**32**	63

r =Spearman correlation coefficient
p=probability *p* is significant at alpha <.05, 2-sided test;
n=number of participants included in the correlation analysis. For correlations, the *n* is determined by the number of participants that have measures on both values being compared.
Bolded figures are significant.

To compare the difference between self-reported birth weights and those found from vital records, paired *t* tests were performed and the results are displayed in Table 7. For participants for whom vital records and verified self-reported data could be obtained, a comparison between their birth weight collected from vital records and verified self-reported birth weight revealed no significant difference, paired t=0.89, p=.3792 (Table 7). Birth weights from vital records and from verified self-report were, therefore, pooled. Verified self-reported birth weights included birth weights obtained by participant from her mother or from records she had on hand, including personal copies of birth certificates, crib cards, and hospital/clinic records.

Table 7. Paired *t* Tests Between Vital Records Birth Weights, Self-Reported Birth Weights Collected at Enrollment, and Self-Reported Birth Weights That Were Verified
U.S.-Born African-American Women 38-57 Years of Age

Birth Weight Source	*n*	Mean Difference, g (*SD*, g)	Paired *t* *(df)*	*p*
Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment),	42	0.28(.848)	2.12 (41)	.0400
Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	*32*	*0.16(1.02)*	*0.89 (31)*	*.3792*
Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	179	-0.06(.607)	-1.40 (178)	.1618

Note. The birth weight variable used in the analysis is italicized. The *n* for each paired *t* test includes women for whom both test categories of birth weight source was available. Birth weight from all three sources were available for 21 women. Total *N* does not add up to 281 since some participants had only one birth weight measure; these participants could not be included in *t* test analyses. Verified self-reported birth weights were based on what the participant learned from her mother or other relative or from a document that she had on hand (hospital record, crib card, family Bible, etc.
Paired *t* test between two different sources of birth weights
df = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test.

Birth weights obtained by participants from documents that they accessed were not statistically different from birth weights that the investigator obtained from vital records offices, $t(10)=1.42$, $p=.1851$ (Table 8). Similarly, there was no significant difference between vital records birth weight and birth weight data that participants obtained from their mothers, $t(5)=0.23$, $p=.8249$, or from their informed recollections, $t(10)=1.08$, $p=.3056$. The test for differences between vital records birth weights and those obtained from all other sources was based on fewer than five individuals, therefore, this test could not produce a stable *t* value.

Table 8. Comparisons of Vital Records to Self-Reported Birth Weights by Source of Birth Weight Data U.S.-Born African-American Women 38-57 Years of Age: *Cases and Controls Combined*

Source of Birth Weight	Birth Weight Comparison	Mean Difference, g (*SD*), g	*t* (*df*)	*p*
Document[a]	Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment)	153 (418)	0.97 (6)	.3702
	Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	64 (263)	1.42 (10)	.1851
	Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	**103 (187)**	**-2.32 (61)**	**.0237**
Mother	Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment)	1,604 (638)	0.05 (2)	.9635
	Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	462 (403)	0.23 (5)	.8249
	Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	64 (270)	0.04 (73)	.9660
Father	Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment)	---	---	---
	Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	-737 (1,042)	-1.00 (1)	.5000
	Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	302 (524))	1.00 (2)	.4226
Participant Recollection	**Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment)**	**310 (360)**	**2.44 (7)**	**.0449**
	Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	153 (471)	1.08 (10)	.3056
	Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	-77 (402)	-1.04 (29)	.3057
All Other Sources	Birth weight (Vital Records) vs. Birth weight (Self-Report at Enrollment)	73 (364)	22 (22)	.3458
	Birth weight (Vital Records) vs. Birth weight (Verified Self-Report)	326 (541)	326 (1)	.5508
	Birth weight (Self-Report at Enrollment) vs. Birth weight (Verified Self-Report)	-45 (166)	145 (9)	.4109

Note. The "Other Sources" category includes birth weight reports from other relatives, mother's friend, missing, and "Don't Know."
The total number of participants in this study was 281. If a participant had multiple sources for self-reported birth weight, only the more accurate source was used in this analysis. A source from a document superseded a mother as a source which superseded other relatives which superseded participant's informed recollection.
[a]Document: Hospital discharge papers, hospital crib card, family Bible entry, baby book, or read from personal copy of birth certificate.
df = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Table 9 presents the mean birth weight of women in the sample, based on vital records and self report data. In particular, mean birth weight for the combined sample (cases and controls, n=281) was 3,079 g (6.8 pounds), SD=593.0 g, with a range from 1,020 g to 4,564 g (Table 9). There was no significant difference between birth

weight for cases (*M*=3,046 g (6.7 pounds), *SD*=680.8 g) and controls (*M*=3,095 g (6.8 pounds), *SD*=543.9 g, *p*=.5380 (Table 9).

Table 9. Mean Birth Weights: Vital Records and Self-Report
U.S.-Born African-American Women 38-57 Years of Age

	All	Cases	Controls		
Birth Weight Source	Mean (*SD*), g Min/Max	Mean (*SD*), g Min/Max	Mean (*SD*), g Min/Max	Paired *t* *(df)*	*p*
Birth weight (Vital Records)	3,301(470.1) 2,183-4,507 *n*=63	3,272(572.2) 2,183-4,507 *n*=22	3,317(412.1) 2,268-4,082 *N*=41	-0.33 (33)	.7421
Birth weight, (*Verified Self-Report*)	3,054(622.7) 1,020-4,705 *n*=250	3,016(716.0) 1,020-4,634 *n*=85	3,069(569.0) 1,049-4,705 *N*=165	-0.64 (140)	.5224
Birth weight (combination of Vital Records and Verified Self-Report)	*3,079(593.0)* *1,020-4,564* *n=281*	*3,046(680.8)* *1,020-4,564* *n=95*	*3,095(543.9)* *1,049-4,535* *N=186*	*-0.62* *(157)*	*.5380*

Note. 2,500 g = 5 pounds, 8 ounces; 3,200 g ~ 7 pounds; 4,100 g ~ 9 pounds
The birth weight variable used in the analysis is italicized.
There was overlap among the different birth weight variables given that some participants self-reported birth weights at enrollment and/or verified self-reported birth weights through follow-up communication and/or an official birth weight obtained from vital records or State Centers for Health Statistics.
The *n*'s represent the number of participants for whom a birth weight from a specific source could be obtained. The totals *n*'s exceed 281 because birth weights were obtained for some participants from more than one source.
For the analyses, vital records birth weights were used, where available. Where vital records birth data were not available, verified birth weights were used.
Women for whom only a birth weight at enrollment was obtained were not included in this total of 281 participants; they were excluded from the study.
Satterthwaite *t* test for unequal sized groups; *df* = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test.

Mean birth weight by category of birth weight (low, normal, high) for cases and controls combined is presented in Table 10. Variability among low birth weight and normal birth weight births was low (*SD*=397 g and 361 g, respectively). Table 11 sorts the sample by case-control status into three categories of birth weights: low, normal and high. The birth weight for the majority of cases (*n*=70, 74%) and controls (*n*=155, 83%) was considered "normal" weight (Table 11). Among the 281 participants in the study, 18 cases (19%) and 25 controls (13%) were born low birth weight, while seven cases (7%) and six controls (3%) were born high birth weight. These differences were not statistically significant, $\chi^2(2)=4.3$, *p*=.1159.

The sizes of the subsamples of participants whose birth weights were categorized as "high" or "low" compared to those whose birth weights were categorized as "normal" weight were so small that the validity of results between any of these birth weight groups would be questionable. Among the 63 participants for whom vital record birth weights were obtained, three cases (14%) and two controls (5%) were born low birth weight. This subsample was too small to determine whether the differences between cases and controls in terms of low birth weight were significant.

Table 10. Mean, Minimum and Maximum Birth Weight by Birth Weight Category
U.S.-Born African-American Women 38-57 Years of Age, *Cases and Controls Combined*

Category of Birth Weight	*N*	Mean(*SD*), g	Min-Max, g
Low Birth Weight[a]	43	2,122(397)	1,020-2,494
Normal Birth Weight[b]	225	3,190(361)	2,502-4,025
High Birth Weight[c]	13	4,321(194)	4,082-4,564

Note. Data are based on pooled vital records and verified self-reported birth weights.
[a]Low birth weight defined as <2,500 g at birth; [b]Normal birth weight defined as 2,500-4,000 g; [c]High birth weight defined as >4,000 g at birth
2,500 g = 5 pounds, 8 ounces; 4,000 g ~ 9 pounds; 1,020 g ~ 2.25 pounds; 4,564 g ~10 pounds

Table 11. Frequencies: Low Birth Weight, Normal Birth Weight, High Birth Weight by Diabetes Status
U.S.-Born African-American Women 38-57 Years of Age

Category of Birth Weight	All		Cases		Controls	
	n	(%)	*n*	(%)	*n*	(%)
Low Birth Weight[a]	43	(15%)	18	(19%)	25	(13%)
Normal Birth Weight[b]	225	(80%)	70	(74%)	155	(83%)
High Birth Weight[c]	13	(5%)	7	(7%)	6	(3%)
Total	281		95		186	

Note. All data are based on pooled vital records and verified self-reported birth weights. Total cases, *n*=95 and total controls, *n*=186
[a]Low birth weight defined as <2,500 g at birth (5 pounds, 8 ounces) 5 pounds
[b]Normal birth weight defined as between 2,500 g and 4,000 g (5 pounds, 8 ounces to ~9 pounds)
[c]High birth weight defined as >4,000 g at birth (~9 pounds)
[c]Rounding resulted in total different from 100%.
χ^2 was generated when comparing cases and controls among three levels of birth weights: low, normal, and high; $\chi^2(2)=4.3$, $p=.1159$; *df* = degrees of freedom
p is significant at $\alpha<.05$, 2-sided test

Birth weight data and participant pregnancy outcomes are presented in Table 12. Twenty percent of the cases (*n*=15) and 4% of the controls (*n*=5) reported

having gestational diabetes. This difference was statistically significant ($\chi^2[1]=14.27$, $p=.0002$).

Table 12. Frequencies: History of Gestational Diabetes or Delivering a Baby Greater than Nine Pounds U.S.-Born African-American Women 38-57 Years of Age

Variable	All		Cases		Controls		$\chi^2(df)$	*P*
	n	(%)	*n*	(%)	*n*	(%)		
Gestational diabetes during pregnancy[a]	**20**	**(7%)**	**15**	**(20%)**	**5**	**(4%)**	**14.27 (1)**	**.0002**
Delivered baby who weighed over 9 pounds at birth[b]	**31**	**(11%)**	**19**	**(24%)**	**10**	**(7%)**	**12.11 (1)**	**.0005**
Gestational diabetes and/or baby over 9 pounds[c]	**44**	**(16%)**	**28**	**(13%)**	**14**	**(10%)**	**20.36 (1)**	**<.0001**

Note. Frequencies do not include women who never delivered a baby.
All information in this table was by self-report.
[a]*N*=219
[b]*N*=209
[c]*N*=219
df = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

Current Body Weight and Height Measurements and BMI

All current adult body measurements were taken by the investigator at the time of enrollment; the descriptive statistics are shown in Table 13. Current adult body measurements and indices, including current weight, body mass index (BMI), and blood pressure were significantly greater for cases than for controls (Table 13). There was no significant difference for height. Height, along with current body weight, was used to calculate BMI.

Mean body weight of sample participants (*n*=281) was 91 kg, *SD*=24.63 kg, range=49 kg to 252 kg (Table 13). Cases were significantly heavier than controls, 100 kg versus 85 kg, *p*=.0001. Mean BMI for the sample was 34, *SD*=9.3, range=19 to 82 (Table 13). Mean BMI for case was 38, compared to a mean BMI of 32 for controls. A BMI of above 30 signifies obesity. Therefore, even though cases, on average, were more obese than controls (*p*=.0001), both groups, on average, are considered obese. Cases weighed more than controls at age 25 years based on

weights reported by the study participants (Table 14). For cases, mean self-reported weight at 25 years was 70 kg (*SD*=21.5 kg) compared to a mean of 63 kg, (*SD*=12.9 kg) for controls. (In terms of pounds, weights for cases and controls were 154 and 139 pounds, respectively.) This difference was significant, p=.0015. (Note: The median weight at age 25 for this sample was 60 kg. For cases, the median weight at age 25 was 64 kg [141 pounds], while for controls, it was 59 kg [130 pounds]).

There were strong-to-weak significant associations among several indicators for obesity. Notably, waist measured at the smallest diameter and its corresponding waist-to-hip ratio were moderately associated with one another, r =.62, p<.0001. Waist at smallest diameter was strongly associated with BMI (r =.90, p<.0001), while waist-to-hip ratio and BMI were weakly associated (r =.34, p<.0001). It should be noted that waist-to-hip ratio is an indicator for abdominal obesity, a measure that was hypothesized for this study as elevating the risk for type 2 diabetes among the study participants. Waist-to-hip ratio is discussed below in more detail.

Table 13. Mean, Minimum and Maximum Blood Pressure and Current Body Measurements U.S.-Born African-American Women 38-57 Years of Age

	All *n*=281	Cases *n*=95	Controls *n*=186		
Actual Measurement	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* *(df)*	*p*
Current weight, kg	**91(24.6) 49-252**	**100(27.5) 54-252**	**85(21.6) 49.1-185**	**4.43 (154)**	**<.0001**
Body mass index	**34(9.3) 20-82**	**38(10.9) 21-82**	**32(7.5) 20-61**	**5.08 (140)**	**<.0001**
Systolic blood pressure, mm Hg	**128(17.1) 93-204**	**133(17.5) 101-186**	**126(16.3) 92-204**	**3.47 (178)**	**.0006**
Diastolic blood pressure, mm Hg	79(9.7) 53-108	79(9.8) 53-105	79(9.5) 57-105	0.60 (194)	.5467
Height, cm	163(7.6) 113-184	162(8.2) 113-179	163(7.2) 138-184	-1.37 (169)	.1715

Note. Body mass index is calculated by dividing weight in kilogram by height in meters squared.
49 to 252 kg = 108 to 554 pounds
Satterthwaite *t* test for groups of unequal size
df = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

Table 14. Mean, Minimum and Maximum Self-Reported Weight at Age 25 Years
U.S.-Born African-American Women 38-57 Years of Age

	All *n*=277	Cases *n*=94	Controls *n*=183		
Self-Reported Measurement	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* *(df)*	*p*
Weight at 25 years, kg	**65(16.7) 38-159**	**70(21.5) 40-159**	**63(12.9) 38-114**	**3.23 (128)**	**.0015**

Note. Questionnaire item: "About how much did you weigh ***when you were 25 years of age?*** ___ pounds"
Participants who did not respond to this questionnaire item were not included in the calculation.
38 to 159 kg = 84 to 350 pounds
Satterthwaite *t* test for groups of unequal size.
df = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Self-Reported Physician Diagnosis of High Blood Pressure Versus Measured Systolic Blood Pressure

The literature identified blood pressure as a covariate of type 2 diabetes and other chronic diseases. Table 15 compares two types of information: (1) information based on self-reports of a physician diagnosis of high blood pressure and (2) measurements collected at the time of enrollment in the study. At enrollment we measured high blood pressure based on systolic and diastolic blood pressures. Table 15 shows that 38% percent of the participants had a self-reported physician diagnosis of high blood pressure. The results in Table 15 indicate that a majority of cases (62%) were more likely than controls (25%) to have had a self-reported physician diagnosis of high blood pressure, $\chi^2(1)=34.7$, $p<.0001$. In addition, 68% of the participants overall had elevated measured systolic blood pressure levels ($\geq$120 mm Hg; Table 15). Moreover, cases (79%) were more likely than controls (63%) to have had elevated measured systolic blood pressure levels, $\chi^2(1)=7.48$, $p=.0062$. Although 46% of the participants had elevated measured diastolic blood pressure levels ($\geq$80 mm Hg), the difference in the prevalence of elevated measured diastolic blood

pressure levels between cases (51%) and controls (44%) was not statistically significant, $\chi^2(1)=1.05$, $p=.3057$.

It is important to look at the difference between measured diastolic and measured systolic blood pressure levels. Twenty percent of the participants had high measured systolic blood pressure levels (≥140 mm Hg). Cases (32%) were significantly more likely than controls (14%) to have had a high measured systolic blood pressure level, $\chi^2(1)=12.2$, $p=.0005$. Overall, 14% of the participants had high measured diastolic blood pressure levels (≥90 mm Hg). The difference in the prevalence of high measured diastolic blood pressure levels between cases (14%) and controls (13%) was not statistically significant, $\chi^2(1)=0.00$, $p=.9550$.

Table 15. Comparing Self-Report of a Physician Diagnosis of High Blood Pressure to Measured Elevated and Measured High Blood Pressure Based on Systolic and Diastolic Blood Pressures Collected at Enrollment, by Diabetes Status
U.S.-Born African-American Women 38-57 Years of Age

Blood Pressure Category	All *n*=281	Cases *N*=95	Controls *n*=186	$\chi^2(df)$	*p*
	n(%)	*n*(%)	*n*(%)		
Self-Reported HBP[a]	**102 (38)**	**57 (62)**	**45 (25)**	**34.70(1)**	**<.0001**
Elevated SBP (≥120 mm Hg)[b]	**192 (68)**	**75 (79)**	**117 (63)**	**7.48(1)**	**.0062**
High SBP (≥140 mm Hg)[c]	**56 (20)**	**30 (32)**	**26 (14)**	**12.20(1)**	**.0005**
Elevated DBP (≥80 mm Hg)[b]	130 (46)	48 (51)	82 (44)	1.05(1)	.3057
High DBP (≥90 mm Hg)[c]	38 (14)	13 (14)	25 (13)	0.00(1)	.9550

Note. Systolic and diastolic blood pressures were measured directly by investigator. Self-reported high blood pressure was collected by the questionnaire completed by the participants.
[a]HBP, High Blood Pressure from Self-Report of Physician Diagnosis
[b]SBP, Systolic Blood Pressure: 120 mm Hg is the cut-point for pre-hypertension; 140 mm Hg is the cut-point for hypertension.
[c]DBP, Diastolic Blood Pressure: 80 mm Hg is the cut-point for pre-hypertension; 90 mm Hg is the cut-point for hypertension.
df = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

Table 16 presents a comparison of self-reported physician diagnosis of high blood pressure and measured diastolic blood pressure levels at enrollment. Note that

in this table the cases and controls are combined for ease of discussion. Fifty-nine percent of the participants with a reported physician diagnosis of high blood pressure had measured diastolic blood pressure levels ≥80 mm Hg, while 36% who reported no physician diagnosis of high blood pressure had elevated diastolic blood pressure levels, $\chi^2(1)=13$, $p=.0003$ (Table 16). Overall, 84% of the participants who reported a physician diagnosis of high blood pressure had measured systolic blood pressure levels ≥120 mm Hg, while 58% who reported no physician diagnosis of high blood pressure had elevated measured systolic blood pressure levels, $\chi^2(1)= 21$, $p<.0001$. Perhaps this discrepancy between self-report of a physician diagnosis and blood pressure measured upon enrollment into the study could have been a result of a participant memory lapse of earlier diagnosis or simply due to measurement error by a health care professional who may or may not have followed standard procedure for collecting blood pressure. As a result, systolic blood pressure (as opposed to self-

Table 16. Self-Reported Physician Diagnosis of High Blood Pressure and Elevated and High Blood Pressure Defined Using Categorized Systolic and Diastolic Blood Pressures Measured at Enrollment: U.S.-Born African-American Women 38-57 Years of Age, *Cases and Controls Combined*

Measured Blood Pressure	All	Self-Report of Physician Diagnosis of HBP,[a] Yes	Self-Report of Physician Diagnosis of HBP,[a] No	$\chi^2(df)$	*p*
	n=270 *n*(%)	*N*=183 *n*(%)	*n*=87 *n*(%)		
Elevated SBP (≥120 mm Hg)[b]	**183(68)**	**86(84)**	**97(58)**	**21(1)**	**<.0001**
High SBP (≥140 mm Hg)[c]	**52(20)**	**37(36)**	**15(9)**	**31(1)**	**<.0001**
Elevated DBP (≥80 mm Hg)[b]	**121(46)**	**60(59)**	**61(36)**	**13(1)**	**.0003**
High DBP (≥90 mm Hg)[c]	**35(14)**	**24(24)**	**11(7)**	**16(1)**	**<.0001**

Note. Systolic and diastolic blood pressures were measured directly by investigator. Self-reported high blood pressure were collected by questionnaires completed by participants. Eleven participants for whom self-reported physician diagnosis of high blood pressure could not be collected were excluded from this analysis. The comparisons were based on participants for whom both a measured SBP or DBP and a self-reported physician diagnosis of high blood pressure were available. The self-reported questionnaire item was the limiting factor given that measured blood pressures were collected on all participants.

[a]HBP, High Blood Pressure

[b]SBP, Measured Systolic Blood Pressure: 120 mm Hg is the cut-point for pre-hypertension; 140 mm Hg is the cut-point for hypertension.

[c]DBP, Diastolic Blood Pressure: 80 mm Hg is the cut-point for pre-hypertension; 90 mm Hg is the cut-point for hypertension.

df = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

reported physician diagnosis of high blood pressure) was used in the statistical models because systolic blood pressure is a direct measure, is continuous, and may be more accurate than self-report of a physician diagnosis of high blood pressure. In addition, Systolic and diastolic blood pressures were moderately correlated for the 281 study participants, $r = .72$, $p < .0001$. Diastolic blood pressure was not included in any logistic or linear statistical models because of multicollinearity; that is, this measure highly correlates with the systolic blood pressure.

Health History

For health history, cases and controls differed significantly on a number of variables, including hypertension, premenopausal status, twin status, and family history of diabetes $p < .05$ (Table 17). Cases were more likely than controls to have had these conditions, except for premenopausal status, where controls were more likely than cases to have had one menstrual period within the past 12 months.

Table 17. Frequencies: Health History Variables from Self-Reported Data
U.S.-Born African-American Women 38-57 Years of Age, *N*=281

Health History	All *n*(%)	Cases *n*(%)	Controls *n*(%)	$\chi^2(df)$	*p*
High blood pressure	**102(38%)**	**57(62%)**	**45(25%)**	**34.5(1)**	**<.0001**
Premenopausal status[a]	**144(52%)**	**33(36%)**	**111(60%)**	**13.8(1)**	**.0002**
Family history of diabetes	**186(66%)**	**76(80%)**	**110(59%)**	**12.2(1)**	**.0005**
Twin[b]	**11(4%)**	**4(7%)**	**7(2%)**	**4.6(2)**	**.0329**
Breastfed as infant or child	95(41%)	39(49%)	56(37%)	2.9(1)	.0865
Premature birth[b,c]	28(10%)	15(16%)	13(7%)	6.4(2)	.4025

Note. All data in this table were by self-report. The frequencies displayed in this table are for women who answered "Yes" to the questionnaire item.
[a]"Had at least one period within past 12 months" is an indicator for premenopausal status.
[b]Unreported values for twin status *n*=3. Unreported values for premature status, *n*=31 (12%).
[c]Self-reported prematurity collected from two questionnaire items: (1) Yes/No to question as to whether participant was born premature and (2) number of months or weeks of gestation.
df = degrees of freedom; *p* is significant at $\alpha < .05$, 2-sided test. Bolded figures are significant.

Table 18 presents prevalence of medication use for diabetes among women in the sample. The majority of participants (66%) reported current use of medication (Table 18). Thirty-four percent of all participants reported no current use of

medication. Controls (51%) were more likely than cases (2%) to have reported no current use of medication, $p<.0001$. (Note: Cases who took no medication for diabetes reported that they controlled their diabetes with exercise and/or diet alone or that they were not complying with the medical orders of their health care provider.) Fifty-three percent of the cases and 17% of the controls reported current use of medications for high blood pressure. This difference was significant, $p<.0001$. More cases (72%) than controls (44%) reported current use of medications for other than diabetes or hypertension. This difference was significant, $p<.0001$.

Table 18. Frequencies: Medication Use Among Cases and Controls
U.S.-Born American Women 38-57 Years of Age, *N*=281

Type of Medication	All, *n*(%)	Cases, *n*(%)	Controls, *n*(%)[a]	$\chi^2(df)$	*p*
Medication-free	**92(34)**	**2(2)**	**90(51)**	**66.24(1)**	**<.0001**
Medication use:					
Blood pressure medications	**81(30)**	**51(53)**	**30(17)**	**39.03(1)**	**<.0001**
Other medications	**146(53)**	**69(72)**	**77(44)**	**20.14(1)**	**<.0001**

Note. Medication measures by self-report. Some participants presented medication containers for investigator to copy names of drugs. Percentages do not sum to 100% because current users of blood pressure medications may or may not have been taking other medications. Other medications included those for asthma, arthritis, allergies, etc. Medication use was collected on 95 cases and 177 controls.
[a]Medication was not reported for nine controls.
df = degrees of freedom; *p* is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Fasting Plasma Glucose

Fasting plasma glucose is used in the screening and diagnosis of diabetes. Elevated fasting glucose levels ($\geq$126 mg/dL) are considered abnormal and indicate diabetes. Fasting glucose levels below 100 mg/dL are considered normal. For those with type 2 diabetes, the goal for good plasma glucose control is to approach the normal level of below 100 mg/dL.

Mean fasting plasma glucose for those with type 2 diabetes in this study was 147 mg/dL, *SD*=54.7 mg/dL. This was significantly higher than for study controls

whose mean fasting plasma glucose was 97 mg/dL, *SD*=12.8 mg/dL, *p*<.0001 (Table 19).

Of those who were classified as controls for the study (*n*=186), 15% had fasting plasma glucose levels equal to or greater than 100 mg/dL, but less than 126 mg/dL as measured at enrollment. This range designates *prediabetes*.

Table 19. Fasting Plasma Glucose
U.S.-Born African-American Women 38-57 Years of Age

	All[a] *N*=253	Cases[a] *n*=71	Controls[a] *n*=182		
Blood Measurement	Mean (*SD*) mg/dL	Mean (*SD*) mg/dL	Mean (*SD*) mg/dL	*t* *(df)*	*p*
Fasting plasma equivalent glucose	**115(60.2)**	**147(54.7)**	**97(12.8)**	**7.61 (73)**	**<.0001**

Note. Plasma Glucose was tested by investigator at enrollment using Hemocue 201 Glucometer.
Satterthwaite *t* test for groups of unequal size
[a]Fasting plasma glucose was not collected on 24 cases and 4 controls at their initial enrollment sessions. Cases were not required to have a fasting plasma glucose. The four controls for whom a fasting plasma glucose was not collected at the initial session had a fasting glucose test at a subsequent visit. Only fasting plasma glucose results from initial enrollment were used in this analysis.
d*f* = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

Waist and Hip Measurements and Waist-to-Hip Ratio

Mean waist circumference, at smallest diameter, for cases was 105 cm, *SD*=19.0 cm, significantly greater than mean waist circumference at smallest diameter for controls, 91 cm, *SD*=15.4 cm, *p*<.0001 (Table 20). Mean waist-to-hip ratio using waist measurement at smallest diameter and hip at largest circumference was significantly greater for cases (*M*=0.84, *SD*=0.070) than for controls (*M*=0.79, *SD*=0.062), *p*<.0001. Abdominal obesity in women is defined as a waist-to-hip ratio above 0.80. On average, both cases and controls had abdominal obesity, though the extent of abdominal obesity for cases was 5% greater than for controls. Fifty percent of the sample had a waist-to-hip ratio greater than 0.80. This translates to 68% percent of cases and 41% of controls with abdominal obesity.

An additional waist measurement, waist one inch above the umbilicus, was collected in the current study. Waist measured at the smallest diameter and waist measured one inch above the umbilicus were highly correlated, $r = .96$, $p < .0001$, for the 251 women for whom both measures were collected. Waist-to-hip ratio using the two different measures of waist circumference were also associated, $r = .80$, $p < .0001$. Mean waist circumference measured one inch above the umbilicus, was not included in the statistical models because this measure was not collected on all participants.

Table 20. Mean, Minimum and Maximum Current Circumference Measurements and Waist-to-Hip Ratio. U.S.-Born African-American Women 38-57 Years of Age

	All	Cases	Controls		
Waist and Hip Measurements	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* *(df)*	*p*
Waist, smallest diameter, cm[a]	**96(18.0) 60-168 *n*=281**	**105(19.0) 75-168 *n*=95**	**91(15.4) 60-148 *n*=186**	**6.28 (159)**	**<.0001**
Waist, above umbilicus, cm[b]	**101(20.0) 59-168 *n*=251**	**111(19.6) 76-168 *n*=87**	**96(18.4) 59-158 *n*=164**	**5.76 (166)**	**<.0001**
Hip, cm	**119(17.8) 86-197 *n*=281**	**126(19.7) 91-197 *n*=95**	**116(15.6) 86-176 *n*=186**	**4.52 (156)**	**<.0001**
Waist-to-hip ratio, smallest diameter	**0.80(0.068) 0.57-1.1 *n*=281**	**0.84(0.070) 0.67-1.1 *n*=95**	**0.79(0.062) 0.57-0.96 *n*=186**	**5.61 (171)**	**<.0001**
Waist-to-hip ratio, above umbilicus	**0.84(0.079) 0.57-1.2 *n*=251**	**0.88(0.070) 0.71-1.1 *n*=87**	**0.83(0.078) 0.57-1.2 *n*=164**	**5.59 (198)**	**<.0001**

Note. 60 cm = 24 inches; 197 cm = 78 inches
[a]Waist at smallest diameter according to standards in Lohman, Roche & Martorell, 1988[117]
[b]Waist at 2.54 cm (1") above umbilicus measured according to procedures used by Folsom et al, 2001[22] and Anderson et al, 2001[126]
d*f* = degrees of freedom; *p* is significant at $\alpha < .05$, 2-sided test. Bolded figures are significant.

The waist-to-hip measures were transformed from ratios to percentages. This resolved the challenge of obtaining an inflated odds ratio for waist-to-hip ratio for the logistic regression model. "The interpretation of odds of the continuous variable is that as the independent variable changes by one unit, the dependent variable changes by the magnitude of the odds" (Min Qi Wang, Professor of Biostatistics, Department of Public and Community Health, University of Maryland, College Park. Private

correspondence, October 2006).[127] With the non-transformed waist-to-hip ratio data, the difference between the largest value and the smallest value was less than one. Per Wang, the recommended solution was to change the score by multiplying it by 100, to obtain a percent measure. Transforming the waist-to-hip ratio to a percentage did not alter the odds ratios for any other variable in the model.

Participants with a Self-Reported Physician Diagnosis of Type 2 Diabetes

Table 21 presents information on a number of factors related to the diagnosis of diabetes for 95 women in the sample. The first panel of the table presents the mean age at diabetes diagnosis, followed by the weight status of the woman at diagnosis. The next two panels of the table present information on the duration of diabetes and methods used to control diabetes. There were 95 participants with a physician diagnosis of type 2 diabetes. The mean age at diagnosis for type 2 diabetes was 44 years (*SD*=8 years), with a range of age at diagnosis from 17 to 57 years. Only four (4%) of the cases were diagnosed with type 2 diabetes before the age of 30 years.

Eighty-eight percent of the cases reported being overweight at the time of diagnosis (Table 21). This report by participants of being overweight was based on their subjective determination of overweight; participants may or may not have been aware that overweight is defined as a BMI 25 to 29.9. Based on actual measurements made by the investigator, 81% of the cases were categorized as obese (defined as a BMI $\geq$30) at the time of enrollment. This percentage of obesity at enrollment for cases based on current measurements was significantly greater than the 58% obesity rate at enrollment for controls, p=.0006.

The majority of the 95 cases (71%) reported taking oral hypoglycemic medications and more than one quarter (26%) of all cases took insulin to control blood glucose. In total, 77 (88%) of the cases reported using some form of hypoglycemic agent. Fifteen percent of the cases had no prescription for diabetes medications as indicated on their screening questionnaire. The discrepancy between total cases who reported hypoglycemic agent use on the screening questionnaire and the total who reported no use of hypoglycemic agents at enrollment was the result of the multiple ways information on diabetes medication use was collected from participant (screening questionnaire versus verbal report at time of blood glucose test during enrollment).

Seventy-eight percent of the cases used a diet or diet plan, 68% exercised, and 62% reported weight loss as part of their regimen to control their blood glucose levels. (They may or may not have lost weight.) Three percent of the cases reported using an alternative treatment, including controlling stress or taking herbs and/or vitamins. Many cases reported using more than one method for controlling their diabetes (Table 21). Some cases reported that though their health care providers had prescribed various lifestyle changes, they had not begun making these changes or had stopped following their doctor's orders.

Table 21. Means, Medians, and Frequencies for Diabetes-Related Variables U.S.-Born African-American Women 38-57 Years of Age, *with Type 2 Diabetes, n*=95		
Mean Age, Diagnosis and Years Duration of Diabetes	Mean (*SD*)	Min-Max
Age at diagnosis of type 2 diabetes, years	44.4 (8.0)	17-57
Year first diagnosed	1998 (6.6)	1967-2005
Duration of type 2 diabetes, years	6.2[a] (6.6)	<1 yr to 38
Frequencies: Self-Reported Overweight at Diagnosis, Duration, and Methods for Controlling Diabetes, *n*=95		
Weight at diagnosis (Based on participant's definition)[b,c]		
Overweight		88%
Normal weight		11%
Underweight		1%
Duration of diabetes[d]		
5 years or less		59%
5.1 to 10 years		25%
10.1 to 15 years		8%
15.1 to 20 years		4%
20.1 to 38 years		4%
Methods for controlling diabetes[e]		
Oral diabetes medications		71%
Insulin		26%
Diet change/Diet Plan		78%
Exercise (strenuous, 3 times per week)[f]		68%
Lose weight		62%
Other		3%

Note. All information in this table was from self-report.
BMI, Body Mass Index. Obesity defined as BMI ≥30. Overweight defined as BMI >25 but less than 30.
[a]One extreme value increased mean and standard deviation for diabetes duration.
[b]Weight at diagnosis for 10 participants with diabetes was not collected. (That is, weight at diagnosis was not found on their questionnaire).
[c]This table displays overweight, normal weight, or underweight as self-reported by participant. Obesity is based on observed measures was 81% for cases and 58% for controls.
[d]Duration of diabetes was not collected for 2 participants with diabetes.
[e]Methods for controlling diabetes was not collected for 2 to 7 participants.
[f]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"

Study Hypotheses: Logistic Regression Analyses

The hypotheses used to answer three of the research questions are as follow:

Hypothesis 1: Birth weight is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

Hypothesis 2: Abdominal obesity, in terms of waist-to-hip ratio, is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

Hypothesis 3: Birth weight and abdominal obesity interact in their association with type 2 diabetes in African-American women 38 to 57 years of age.

Results for Hypotheses 1 to 3 are reported as odds ratios. Chi square (χ^2) test results are reported for comparisons between cases and controls for non-continuous variables and *t* tests are reported for continuous variables. Degrees of freedom for *t* tests, correlations, and χ^2 are presented in parentheses next to the statistic. Logistic regression analyses were repeated after the removal of the case with the most extreme value of current body weight and body mass index. Given that the odds ratio results were similar to when this case was included, the original results with this case included are presented.

Independent variables chosen to be analyzed for inclusion in the model were selected based on the diabetes literature previously discussed in this dissertation. (See Chapters 1 and 2 of this dissertation.) Enter was the selection method used for the logistic regressions. The Hosmer and Lemeshow Goodness-of-Fit test statistic is reported for logisitic regression. A Goodness-of-Fit test statistic of $\leq$.05 indicates a rejection of the null hypothesis that there is no difference between the observed and predicted values of the dependent variable. If this statistic is >.05, the null hypothesis that there is no difference is not rejected. Therefore, the conclusion would be that the data fit the specified model.

Model Testing

The initial logistic regression model tested was as follows:

The natural log of (DIABETES/1-DIABETES) = β_0*Intercept + β_1*BW + β_2*WHR + β_3*PERIOD + β_4*HBP + β_5*WT25 + β_6*GDM + β_7*AGE + β_8*FAMILY HX +

β_9*EDUCATION + β_{10}*SMOKING + β_{11}*STRENUOUS PHYSICAL ACTIVITY + β_{12}*TWIN+ β_{13}*BMI + β_{14}*TWIN + β_{15}*PREMATURE.

Key: DIABETES = probability of having type 2 diabetes; 1-DIABETES = probability of not having type 2 diabetes; BW = birth weight; WHR = waist-to-hip ratio; PERIOD = menopausal status; HBP = high blood pressure; WT25 = weight at age 25 years; GDM = gestational diabetes; AGE = age at enrollment; FAMILY HX = family history of diabetes; EDUCATION = education level attained; SMOKING = current smoker; STRENUOUS PHYSICAL ACTIVITY = strenuous physical activity; TWIN = born a twin; BMI = body mass index; PREMATURE = born premature.

Single Covariate Testing

Each indicator variable was assessed to discover its relationship with type 2 diabetes and was used as a baseline model, not taking into account covariates (Table 22). Covariates such as current smoker and prematurity status were excluded at this stage because they were not significant. Big baby and the combination of birth weight and big baby were redundant with gestational diabetes and therefore were not included. Although age and premenopausal status were highly correlated, neither variable was dropped from the model at this point because the investigator needed to assess their relationships for this sample. Twin status was not included in the model given that only 11 of the 281 participants (4%) reported being born a twin. This number included seven cases and four controls.

Although it was not significant, birth weight was retained for the next stage of model testing because it was part of the hypothesis being tested. Other variables retained for model testing at this stage were abdominal obesity, systolic blood

pressure, gestational diabetes, weight at age 25 years, BMI, age, premenopausal status, family history of diabetes, strenuous physical activity, and college education.

Table 22. Model Testing: Odds Ratios for 16 Single Independent Variables
U.S.-Born African-American Women 38-57 Years of Age

Covariate	Cases *n*	Controls *n*	Odds Ratio	95% Confidence Interval	*p*
Birth Weight	95	186	1.00	1.00, 1.00	.5064
Abdominal Obesity[a] (WHR*100)	**95**	**186**	**1.12**	**1.07, 1.17**	**<.0001**
Gestational Diabetes[b]	**95**	**186**	**6.79**	**2.39, 19.3**	**.0003**
Big Baby[b]	**95**	**186**	**5.00**	**2.24, 11.1**	**<.0001**
Gestational Diabetes/Big Baby Combined Variable[b]	**95**	**186**	**5.67**	**2.83, 11.4**	**<.0001**
Body Mass Index (BMI)	**95**	**186**	**1.09**	**1.05, 1.12**	**<.0001**
Premenopausal[b,c]	**91**	**185**	**0.38**	**0.23, 0.64**	**.0003**
Weight at age 25, kg[b]	**94**	**183**	**1.03**	**1.01, 1.05**	**.0005**
Age[b]	**95**	**186**	**1.08**	**1.03, 1.13**	**.0006**
Family History of Diabetes[b]	**95**	**186**	**2.76**	**1.55, 4.94**	**.0006**
Systolic Blood Pressure	**95**	**186**	**1.03**	**1.01, 1.04**	**.0008**
College Education[b]	**95**	**186**	**0.46**	**0.26, 0.82**	**.0076**
Strenuous Physical Activity[b,d]	**94**	**186**	**0.50**	**0.29, 0.84**	**.0089**
Twin[b]	**94**	**184**	**3.62**	**1.03, 12.7**	**.0445**
Current Smoker[b]	95	183	2.10	0.98, 4.51	.0569
Premature[b]	95	186	1.09	0.95, 1.24	.2280

[a]Abdominal obesity is defined as WHR >0.80. Another measure of abdominal obesity used for women is waist circumference >88 cm; WHR, waist-to-hip ratio. Overall obesity is indicated by a BMI ≥30. A BMI between 25 and 25.9 is considered overweight. A BMI between 18 and 24.9 is considered normal. A BMI < 18 is considered underweight.[26]
[b]Self-reported data: Data not reported on questionnaire for 0-3 participants.
[c]Participants were asked if they had had a period within 12 months. Having had a period for more than 12 months is an indicator for premenopausal status.
[d]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"
p is significant at α<.05, 2-sided test. Bolded figures are significant.

Birth Weight and Abdominal Obesity with an Additional Covariate

The next step for model testing was to run an analysis that included both birth weight and abdominal obesity (Table 23). The remaining covariates were entered into the model to ascertain their contributions to the model that examined the associations between birth weight, abdominal obesity, and type 2 diabetes.

Table 23. Odds Ratios from 10 Logistic Regression Models with Birth Weight and Abdominal Obesity, Plus an Additional Covariate (BMI, Age, Gestational Diabetes, Premenopausal Status, Weight at Age 25, Family History of Diabetes, Strenuous Physical Activity, Systolic Blood Pressure, College Education, Twin)
U.S.-Born African-American Women 38-57 Years of Age

Covariate	Odds Ratio	95% Confidence Interval	*p*	χ^2 Goodness of Fit Test (*df*), *p*
Body Mass Index (BMI)	**1.06**	**1.03, 1.10**	**.0002**	**8.35(8), .4001**
Age	**1.08**	**1.03,1.13**	**.0002**	**6.89(8), .5490**
Gestational Diabetes[a]	**9.81**	**3.23, 29.8**	**.0003**	**6.60(8), .5805**
Premenopausal Status[a,b]	**0.36**	**0.21, 0.62**	**.0003**	**16.46(8), .0363**
Weight at age 25 years, kg[a,c]	**1.03**	**1.01, 1.05**	**.0026**	**8.62(8), .3753**
Family History of Diabetes[a]	**2.35**	**1.27, 4.34**	**.0062**	**11.69(8), .1654**
Strenuous Physical Activity[a,d]	**0.56**	**0.32, 0.98**	**.0406**	**9.43(8), .3070**
Systolic blood pressure	1.02	1.00, 1.03	.0553	10.16(8), .2540
College Education[a]	0.58	0.32, 1.06	.0761	9.34(8), .2761
Twin[a]	2.58	0.67, 9.92	.1665	11.68(8), .1662

Note. Number of cases and controls for each covariate was as follows: Premenopausal: 91 cases, 185 controls; Weight at age 25: 94 cases, 183 controls; Strenuous physical activity: 94 cases, 186 controls; Twin: 94 cases, 184 controls. Birth weight, Abdominal obesity, BMI, Age, Gestational diabetes, Family history of diabetes, Systolic blood pressure and, College education, 95 cases and 186 controls.

[a]Self-reported data

[b]Participants were asked if they had had a period within the last 12 months. Having had a period within the last 12 months is an indicator for premenopausal status.

[c]Questionnaire item: "About how much did you weigh ***when you were 25 years of age?***___ pounds"

[d]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"

The Hosmer and Lemeshow χ^2 Goodness of Fit Test examines the strength of the model to explain the relationship between the dependent variable and the independent variables.

Enter was the selection method used.

p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Several variables in Table 23 were found to be statistically significant in predicting the odds of having type 2 diabetes among African-American women. In particular, the covariates that made significant contributions to a model that included birth weight and abdominal obesity were body mass index, age, gestational diabetes, premenopausal status, weight at age 25 years, family history of diabetes, and strenuous physical activity (Table 23). Systolic blood pressure, college education, and twin were excluded because their odds ratios were not statistically significant (Table 23).

Gestational diabetes was excluded as a candidate covariate for the final model because it had a relatively wide confidence interval (*OR*=9.81, *CI*=3.23, 29.8,

p=.0003), an indication of an unstable point estimate which may have been attributed to the small number of participants who had gestational diabetes. In fact, only 15 (16%) of the cases and five (3%) of the controls out of 95 and 186 cases and controls, respectively, reported having had gestational diabetes.

Selecting the Most Powerful Model

The final step was to select the most powerful model for determining the odds of having type 2 diabetes. A series of logistic regression analyses were conducted that began with an analysis that included all nine covariates that remained from the previous stage of analysis. These variables were birth weight, abdominal obesity, body mass index, age, gestational diabetes, premenopausal status, weight at age 25 years, family history of diabetes, and strenuous physical activity. The Hosmer and Lemeshow Goodness-of-Fit test reveals the strength of a model to go beyond the data. In other words, this test ascertains the ability of the model for future studies to explain the odds of having the outcome variable. In this study, the outcome variable is type 2 diabetes.

Table 24 reveals the results of a series of logistic regression analyses where one or two covariates were removed. Including the nine covariates listed below in the model resulted in a χ^2 Goodness-of-Fit statistic of 10.4(8), *p*=.2391. Given the wide confidence interval for gestational diabetes, the investigator began by removing it from the model. Removing gestational diabetes from the model increased the power of the model (χ^2[8]=4.58, *p*=.8010). The most powerful model involved removing strenuous physical activity (χ^2[8]=2.35, *p*=.9685); however, when both gestational diabetes and strenuous activity were removed, the model's power decreased

(χ^2[8]=9.13, p=.3316). Therefore, the final model that was selected included eight of the nine covariates that independently explained the association between birth weight, abdominal obesity, and type 2 diabetes. When weight at age 25 years was not removed from the model, the result was one of the weakest of the models, second only to the model where age was removed (χ^2[8]=11.4, p=.1787).

Table 24. Linear Regression Analyses for Explaining Type 2 Diabetes. Covariates: Body Mass Index, Age, Gestational Diabetes, Premenopausal Status, Weight at Age 25 Years, Family History of Diabetes, Strenuous Physical Activity
U.S.-Born African-American Women 38-57 Years of Age

Covariate *Removed*	Cases *n*	Controls *n*	χ^2 Goodness of Fit Test (*df*)	*p*
Strenuous Physical Activity[a,d]	90	182	2.35(8)	.9685
Gestational Diabetes[a]	89	182	4.58(8)	.8010
Body Mass Index (BMI)	89	182	5.00(8)	.7579
Family History of Diabetes[a]	89	182	5.20(8)	.7360
Premenopausal Statusa,[b]	93	182	6.29(8)	.6141
Gestational Diabetes, Strenuous Physical Activity	90	182	9.13(8)	.3316
None	90	182	10.4(8)	.2391
Weight at age 25 years, kg[a,c]	90	182	10.5(8)	.2313
Age	89	182	11.4(8)	.1787

Note. Numbers of cases and controls for each covariate were as follow: Premenopausal: 91 cases, 185 controls; Weight at age 25: 94 cases, 183 controls; Strenuous physical activity: 94 cases, 186 controls; Twin: 94 cases, 184 controls. Birth weight, Abdominal obesity, BMI, Age, Gestational diabetes, Family history of diabetes, Systolic blood pressure and, College education, 95 cases and 186 controls.
[a]Self-reported data
[b]Participants were asked if they had had a period within 12 months. Having had a period for more than 12 months is an indicator for premenopausal status.
[c]Questionnaire item: "About how much did you weigh ***when you were 25 years of age?***___ pounds"
[d]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"
The Hosmer and Lemeshow χ^2 Goodness of Fit Test examines the strength of the model to explain the relationship between the dependent variable and the independent variables. A Goodness-of-Fit test where p>.05 signifies that the data fit the model; p values closest to 1.0 are better fits.
Enter was the selection method used; p is significant at α<.05, 2-sided test.

The results from the final logistic regression model for examining the associations between birth weight, abdominal obesity, and type 2 diabetes, revealed that abdominal obesity and family history of diabetes were significant contributors to the ability of the logistic regression model to explain the relationship between the covariates and type 2 diabetes in African-American women (Table 25). For every 1% increase in waist-to-hip ratio, there was an 8% increase in odds of type 2 diabetes,

OR=1.08, 95% *CI*=1.03, 1.13, *p*=.0014. Having a family history of diabetes increased the odds of type 2 diabetes 2.43 times that of women with no history of gestational diabetes, 95% *CI*=1.24, 4.76, *p*=.0149. The odds of having type 2 diabetes was not explained by body mass index, *OR*=1.00; 95% *CI*=1.00, 1.00, *p*=.0096.

Table 25. Final Logistic Regression Model: Relationship Between Type 2 Diabetes, Birth Weight, and Abdominal Obesity, Controlling for Covariates, Including Body Mass Index, Age, Gestational Diabetes, Premenopausal Status, Weight at Age 25 Years, Family History of Diabetes, Strenuous Physical Activity

U.S.-Born African-American Women, 38-57 Years of Age

Covariate	Odds Ratio	95% Confidence Interval	*p*
Abdominal Obesity (WHR*100)	**1.08**	**1.03, 1.13**	**<.0001**
Family History of Diabetes[a]	**2.43**	**1.24, 4.76**	**.0149**
Body Mass Index (BMI * 100)	**1.00**	**1.00, 1.00**	**.0096**
Premenopausal[a,b]	0.55	0.24, 1.01	.0548
Age	1.06	0.99, 1.13	.0899
Strenuous Physical Activity[a,c]	0.61	0.33, 1.13	.1163
Weight at Age 25 Years[a]	1.02	0.99, 1.04	.1892
Birth Weight	1.00	1.00, 1.00	.1902

Note. Eighty-nine cases and 182 controls were included in this analysis; WHR, waist-to-hip ratio.
[a]Self-reported data.
[b]Participants were asked if they had had a period within 12 months. Not having had a period for more than 12 months is an indicator for postmenopausal status.
[c]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"
[d]Questionnaire item: "About how much did you weigh ***when you were 25 years of age?*** ___ pounds"
Likelihood Ratio Test: 73.4(1), $p<.0001$
Hosmer and Lemeshow Goodness-of-Fit Test: $\chi^2(8)=4.58$, $p=.8010$
The Hosmer and Lemeshow χ^2 Goodness of Fit Test examines the strength of the model to explain the relationship between the dependent variable and the independent variables.
Enter was the selection method used.
p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Other covariates included in the final model that did not independently contribute to the ability of the model to explain the odds of having type 2 diabetes were age, weight at 25 years, premenopausal status, and strenuous physical activity. Birth weight was not shown to independently contribute to the power of this regression model to determine the odds of having type 2 diabetes. The Hosmer and Lemeshow Goodness-of-Fit test indicated that the overall logistic regression model fit

the observed data well, $\chi^2(8)=4.58$, $p=.8010$. Again, when the Goodness-of-Fit test statistic has a p value of >.05, the implication is that the model has the power to examine associations using data beyond that of the current study; that is, using data from similar studies.

Fasting Plasma Glucose by Birth Weight and Abdominal Obesity

The fourth, and final hypothesis addressed by the current study is as follows: **Hypothesis 4:** Among African-American women without a physician diagnosis of type 2 diabetes and with fasting plasma glucose levels <126 mg/dL (controls), there is an association among birth weight, abdominal obesity, and fasting plasma glucose level.

To test Hypothesis 4, a multiple linear regression analysis was conducted to examine the association between fasting plasma glucose and the explanatory variables of the final logistic model described above that explored the association of these variables with type 2 diabetes. The multiple linear regression analysis involved the use of actual fasting blood glucose levels, not self-reported physician diagnosis of type 2 diabetes. In addition to birth weight and abdominal obesity, the covariates included in the model were weight at age 25 years, body mass index, family history of diabetes, age, premenopausal status, strenuous physical activity. Only the 186 women without a reported physician diagnosis of type 2 diabetes were included in the analysis.

Table 26 shows that the independent variables help to explain 16% of the variability in the regression model. That is, 16% of the variation in fasting plasma glucose between cases and controls was attributable to this multiple linear regression

model (R^2=.16, p=.0002, Table 26). The two independent variables that were statistically significant were weight at age 25 years and body mass index (BMI). The negative sign suggests that lower weight at age 25 reduces the odds of developing type 2 diabetes. In contrast, the positive sign on the BMI variable indicates that the odds of contracting this disease increase as BMI increases.

Table 26. Multiple Linear Regression Analysis of Fasting Plasma Glucose Examining the Association Among Birth Weight, Abdominal Obesity, and Covariates (Body Mass Index, Age, Premenopausal Status, Weight at Age 25 Years, Family History of Diabetes, and Strenuous Physical Activity)
U.S.-Born African-American Women, 38-57 Years of Age, *Controls, Only* (*N*=181)

Variable	*df*	Parameter estimate	Std Error	*t* value	*p*
Intercept	**1**	**106.0**	**17.0**	**6.22**	**<.0001**
Weight at Age 25 Years	**1**	**-0.38**	**0.1**	**4.04**	**<.0001**
Body Mass Index (BMI*100)	**1**	**0.01**	**0.0**	**-4.58**	**<.0001**
Family History of Diabetes	1	2.94	1.9	-1.56	.1200
Age	1	-0.21	0.2	1.03	.3039
Premenopausal Status	1	2.03	2.4	-0.85	.3982
Strenuous Physical Activity	1	0.95	1.9	-0.50	.6164
Birth Weight	1	0.00	0.0	-0.42	.6716
Abdominal Obesity (WHR*100)	1	-.054	0.2	0.34	.7337

Note. This analysis was based on data collected on 181 of the 186 controls. Five controls with no response to a questionnaire items(family history of diabetes, premenopausal status, weight at age 25 years, and/or strenuous activity) were not include in this analysis.
WHR, waist-to-hip ratio
Enter was the selection method used.
R^2=.16; adjusted R^2=.12; $F(8,172)$=3.65, p=.0002
d*f* = degrees of freedom; p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

A Focus on Low Birth Weight Participants

Descriptive statistics for continuous variables for low birth weight participants are presented in Tables 27 to 30. Forty-three participants (15%) had birth weights <2,500 g (5 pounds, 8 ounces). Low birth weight cases were significantly older than low birth weight controls, M=52 years, SD=4.6 years versus 48 years, SD=5.9 years, $t(40.8)$=2.21, p=.0259. There was no statistically significant difference between the mean birth weight of low birth weight cases (n=18) and low birth weight controls (n=25), $t(28.5)$=1.71, p=.5134. However, there was a significant difference in the mean waist-to-hip ratio of low birth weight cases and low birth weight controls,

t(28.2)=5.61, *p*=.0208 (Table 27). Comparison between low birth weight cases and low birth weight controls showed no significant differences in terms of history of gestational diabetes, premenopausal status, family history of diabetes, strenuous physical activity level, and education. Finally, among low birth weight participants, cases had significantly higher mean fasting plasma glucose than did controls *t*(13.4)=2.18, *p*=.0475 (Table 30).

Table 27. Mean, Minimum and Maximum Age, Current Circumference Measurements *Among Low Birth Weight (<2,500 g) Women:*
U.S.-Born African-American Women 38-57 Years of Age, *N*=43

	All *n*=43	Cases *n*=18	Controls *n*=25		
Waist and Hip Measurements	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* *(df)*	*p*
Waist, smallest diameter, cm[a]	97(20.9) 70-168	104(24.3) 76-168	92(17.0) 70-146	1.71 (28.5)	.0985
Hip, cm	119(18.5) 91-160	123(18.5) 91-160	117(16.3) 91-157	0.92 (30.4)	.3668
Waist-to-hip ratio, smallest diameter	**0.81(0.073) 0.69-1.1**	**0.84(0.083) 0.75-1.1**	**0.79(0.057) 0.69-0.93**	**5.61 (28.2)**	**.0208**

Note. 70 to 168 cm = 28 to 66 inches
[a]Waist at smallest diameter according to standards in Lohman, Roche & Martorell, 1988 [171]
Satterthwaite *t* test for groups of unequal size
d*f* = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

Table 28. Mean, Minimum and Maximum Current Body and Blood Pressure Measurements *Among Low Birth Weight (<2,500 g) Women*
U.S.-Born African-American Women 38-57 Years of Age, *N*=43

	All, *n*=43	Cases, *n*=18	Controls, *n*=25		
Measurement	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* *(df)*	*p*
Current weight, kg	90.6(24.6) 49-252	94(30.4) 56-174	86(24.5) 49-156	.89 (31.7)	.3813
Height, cm	163(7.6) 113-184	159(8.2) 113-179	160(7.2) 149-171	-.64 (21.9)	.5257
Body mass index	34(9.3) 20-82	39(15.5) 22-81	33(8.6) 21-59	1.31 (24.5)	.2023
Systolic blood pressure, mm Hg	128(17.1) 93-204	137(18.9) 101-166	126(13.2) 103-152	1.95 (28.4)	.0611
Diastolic blood pressure, mm Hg	79(9.7) 53-108	80(9.7) 64-965	808.9) 62-100	-0.22 (39.6)	.8244

Note. All measurements in this table were collected at the time of enrollment by the investigator.
49 to 252 kg = 108 to 554 pounds
113 to 184 cm = 44 to 72 inches
Satterthwaite *t* test for groups of unequal size
df = degrees of freedom; *p* is significant at α<.05, 2-sided test.

Table 29. Mean, Minimum and Maximum Self-Reported Weight at Age 25 *Among Low Birth Weight (<2,500 g) Women*
U.S.-Born African-American Women 38-57 Years of Age, *N*=43

	All, *n*=43	Cases, *n*=18	Controls, *n*=25		
Variable	Mean (*SD*), Min-Max	Mean (*SD*) Min-Max	Mean (*SD*) Min-Max	*t* (*df*)	*p*
Weight at 25 years, kg	65(16.7) 45-159	67(25.4) 46-159	63(14.8) 45-100	0.57 (25.3)	.5723

Questionnaire item: "About how much did you weigh ***when you were 25 years of age?*** ___ pounds"
45 to 159 kg = 99 to 350 pounds
Satterthwaite *t* test for groups of unequal size.
df = degrees of freedom; *p* is significant at α<.05, 2-sided test.

Table 30. Mean Fasting Plasma Glucose[a] *Among Low Birth Weight (<2,500 g) Women:*
U.S.-Born African-American Women 38-57 Years of Age, *N*=43

	All *n*=36	Cases *n*=12	Controls *n*=24		
Variable	Mean (*SD*) mg/dL	Mean (*SD*) mg/dL	Mean (*SD*) mg/dL	*t* *(df)*	*p*
Fasting plasma equivalent glucose (FPG)	**115(60.2)**	**121(37.3)**	**96(17.4)**	**2.18 (13.4)**	**.0475**

Note. Comparing cases to controls: Six cases had no FPG. One control had no FPG for this comparision, but a FPG was collected on her at a subsequent visit.
[a]Fasting Plasma Glucose tested by investigator at enrollment using the Hemocue 201 Glucometer.
FPG (fasting plasma-equivalent glucose)
Satterthwaite *t* test for groups of unequal size
df = degrees of freedom; *p* is significant at α<.05, 2-sided test. Bolded figures are significant.

The results from the logistic regression model for examining the associations for type 2 diabetes among low birth weight participants (*n*=43) revealed that family history of diabetes was independently associated with type 2 diabetes in African-American women (Table 31). For women who were born with low birth weight, having a family history of diabetes increased the odds of having type 2 diabetes by 1.22, *OR*=1.22, 95% *CI*=1.02, 1.48, *p*=.0345. Other variables in the model included self-reported weight at age 25, current weight, age, body mass index, premenopausal status, abdominal obesity, and birth weight. These are the same variables that comprised the final logistic model used when examining the full range of birth weights (*n*=281).

This model could not be utilized for participants who were born with a high birth weight because of the small size of that subsample (*n*=8 cases and 6 controls). Any estimates from such a small sample size would be unstable and not useful.

Table 31. Logistic Regression Model: Relationship Between Type 2 Diabetes, Birth Weight, and Abdominal Obesity, Controlling for Covariates, Including Body Mass Index, Age, Gestational Diabetes, Premenopausal Status, Weight at Age 25 Years, Family History of Diabetes, Strenuous Physical Activity
U.S.-Born African-American Women, 38-57 Years. of Age, *Low Birth Weight (<2,500 g) Women, N*=43

Covariate	Odds Ratio	95% Confidence Interval	*p*
Family History of Diabetes[a]	**1.22**	**1.02, 1.48**	**.0345**
Age	0.23	0.04, 1.32	.1005
Premenopausal[a,b]	1.00	1.00, 1.00	.2031
Body Mass Index (BMI * 100)	2.84	0.24, 19.18	.2836
Abdominal Obesity (WHR*100)	1.08	0.38, 1.26	.3151
Strenuous Physical Activity[a,c]	1.00	1.00, 1.00	.8742
Birth Weight	0.88	0.14, 5.61	.8933
Weight at Age 25 Years[a]	1.00	0.94, 1.06	.9717

Note. All 18 cases and 25 controls with low birth weights were included in this analysis;
WHR, waist-to-hip ratio.
[a]Self-reported data.
[b]Participants were asked if they had had a period within 12 months. Not having had a period for more than 12 months is an indicator for postmenopausal status.
[c]Strenuous Physical Activity questionnaire item: "Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?"
[d]Questionnaire item: "About how much did you weigh ***when you were 25 years of age?*** ___ pounds"
Likelihood Ratio Test: 16.4(8), *p*=.0365
Hosmer and Lemeshow Goodness-of-Fit Test: $\chi^2(9)=6.13$, *p*=.7266
The Hosmer and Lemeshow χ^2 Goodness of Fit Test examines the strength of the model to explain the relationship between the dependent variable and the independent variables.
Enter was the selection method used.
p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

The results from a series of logistic regression analyses using individual independent variables revealed that abdominal obesity was a significant factor for explaining the odds of having type 2 diabetes among African-American women (Table 32). For every 1% increase in waist-to-hip ratio, there was a 1.15 increase in the odds of type 2 diabetes (*OR*=1.15, 95% *CI*=1.01, 1.29, *p*=.0303). In other words,

among African-American women who were born low birth weight, waist-to-hip ratio was found to provide some explanation of the difference in odds of having type 2 diabetes. Age was also statistically significant in explaining the odds of type 2 diabetes among this group of women. For every one year increase in age, there was a 1.16 increase in the odds for having type 2 diabetes (*OR*=1.16, 95% *CI*=1.00, 1.34, *p*=.0446). As with the model developed for the full sample and described above (*n*=281), birth weight was not a significant contributor to the model that was developed for women born with low birth weight (*n*=43).

Other covariates from the model developed using the full sample (*n*=281) were not included in this model developed for women with low birth weight (*n*=43). There are several reasons for this. The first is that as the sample size decreases, a large number of independent variables may increase the error of the estimate. Another reason is that a series of logistic regression analyses for women born low birth weight resulted in models that were not statistically significant when family history of diabetes, BMI, strenuous physical activity, weight at age 25, and premenopausal status were also included.

Table 32. Logistic Regression Model: Relationship Between Type 2 Diabetes and Abdominal Obesity, Controlling for Age
U.S.-Born African-American Women, 38-57 Years of Age, *Low Birth Weight (<2,500 g) Women,: N*=43

Independent Variable	Odds Ratio	95% Confidence Interval	*P*
Abdominal Obesity (WHR*100)	**1.15**	**1.01, 1.29**	**.0303**
Age	**1.16**	**1.00, 1.34**	**.0446**
Birth Weight	1.00	1.00, 1.00	.6746

Note. All 18 cases and 25 controls with low birth weights were included in this analysis.
WHR, waist-to-hip ratio
Likelihood Ratio Test: 11.3(3), p=.0102
Hosmer and Lemeshow Goodness-of-Fit Test: $\chi^2(9)=8.53$, p=.4817
The Hosmer and Lemeshow χ^2 Goodness of Fit Test examines the strength of the model to explain the relationship between the dependent variable and the independent variables.
p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

Highlighting Participants for Whom Vital Records Birth Weights Were Obtained

Most of the results presented above involved the final sample (N=281). The final sample of pooled participants consisted of individuals with birth weights obtained from vital records and those verified through secondary self-report. Specifically, at enrollment, all participants were asked to self report their birth weights. The protocol required that these self-reported birth weights be confirmed with birth weights obtained from vital records offices. However, it turned out that vital records data were not available for the majority of respondents. Therefore, participants were asked to confirm their self-reported birth weights with a second source (i.e. mother, birth certificate, another family member, etc.) For 63 respondents, self-reported birth weights were compared to birth weights obtained from vital records to assess whether birth weights from different sources could be pooled.

The following are results for those participants for whom vital records birth weight data were obtained (n=63). These participants are referred to as the *vital records sample* in this section of the results.

The mean age for women for whom vital records birth weights were obtained was 49 years (SD=5.4 years). Among these participants with vital records birth weights, cases (n=22) were significantly older (M=52 years, SD=4.1 years) than controls (M=48 years, SD=5.6 years), t(55.2)=3.02, p=.0038. Among the vital records subsample, there was no significant difference between the cases (M=3,272 g, SD=572.2 g) and the controls (M=3,317 g, SD=412.1g) in terms of birth weight, t(33)= -0.33, p=.7421. The majority (87%) of the vital records subsample was normal weight at birth (n=55), eight percent were born low birth weight (n=5), and five percent were born high birth weight (n=3).

Mean current body weight for the vital records sample was 99.2 kg (SD=24.65 kg) for cases and 88.8 kg (SD=24.65) for controls. The difference in current body weight was not significant, t(37.6)=2.94, p=.1039. Mean waist-to-hip ratio for cases (M=0.81, SD=.079) was significantly greater than for controls (M=0.79, SD=.068), p=.0056. Likewise, mean fasting plasma glucose for cases (M=165 mg/dL, SD=15.5 mg/dL) was significantly greater than for controls (100 mg/dL, SD=13.9 mg/dL), t(15.3)=2.87, p=.0115. Systolic blood pressure approached significance, t(45.1)=2.01, p=.0625, with mean systolic blood pressure for cases (M=134 mm Hg, SD=15.5 mm Hg) significantly higher than that for controls (M=125 mm Hg, SD=16.3 mm Hg), t(45.1)=2.01, p=.0502. There were no significant differences between cases and controls when examining body mass index, t(35.7)=1.87, p=.0692, or diastolic blood pressure, t(49.5)=0.76, p=.4488.

Table 33 fits the final model (discussed earlier in the Model Testing section) to the data obtained from the vital records subsample (n=63). The Goodness-of-Fit

Test indicated that the overall logistic regression model fit the observed data for the vital records birth weight subsample (Goodness-of-Fit $\chi^2[8]=14.0$, $p=.0816$) and that, therefore, the model was acceptable for examining associations between type 2 diabetes, birth weight, and abdominal obesity. In other words, knowing a woman's age and her abdominal obesity helps to explain the odds of her contracting type 2 diabetes: for every one year increase in age, there was a 20% increase in the odds of having type 2 diabetes, *OR*=1.20, 95% *CI*=1.02, 1.42, $p=.0266$). Abdominal obesity also contributed independently to this model: for every 1% increase in waist-to-hip ratio, there was a 12% increase in odds of type 2 diabetes in, *OR*=1.20, 95% *CI*=1.00, 1.26, $p=.0482$). Therefore, when examining the 63 participants for whom vital records data were obtained, the hypothesis stating that type 2 diabetes is associated with abdominal obesity holds.

Table 33. Logistic Regression Model: Relationship Between Type 2 Diabetes, Birth Weight, and Abdominal Obesity, Controlling for Covariates, Including Body Mass Index, Age, Gestational Diabetes, Premenopausal Status, Weight at Age 25 Years, Family History of Diabetes, Strenuous Physical Activity
U.S.-Born African-American Women, 38-57 Years, of Age *Participants for Whom Vital Records Birth Weights Were Obtained, N=63*

Covariate	Odds Ratio	95% Confidence Interval	*p*
Age	**1.20**	**1.02, 1.42**	**.0266**
Abdominal Obesity, WHR*100	**1.12**	**1.00, 1.26**	**.0482**
Family History of Diabetes[a]	4.79	0.89, 25.7	.0681
Weight at Age 25 Years[a]	1.03	0.96, 1.10	.3764
Birth Weight	1.00	1.00, 1.00	.4392
Strenuous Physical Activity[a,c]	0.66	0.17, 2.56	.5439
Premenopausal[a,b]	0.83	0.17, 4.10	.8229
Body Mass Index (BMI * 100)	1.00	1.00, 1.00	.8680

Note. WHR, waist-to-hip ratio. Sixty-two of 63 women for whom vital records birth weights could be obtained (22 cases and 40 controls) were included in this analysis.
[a]Self-reported data
[b]Participants were asked if they had had a period within 12 months. Having had a period for more than 12 months is an indicator for premenopausal status.
Likelihood Ratio Test: $\chi^2(8)=23.5$, $p=.0028$
Hosmer and Lemeshow Goodness-of-Fit Test: $\chi^2(8)=14.0$, $p=.0816$.
p is significant at $\alpha<.05$, 2-sided test. Bolded figures are significant.

When we tried to examine the same hypothesis to a sample of women for whom we could obtain vital records *and* who had low birth weights, the percentage

was less than 10%. Specifically, only five (8%) of the 63 participants for whom vital records data were obtained had birth weights <2,500 g (5 pounds, 8 ounces). Three were cases and two were controls. This number of low birth weight participants among participants for whom vital records were obtained was too small to detect a significant difference between cases and controls in terms of the relationship of abdominal obesity to type 2 diabetes. Therefore, the hypothesis could not be tested for the vital records subsample of low birth weight women.

Fasting Plasma Glucose Among Cases: Hypoglycemic Use

Among the 95 cases from the full sample of 281 participants, 52 used oral medications and no insulin, six used insulin and no oral medications, 14 used both oral medications and insulin, and 14 controlled their blood glucose levels by diet and exercise alone. Two cases had stopped taking diabetes medications per the order of their physician, while three stopped contrary to the order of their physician. Table 34 shows that among cases, there was no significant difference in mean fasting plasma glucose levels between those who used hypoglycemic agents to control their glucose levels (mean fasting plasma glucose=149 mg/dL, *SD*=57.8 mg/dL) and those who did not use hypoglycemic agents (mean fasting plasma glucose=140 mg/dL, *SD*=42.4 mg/dL, *p*=.4960).

Table 34. Mean Fasting Plasma Glucose by Hypoglycemic Agent Use,[a]
U.S.-Born African-American Women 38-57 Years of Age, *Cases, Only*

	All Cases[b] *n*=67	Diabetes Medications Used, *n*=52	Diabetes Medications Not Used, =15		
	Mean (*SD*),	Mean (*SD*)	Mean (*SD*)	*t* *(df)*	*p*
Fasting Plasma Glucose, mg/dL	147(54.7)	149(57.8)	140(42.4)	.069 (30.7)	.4960

[a]Hypoglycemic Agent Use was by self-report.
[b]Four cases were not included because no hypoglycemic medication use data were obtained on them. Twenty cases were not included because no fasting plasma glucose measurement collected on them.
df = degrees of freedom; *p* is significant at α<.05, 2-sided test.

Among the cases for whom fasting plasma glucose was collected, 31 (44%) had fasting plasma glucose levels <126 mg/dL, while 40 (56%) had elevated fasting plasma glucose levels. This revealed that approximately half of the cases had elevated fasting plasma glucose levels regardless of whether they received treatment with oral hypoglycemic medications, insulin, or with exercise and/or diet.

Summary of Results for the 281 Participants, Including Subsamples

The final model used to test associations of various covariates with type 2 diabetes in a sample of 281 African-American women 38 to 57 years of age included birth weight, waist-to-hip ratio, family history of diabetes, weight at age 25 years, strenuous activity level, age, body mass index, and premenopausal status (measured by self-report of having had a menstrual cycle at least once in the past 12 months). This model held similar results for the subsample of 63 participants for whom vital records birth weights were obtained.

Hypothesis 1: Birth weight is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

This hypothesis was not supported in the current study.

Hypothesis 2: Abdominal obesity, in terms of waist-to-hip ratio, is independently associated with type 2 diabetes in African-American women 38 to 57 years of age.

The current study found that waist-to-hip ratio, an indicator for abdominal obesity, was associated with type 2 diabetes for African-American women 38 to 57 years of age.

Hypothesis 3: Birth weight and abdominal obesity interact in their association with type 2 diabetes in African-American women 38 to 57 years of age.

This hypothesis was not supported by the study for the full spectrum of birth weights. However, when restricting the logistic regression analysis to women who were born low birth weight, *n*=43, low birth weightcases were 1.15 times more likely than low birth weight controls to have developed abdominal obesity, (95% *CI*=1.01, 1.29, *p*=.0250; Table 32). In other words, those who were born low birth weight and developed type 2 diabetes had higher waist-to-hip ratios (abdominal obesity) than those who had not developed type 2 diabetes. It follows that those who were born small and who then developed abdominal obesity later in life were more likely to have type 2 diabetes. Thus, for the women in the current study who were born low birth weight, *n*=43, the theory of the fetal origins of chronic disease (born small, grew large = higher risk for chronic diseases) in terms of the outcome of type 2 diabetes in African-American women was supported.

Hypothesis 4: Among African-American women without a self-reported physician diagnosis of type 2 diabetes and with a measured fasting plasma glucose levels <126 mg/dL, there is a clear association among birth weight, abdominal obesity, and fasting plasma glucose level.

The multiple linear regression model that included birth weight and waist-to-hip ratio explained 13% of the variation in fasting plasma glucose levels among the study controls (*n*=185). However, birth weight and waist-to-hip ratio did not independently contribute to this model. Independently, they were not statistically significant in explaining the difference in fasting plasma glucose levels among controls (the women in the study who did not have type 2 diabetes).

Chapter 5: Discussion and Conclusions

The overall purpose of the current study was to better understand factors that influence type 2 diabetes among African-American women born between 1946 and 1964 who were 38 to 57 years of age at the time of enrollment. This project began by examining the fetal origins of chronic disease (specifically type 2 diabetes) among African-American women, utilizing birth weights from vital records and directly measuring current weight, height and waist and hip circumferences. In addition, fasting plasma glucose was examined in greater detail.

This discussion begins with a comparison between findings from the current study and previous studies. Issues raised regarding vital records birth weights are then addressed. Next, vital records birth weights for the United States and the District of Columbia are presented. The issue of utilizing verified self-reported birth weight for the current study is also discussed. The findings on abdominal obesity as it relates to type 2 diabetes are highlighted. This is followed by a look at obesity in African-American women. Next, the relationship between birth weight, abdominal obesity, and type 2 diabetes is discussed as is the relationship between birth weight, abdominal obesity, and fasting plasma glucose. Finally, a discussion of undiagnosed diabetes and blood pressure in African-American women is presented. This chapter is capped with a list of the study limitations and strengths. It ends with recommendations for future investigators and practitioners.

The first hypothesis of this case-control study stated that birth weight is independently associated with type 2 diabetes in African-American women 38 to 57 years of age. Like the cohort study by Lithell and associates[85] that looked at the

relationship between size at birth and type 2 diabetes in Swedish-born men aged 50 to 60 years of age, the current study was unable to support the hypothesis that birth weight is independently associated with type 2 diabetes. Lithell and associates[85] obtained birth weights from hospital records for 718 of their 1585 (45%) participants. Diabetes status was based on blood glucose cut-points and drug treatment for diabetes. Lithell and associates[85] found that the prevalence of diabetes at age 60 years was 8% in men whose birth weights were less than 3,250 g (~7 pounds) compared to 5% in men with birth weights 3,250 g or more; however, this difference was not significant (95% *CI* for difference -.03% to 6.8%, p=.08). This Swedish study[85] did find a difference in the prevalence of diabetes for those at the lowest fifth of ponderal index (12%) compared to those in the other four-fifths of ponderal index (4%), 95% *CI*=3.0%, 12.6%, p=.001. The current study did not measure ponderal index because birth lengths were not available.

Although findings in this study were similar to those in the Swedish study,[85] not all studies on birth weight and type 2 diabetes came to the same conclusions with respect to no significant association between these two variables. The Rich-Edwards and associates[33] study involving nearly 70,000 women 30 to 70 years of age who were part of the Nurses' Health Study found contradicting results to the current study. They found that when controlling for age, women who were born small (<2.50 kg) had an increased risk for developing type 2 diabetes compared to the reference group (birth weight 3.16 to 3.82 kg). The Relative Risk was 1.55 (95% *CI*=1.32, 1.83, p<.0001) for those born 2.25 to 2.48 kg and 1.88 (95% *CI*=1.59, 2.21, p=.0001) for those born less than 2.25 kg. Although the Rich-Edwards and associates[33] study used

self-reported data for type 2 diabetes, birth weight, and current weight, height, waist and hip circumferences, their large sample size yielded a relatively stable estimate. However, the Rich-Edwards study[33] did not focus on African-American women: their study involved a sample that was approximately 95% European-American. In contrast, this current study included only African-American women who fell within a relatively narrow age range (38 to 57 years). This study confirmed the Rich-Edwards findings in that among the current study's sample, individuals in the small subgroup who were born small and who then developed abdominal obesity later in life were more likely to have type 2 diabetes. It is possible that the relationships between birth weight, abdominal obesity, and type 2 diabetes would have been less ambiguous for this current study if fewer participants from the current study's original sample of 376 had not been excluded due to lack of a verified birth weight. This issue is discussed in more detail below.

Despite their large sample size, Rich-Edwards and associates[33] did not measure adominal obesity: they used the self-report of study participants. It is possible that the interaction of birth weight and abdominal obesity is truly the factor that explains a significant proportion of cases of type 2 diabetes rather than low birth weight alone. Without considering this interaction, Rich-Edwards and associates[33] overlooked the possibility that low birth weight may be simply a proxy measure for adominal obesity. This has great implications given that 15% of the current study's participants were born low birth weight (<2,500 grams) and 50% were categorized as having abdominal obesity.

There are many methodological differences between the current study and the two studies cited above. The Swedish study[85] involved men only and the Nurses' Health Study[33] involved primarily European-American women. Despite the availability of birth weights obtained from hospital records, Lithell and associates[85] did not find an association between birth weight and type 2 diabetes. Rich-Edwards and associates[33] did find an association between these two variables, but they divided birth weight into categories in which birth weight differences ranged from one-half kilogram (500 g, or one-half pound) to one and one-half kilogram (a range of 1,500 g, or one and one-half pound). This current study utilized three categories of birth weights that followed the standard cut-points for low birth weight, normal birth weight, and high birth weight. Given the relatively small sample size of this study, a larger number of birth weight categories would serve to reduce further the power of the statistical analyses.

A study by Fall and associates[14] examined the relationship between size at birth, maternal weight, and type 2 diabetes in 506 Asian-Indian men and women, aged 39 to 60 years. They defined type 2 diabetes as "already known to have Type 2 diabetes" or as having a 120-minute glucose concentration of $\geq$11.1 mmole/liter. Two investigators collected all current body measurements used in their study. Birth weights were obtained from one hospital in Mysore, South India. As with the current study, the prevalence of type 2 diabetes in the Fall and associates[14] study was not shown to be related to birth weight, unadjusted or adjusted for age, sex, and body mass index. However, Fall and associates[14] did find that the risk for type 2 diabetes fell with increasing birth length and rose with increasing ponderal index. These

results were simlar to the Swedish study[85] where birth length was examined. Again, the current study did not collect birth lengths for the calculation of ponderal index.

A longitudinal study by McCance and colleagues[128] examined the relationship between birth weight and type 2 diabetes in 1,179 Pima Indians of Arizona, ages 20 to 39 years. Similar to to study by Rich-Edwards and associates[33], McCance and colleagues[128] found that compared to the reference group where birth weights ranged from 2,500 to 4,499 g, those who were born low birth weight (<2,500 g) were more likely to have type 2 diabetes, *OR*=3.81, 95% *CI*=1.70, 8.52, *p*=.001. Those with high birth weights (>4,500 g) were not more likely to have type 2 diabetes, when controlling for the diabetes status of their mothers during pregnancy, *p*=.269. The diabetes status during the pregnancy of the mothers of participants of this current (*n*=281) study was not available.

The current study attempted to examine the interaction of birth weight and abdominal obesity as an indicator of odds for the development of type 2 diabetes. This is the only study to date that examined this interaction in African American women specifically. However, the question regarding the relationship between low birth weight, abdominal obesity, and type 2 diabetes could not be answered definitively as the results were mixed, depending on the subsample examined. For the full spectrum of birth weights (*n*=281), the investigator was unable to uncover any interaction between birth weight, abdominal obesity, and type 2 diabetes, if such an interaction exists. For the subsample of 43 participants who were born low birth weight, results confirmed those of the study by Rich-Edwards and associates[33] for women in the current study with low birth weights who developed abdominal obesity

later in life, the odds of having type 2 diabetes was 1.22 times greater than for those who did not develop abdominal obesity.

Vital Records and Verified Self-Reported Birth Weight for Study Sample

Initally, vital records birth weight information was to be collected for each study participant. Unfortunately, official birth weights could not be obtained for the majority of study participants because the technology for data storage in earlier years was limited.[129] Vital records data systems now in place are more sophisticated than those available from 1946 to 1964, the years during which study participants were born. Several vital records offices retained only those parts of the birth certificates they were required by law to keep. In many instances, confidential data, including birth weights, were not captured, or when recorded, not retained due to budgetary constraints for storing and archiving large amounts of data for long periods of time.[129]

Therefore, statistical tests were conducted to compare self-reported birth weights with official birth weights for the 63 participants for whom vital records data were available. Birth weights reported at enrollment did not agree closely with vital records birth weights. However, birth weights that were reported after participants were able to refer to written documents or after they had conferred with their mothers (what is referred to in this study as "verified birth weights"), agreed closely with official birth weights. Because there was no statistically significant difference between the verified birth weights and the vital records birth weights, it was determined the verified birth weights could be used as a proxy measure for the vital records data. Thus the majority of participants for whom vital records data were not available could still be included in the study sample.

Given the small number of participants for whom vital records birth weights were obtained, the issue of the accuracy of birth weights used in this study needed to be addressed. Andersson and colleagues[39] showed poor agreement between self-reported birth weights and birth weights from original records in adult women. Checking against actual birth records, these investigators found that for self-reported birth weights, 53% were incorrect by ≥250 g (~1/2 pound) and 31% were incorrect by ≥500 g (~1 pound). Allen and associates[40] found that 25% of their 244 respondents reported their birth weight within four ounces of their official birth weight, 28% reported it inaccurately, and 47% did not know their birth weight. These investigators found that having a living mother and a low birth weight (less than six pounds or 2,722 g) increased the likelihood of the availability of a self-reported birth weight. The accuracy of self-reported birth weights was higher among those who were the youngest or the eldest child.

This current study also quantified the variability between birth weights from vital records and those from other sources. It was found that birth weights from verified sources and birth weights from vital records were correlated, $r = .70$, $p < .0001$ (Table 6).

Vital Records Birth Weight for United States and the District of Columbia

District- and national-level birth weight statistics support the investigator's focus on African Americans when addressing the issue of the fetal origins of chronic disease. First, the percentage of women in this sample who were born low birth weight (15% overall: 13% for controls and 19% for cases) parallels the percentages of African Africans who were born low birth weight during the years in which study

participants were born. Second, given that African Americans are at greater risk for being born low birth weight, if the fetal origins of chronic disease holds (where being born low birth weight and subsequently developing abdominal obesity put one at greater risk for type 2 diabetes later in life), then interventions that address low birth weight in this population may be needed even more.

A by-product of this current study was that the investigator compiled a table that shows low birth weight rates and ratios among black and white persons, by year, from 1950 to 1970 and 1972 (Table M1, Appendix M). Data on birth weights were not available at the national level before 1950; therefore, the birth weights of the study participants who were born before this date could not be placed within an historical context.

Birth weight distributions for the United States and Washington, D.C., by race for 1950 through 2001 are presented in Appendix M (Tables M1 and M2). In the United States from 1950 to 1970, the percentage of whites with low birth weight was between 6.5% to 7.2%. By comparison, for non-whites, those rates were between 10.1% and 14.4%. Between 1950 and 1970, 12.1% to 17.0% of non-white males and females who were born in the District of Columbia were born low birth weight. For whites, this range was 6% to 11% (Table MI, Appendix M). National and District of Columbia birth weight distributions and low birth weight ratios revealed that non-white, including black, persons were more likely than white persons to have been born low birth weight (ratios 1.5 to 2.1) between 1950 and 1970, years in which 79% of the participants in the current study were born. No birth weight distribution data were available between 1945 and 1949, the years in which the remaining participants

were born. In total, 85% (*n*=238) of the participants were born between 1946 and 1964, while 7% (*n*=19) were born before 1948 and 9% (*n*=24) were born between 1965 and 1970. Nationally, disparities between whites and blacks continued from 1980 to 2002 (Table M2, Appendix M).

Table M3 of Appendix M displays the population distribution of the United States and of the District of Columbia by race and Hispanic origin. It gives an historical context of the changing racial composition of the District of Columbia, compared to the population at the national level. The statistics for the District of Columbia were highlighted because of the large number of study participants who were born there.

Abdominal Obesity and Type 2 Diabetes

The second hypothesis tested in the current study stated that abdominal obesity, in terms of waist-to-hip ratio, is independently associated with type 2 diabetes in African-American women 38 to 57 years of age. The current study revealed that those with type 2 diabetes had a 1.13 odds of having abdominal obesity compared to women without type 2 diabetes (*CI*=1.08, 1.19, $p<.0001$). Similar to this current study, Okosun[17] found that abdominal obesity, based on waist circumference, was associated with an increased risk for type 2 diabetes. Okosun employed data from a nationally representative sample of 429 African-American women who participated in the Third National Health and Nutrition Examination Survey (NHANES III). His model included abdominal obesity, age, smoking, and alcohol use.

Okosun[17] found that for African-American women, the population attributable risk fraction of abdominal obesity was 39.9%. That is, nearly 40% of the risk for type 2 diabetes in African-American women could have been avoided if abdominal obesity were absent. Okosun estimated that the risk for type 2 diabetes contributed by abdominal obesity was significant, *OR*=3.85, 95% *CI*=1.41, 10.44, $p<.01$. When the model was adjusted for body mass index, the results were similar, *OR*=2.27, 95% *CI*=1.23, 4.69, $p<.01$.

Similarly, Lundgren and associates[20] found that abdominal obesity was associated with type 2 diabetes in Swedish women. These findings were confirmed by using a waist-to-hip ratio measure instead of the waist circumference measure used by Okosun. In particular, Lundgren and associates[20] found that the incidence of diabetes for women in the upper quintile of waist-to-hip ratio increased by 13.6 times compared to those in the lowest quintiles, $p<.001$.

The current study utilized waist-to-hip ratio, instead of waist circumference, as an indicator for abdominal obesity. Other investigators (for example, Folsom and associates[22]) found that waist-to-hip ratio is a better predictor for health outcomes than waist circumference alone. Lundgren and associates,[20] McKeigue and associates,[19] and Okosun[17] also employed waist-to-hip measure as the indicator for abdominal obesity in their studies.

The use of waist-to-hip ratio in this current study was appropriate for examining the relationship between this factor and the outcome, type 2 diabetes. The sample as a whole had abdominal obesity. The mean waist-to-hip ratio for the sample

(n=281) was 0.80, the cut-point for abdominal obesity. The population examined by this study was similar to the population examined by Okosun.

Obesity in African-American Women

The high prevalence of obesity among participants of the current study parallels that of African-American women who participated in national studies, such as that of Okosun,[17] where NHANES III data were utilized. Most participants in the current study presented as overweight or obese despite efforts to include more normal-weight individuals through a comprehensive recruitment campaign. The mean body mass index for women in the current study was 34 (SD=9.3, n=281). This was above 30, the cut-point to indicate obesity. For abdominal obesity, indicated by a waist-to-hip ratio of 0.80 or greater, the sample of 281 participants (50%) had abdominal obesity (waist-to-hip ratio>0.80). Despite the fact that the study sample as a whole was obese, the current study was able to reveal the association of abdominal obesity with type 2 diabetes.

Abdominal obesity has been defined in several ways in the literature. In the current study, three versions of waist measurements were collected on either all or a fraction of the study participants. First, waist at the smallest diameter was obtained for each participant. Secondly, waist measured one inch above the umbilicus was collected, but not on the first 38 participants. Finally, in this study, waist was measured at the midpoint between the lower rib and the iliac crest for only a small number of participants in the pilot study and in the full study. The lower rib-iliac crest method was used by NHANES to measure waist circumference.[34] This

NHANES method proved to be impractical for the current study because of its invasiveness. Therefore, it was not continued for the remainder of the study.

The smallest diameter at waist was used in the current study because based on the standard method proposed by Lohman[117] and on findings from the pilot study, it appeared to be the most feasible method for a community-based study. Waist measured one inch above the umbilicus was collected on the majority of study participants to address the concerns of participants about the actual location of their waist and to compare this measure with the study's originally proposed waist circumference measure. There was a strong correlation (r =.96) between waist at the smallest diameter and waist one inch above the umbilicus. Therefore, it is apparent that for African-American women, comparisions of the results between studies that measured waist at the smallest diameter and those that measured waist one inch above the umbilicus can be made.

Birth Weight, Abdominal Obesity, and Type 2 Diabetes

The third hypothesis of this study stated that birth weight and abdominal obesity interact in their association with type 2 diabetes in African-American women 38 to 57 years of age. Though the current study was not able to support this hypothesis for the full spectrum of birth weights, when restricting the analyses to women who were born low birth weight, cases were more likely than controls to have developed type 2 diabetes. Thus, for the current study's participants who were born low birth weight, the fetal origins of chronic diseases hypothesis as first proposed by Barker[75] was supported. In other words, for those who were born low birth weight

and who subsequently developed abdominal obesity, the odds increased for the development of type 2 diabetes.

The findings of this study are important to health care providers and policymakers. Given the high risk for African-American women to develop type 2 diabetes and to be overweight or obese, it is imperative that factors that have been shown to be related to this disease be addressed. Not only should low birth weight and abdominal obesity be targeted independently, but as this study has shown, the interaction of these two factors must be considered when planning how to make the most of limited resources. Therefore, women who were born low birth weight should be especially cautioned to avoid developing abdominal obesity. Though this study could not address any cause-and-effect issues for the development of type 2 diabetes, it does provide insight into how body measurements at birth and later in life might be associated with this devastating disease.

Birth Weight, Abdominal Obesity, and Fasting Plasma Glucose

The fourth and final hypothesis of the current study stated that among African-American women who were without a physician diagnosis of type 2 diabetes and with fasting plasma glucose levels <126 mg/dL (controls, n=181), there is an association among birth weight, abdominal obesity, and fasting glucose level. This study found that 16% of the variation in fasting plasma glucose between cases and controls was attributable to the multiple linear regression model that included birth weight and abdominal obesity (R^2=.16, p=.0002). However, neither birth weight nor abdominal obesity contributed independently to the multiple linear regression model that explained the variation in fasting plasma glucose levels. This model also

included weight at 25 years of age, body mass index, family history of diabetes, age, premenopausal status, and strenuous physical activity.

Though birth weight was not found to be an independent explanatory variable for fasting plasma glucose in the current study, other studies involving various populations have shown birth weight to be an explanatory variable for glucose intolerance or insulin resistance.[13,18,19,66] A study by Phipps and associates[13] revealed the association between impaired glucose tolerance in adult life and low birth weight in men and women born in the United Kingdom. Birth weights were obtained from hospital records. Among women, those who were born weighing less than 2.50 kg (<5.5 pounds) were more likely (*OR*=12.1, 95% *CI*=2.0, 73) to have impaired glucose tolerance compared to those who were born >3.41 kg (reference group). The increased risk for women who were born 2.50 to 2.95 kg was about half that for women who were born low birth weight, (*OR*=6.2, 95% *CI*=1.1, 35), while those who were born between 2.95 and 3.41 kg were not significantly different from the reference group in terms of risk for impaired glucose tolerance. (The χ^2 value for trend among all the birth weight categories was 9.9, *p*=.002.)

In contrast to the Phipps and associates[13] study, the current study did not measure glucose intolerance, but used fasting plasma glucose levels as an outcome variable to test this hypothesis. Perhaps because of a difference in methodology and in sample size, this current study could not confirm that low birth weight independently explained plasma glucose levels in controls.

These findings suggest that although birth weight and abdominal obesity combined did not reveal an independent association with type 2 diabetes in this study,

these two factors contributed to a model that explained 16% of the difference in fasting plasma glucose between women with type 2diabetes and those without diabetes. It is suggested that African-American women 38 to 57 years of age have regular fasting plasma glucose tests given their elevated risk for developing diabetes. In addition, higher fasting glucose levels increase one's risk for developing type 2 diabetes. Added to their increased risk for being born low birth weight and for having abdominal obesity, health care providers must aggressively screen for elevated plasma glucose in this population.

Undiagnosed Diabetes

The Centers for Disease Control and Prevention reported that in 2000, for the general U.S. population, one out of every three persons with diabetes was undiagnosed.[44] Through measurements obtained from blood glucose screening, the current study, as did NHANES III,[34] uncovered cases of undiagnosed diabetes among the study participants. In NHANES III, the category of undiagnosed diabetes was comprised of people who initially presented as having no physician diagnosis of diabetes but who subsequently were found to have diabetes through a blood glucose test.

In the current study, two women who were diagnosed and treated for type 2 diabetes soon after enrollment were categorized as cases and retained in the study. This is an important, though indirect, consequence of the study. Two women who otherwise would have continued living with diabetes without treatment were identified. Making an immediate difference to the lives of individual study

participants is one of the ways that community-based research studies can make positive contributions to society.

Blood Pressure in African-American Women

Though measured systolic blood pressure levels were significantly different between cases and controls in the current study, the means for both groups fell below the cut-point (140 mm Hg0 used to identify those with hypertension. This cut-point was established by the National High Blood Pressure Education Program Work Group[119] to denote Stage I hypertension. The mean systolic blood pressure for women 38 to 57 years in this study was 128 mm Hg, (*SD*=17.1) with the mean for cases at 133 mm Hg (*SD*=17.5) and the mean for controls at 126 mm Hg (*SD*=16.3). A study by Brown and his colleagues,[130] based on NHANES data, showed similarly low mean systolic blood pressure readings (121 mm Hg, *SE*=0.49) for a national sample of African-American women 40 to 59 years of age. For women with BMI>30, as is true for the current study's sample, Brown[130] and associates found that mean systolic blood pressure was 129 mm Hg, *SE*=0.75. This suggests that the current study's sample of African-American women, on average, had better systolic blood pressure control than a national sample of women of various races and ethnicities.

This study revealed that among a highly-educated group of African-American women, blood pressure was well controlled. This may be an indication of their understanding of the importance of controlling blood pressure. On the other hand, it could be an indication that most of the women in the study had adequate health insurance so that any problems with blood pressure could be identified and corrected

in a timely manner. Had the sample contained more women who were less educated and who were poor, the blood pressure findings might have been different.

This study also found that although this sample of African-American women was highly educated, on average, the women were obese in terms of waist-to-hip ratio and body mass index. In contrast to adhering to medication regimens as prescribed by health care providers, lifestyle changes, such as reducing caloric intake and increasing physical activity, are more difficult. Perhaps this is why there were not more normal weight women in the study, something one might expect in a hightly educated sample.

This community-based study was able to support the message of controlling blood pressure by providing each participant with the results of her blood pressure measurements. In addition, each woman received information on how to reduce her risk for developing high blood pressure and/or how to improve control of her high blood pressure if she already had a physician diagnosis of this condition.

Limitations

As with any study some limitations exist with the current study. Most important, the investigator was unable to obtain vital records data for the entire sample. Information based on vital records is more accurate than self-reported accounts of retrospective events. Nonetheless, with considerable effort researchers can rely on respondents to provide reliable information on their background. In the current study, respondents verified their information with their parents and family documents to increase data accuracy. Many studies like that of Rich-Edwards and associates[33] utilized data from the Nurses' Health Study and, thus, also relied on self-

reported birth weights. These studies help to support the claim of the current study's investigator that this approach is viable if not 100% reliable. Because national studies often involve thousands and tens of thousands of participants, obtaining self-reported data is the the most feasible way to collect information. In the present study which involved a few hundred participants, it was possible to obtain vital records information for 63 (22%) of the participants and to collect verified self-report for the remainder.

Another limitation was that although the current study supported the hypothesis that abdominal obesity in the presence of low birth weight (*n*=43) may increase the odds for the development of type 2 diabetes, no causation could be determined given that this was a retrospective case-control study. In addition, since the current study involved convenience sampling, birth weights may not have been distributed similarly to birth weights for the population of U.S.-born African-American women who were 38 to 57 years of age. The rate of low birth-weight births among a national sample of non-white births ranged between 10.1% and 14.4% from 1950 to 1969, the years in which the participants were born. In contrast, the rate of low birth-weight births for whites ranged from 6.4% to 7.1%. (See Table M1.[131]) For this study, a higher percentage (15.3%, *n*=281) of the sample compared to whites was born low birth weight, although the percentage is similar to the national rates found among non-whites.

It is also likely the study sample was biased given the high level of educational attainment of participants (54% had obtained a bachelor's degree or higher) and the region where the women were born (mainly in the South). The results

of the current study cannot be generalized for several reasons, including to women living and working outside of the region or to women with a lower educational level. In addition, the reader is reminded that the results of the current study cannot be generalized to men or to non-African Americans. Finally, given that birth weight data could not be verified for each of the 368 women who initially were eligible to participate in the current study, the sample size was reduced by 84 participants, leaving a final sample of 281 women. This resulted in a smaller power than initially intended for the study. Despite the reduced sample size, relationships among birth weight, abdominal obesity, and type 2 diabetes were still observed for specific subgroups.

Strengths

The current study has several strengths. It was designed to measure the relationship between birth weight and abdominal obesity and type 2 diabetes in a sample comprised exclusively of African-American women, a population at high risk for this disease. In addition to controlling for race and gender, the current study examined an age range of approximately 20 years. Self-reported body measurements were not used in the current study; instead, all body measurements were uniformly measured by one observer. This eliminated inter-observer variation and the use of self reported data for these measures. Again, although vital records birth data were not obtained for all participants, vital records birth weights were obtained for nearly one quarter of respondents (22%).

Other strengths of this study were that the instruments and procedures were pilot-tested to allow for an efficient and accurate method of collecting data. In

addition, having an investigator who was of the same race and ethnicity as the participants may have positively impacted recruitment efforts. The investigator was a Registered Dietitian with over 20 years experience working in community and public health settings, providing participants with a benefit that may not have been realized for similar studies. This benefit was that each participant received an individualized nutrition consult that was based on her diabetes status, her blood pressure, and her weight. The nutrition consult also increased word-of-mouth referral to the study. Future studies similar to the current study should consider a service component to help increase word-of-mouth referral and to guide participants to take charge of their health.

Future Recommendations

Investigators of future studies should note that obtaining birth records information from State Centers for Health Statistics and from vital records offices should prove to be less difficult for individuals born beginning in the 1990s when birth weights were recorded on the face of birth certificates in all states and not relegated to the reverse side of the certificate or to supplemental files that might have been destroyed within one to 10 years, on average. (This information was gathered from private conversations with officials from several vital records offices.) In addition, electronic storage of birth weights and other birth data will make the retrieval of birth data less costly and more rapid.[129] Collecting official birth weights involves many steps, including for many states, application for IRB approval. Future researchers should build in a lag time of six to nine months to obtain available birth weights for the majority of their study participants.

Future studies that have greater access to vital records birth weights will be better able to address the contribution that birth weight has for examining the associations of type 2 diabetes in African-American women. Despite the limitation of collecting vital records birth weights for the majority of participants, the current study suggests that for those who are born low birth weight, extra vigilance should be taken to help prevent the development of abdominal obesity later in life.

In addition, the problem of the elevated risk for low birth weight faced by African Americans must be addressed. African Americans are more likely than European Americans to be born low birth weight.[44] This study was not able to unambiguously uncover the relationship between type 2 diabetes and low birth weight. However, based on the literature and results from a subsample of participants in the current study, if African-American women who were born low birth weight can avoid developing abdominal obesity later in life, perhaps they might reduce their risk for developing type 2 diabetes. Stevens[26] and Railey[27] also found that it is important to prevent abdominal obesity in African-American women to reduce their risk for developing type 2 diabetes. However, their studies did not examine the fetal origins of chronic disease as this current study did.

The importance of finding an increased odds for type 2 diabetes among women who were born low birth weight and who subsequently developed abdominal obesity cannot be understated, especially given that the risk for being born low birth weight is elevated for African Americans. Among women who were born low birth weight (n=43) in this study the odds of having abdominal obesity was 1.13 times more likely than for those without type 2 diabetes. Another approach would be to

identify those women who were born low birth weight and to utilize intensive prevention and intervention strategies to combat the development of abdominal obesity in this high-risk population of women.

Conclusions

The current study is the first to test the fetal origins of chronic disease in African-American women. When focusing only on those women who were born low birth weight, the results show that those with a self-reported physician diagnosis of type 2 diabetes had a larger mean waist-to-hip ratio than those without a self-reported physician diagnosis of type 2 diabetes. Data collected from this study support earlier studies that showed how abdominal obesity, as indicated by waist-to-hip ratio, is associated with type 2 diabetes in African-American women. The current study did not validate the role of birth weight in type 2 diabetes for African-American women when looking at a wide spectrum of birth weights (n=281). This lack of a positive finding does not mean, however, that no difference in birth weight exists between African-American women with and those without a self-reported physician diagnosis of type 2 diabetes. A reduction in the size of the sample due to challenges with obtaining vital records or verified self-reported birth weights for 85 of the original enrollees (n=376) may have obscured relationships between birth weight and type 2 diabetes. Continued efforts will be made to obtain birth weights for participants born in the state with the largest number of study participants. In fact, as of March 2007, this state is attempting to extract birth weights for participants from a national database.

The current study demonstrated that it is difficult, though not impossible, to conduct investigations that involve matching data from birth records of individuals born throughout the United States in the 1940s, 1950s, and 1960s, with objective and subjective data collected directly from individuals who are now in their middle adult years. When studies are restricted to a single state, the percent of women for whom vital records birth weights are obtained may be significantly higher than for this current study.

In sum, this study demonstrated that community-based research can contribute not only to the body of literature on the specific questions addressed in this study, but that they can work to improve knowledge and change health behaviors in participants and their families. Finally, it was consistent with studies that addressed the fetal origins of chronic disease: those who were born small and became overweight or obese in adulthood had greater odds for having type 2 diabetes than those who were not born small.

Appendices

The appendices contain information supplemental to the full study.

Appendix A. Screening Questionnaire
Appendix B. Study Questionnaire
Appendix C. Variable List and Codebook
Appendix D. Selected Recruitment Materials and Resources
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Appendix A. Study Questionnaire

WOMEN'S HEALTH STUDY QUESTIONNAIRE

Study Title: Birthweight and Current Weight Status in African American Women and Their Relationship to Type 2 Diabetes

Thank you for your interest in helping us to learn more about health issues in African American women. Please answer each question on pages 2 to 6 as completely as you can. Let us know if any question is unclear.

Confidentiality: The information you provide is confidential. Your name will not be revealed at any time. Your information will be grouped with the information of others for any reports. Your information will be stored in a locked drawer in the Nutrition Department of the University of Maryland. Only the researcher will be able to open this locked drawer.

For more information or for a copy of the study report, please contact:

Michelle Harris, MS, RD, MPH
Nutrition Program, University of Maryland
Room 0112 Skinner Hall
College Park, MD 20742
Phone: 202-291-1798 / E-mail:bharris2@umd.edu

Birth Information

We need the information listed below so we can get your birth records from the Vital Records Office of the state where you were born. For example, we need official information on your birth weight, whether you were born before your due date, whether you were a twin, and whether your mother had diabetes when she was pregnant with you. The study needs to collect official birth information to assure that birth data are collected for all participants in the same way. Your information will be used for this research project, only.

Please answer as many items as you can. Please ***print*** your answers.

1. What is ***your*** date of birth? ☐☐ ☐☐ **1** **9** ☐☐
   (Month) (Day) (Year)

   For example, a person born on May 16, 1949 would write: 0 5 — 1 6 — **1** **9** 4 9
   (Month) (Day) (Year)

2. What is ***your*** current name? _____
   First Name(s) Middle Name(s) Last Name(s)

3. What is the name on ***your*** birth certificate? _____
   First Name(s) Middle Name(s) Last Name(s)

your mother

4. What is your birth ***mother's*** name? _____
   First Name(s) Middle Name(s) Last Name(s)

5. What was your birth ***mother's*** maiden name? _____
   First Name(s) Middle Name(s) Last Name(s)

6. In what state/***country*** was your ***mother*** born? _____ / _____

your father,

7. What is your birth ***father's*** name? _____
   First Name(s) Middle Name(s) Last Name(s)

About you,

8. In what state were ***you*** born? _____
   If you were born in the District of Columbia, please write "DC" or "District of Columbia"

9. In what county, borough, or parish were ***you*** born? _____
   If you were born in the District of Columbia, please write "DC" or "District of Columbia"

10. In what city or town were ***you*** born? _____
    If you were born in the District of Columbia, please write, "Washington"

11. In what hospital were ***you*** born? _____

If you were not born in a hospital, where were you delivered? _____

Personal Health History

Do you now have any of the conditions listed in questions **1-5?** Please **circle** your response. Circle "Not sure" if you are not sure of your answer or if you do not know the answer.

1.	High blood pressure (hypertension)	Yes	No	Not sure
2.	High blood cholesterol (hypercholesterolemia)	Yes	No	Not sure
3.	High blood lipids (hyperlipidemia, high blood fat, high blood triglycerides)	Yes	No	Not sure
4.	Heart disease	Yes	No	Not sure
5.	Type 2 diabetes ("adult-onset diabetes" or "non-insulin-dependent diabetes")	Yes	No	Not sure

If you *have* type 2 diabetes, please continue. If you *do not* have type 2 diabetes, please skip to question 15.

6. What year did you first learn you had type 2 diabetes? **19 ___ ___** or **20 ___ ___.**
7. What was your age when you first learned you had type 2 diabetes? _____ years.
8. What was your weight status when you first learned you had type 2 diabetes? Please **circle** your answer.

Underweight	Normal Weight	Overweight	Not sure
1	3	5	9

What do you currently use to control your diabetes? Please circle your answer(s). Circle ***all*** that apply.

9.	Oral diabetes medications (hypoglycemic agents, pills)	Yes	No	Not sure
10.	Insulin (shots)	Yes	No	Not sure
11.	Diet change/Diet Plan	Yes	No	Not sure
12.	Exercise	Yes	No	Not sure
13.	Lose weight	Yes	No	Not sure
14.	Other (please write in): _____			

15.	Did you ever have ***gestational diabetes?*** (diabetes while you were pregnant)	Yes	No	Not sure	N/A
16.	Did you ever have a baby who weighed over ***9 pounds*** at birth?	Yes	No	Not sure	N/A

17. About how much did you weigh ***when you were 25 years of age?*** _____ pounds
18. Have you lost weight ***within the last 6 months?*** Yes No Not sure
19. Were you trying to lose weight ***within the last 6 months?*** Yes No Not sure
20. How much weight did you lose ***within the last 6 months?*** _____ pounds
21. Have you gained weight ***within the last 6 months***? Yes No Not sure
22. Were you trying to gain weight ***within the last 6 months?*** Yes No Not sure
23. How much weight did you gain ***within the last 6 months?*** _____ pounds

24. Are you going through menopause now? ("the change") Yes No Not sure
25. Have you gone through menopause? Yes No Not sure
26. Have you had a hysterectomy? (your uterus removed or both of your ovaries removed) Yes No Not sure
27. Did you have ***at least one*** period (menstrual cycle) ***within the past 12 months?*** Yes No Not sure
28. Are you on hormone replacement therapy (HRT)? Yes No Not sure

29. Were you breastfed when you were an infant or child Yes No Not sure
30. For how long were you breastfed when you were an infant or child? (Please **circle** your answer below.)

I was not breastfed	1-3 months	4-6 months	7-9 months	10-12 months	More than 12 months	Not sure
00	03	06	09	12	13	99

Please go to the next section on the next page (page 5) when you are finished with this page.

Family Diabetes History

The questions on this page ask about diabetes in your family. Please include information only about the family members related to you by blood.

Please write the correct number on the line beside each question. Circle "don't know" if you do not know the number of brothers and sisters or children or grandchildren who have diabetes.

1. How many **brothers** do/did you have? _____ Don't know
2. How many of your brothers have/had diabetes? _____ Don't know N/A
3. How many **sisters** do/did you have? _____ Don't know
4. How many of your sisters have/had diabetes? _____ Don't know N/A
5. How many **children** do/did you have? _____
6. How many of your children have/had diabetes? _____ Don't know N/A
7. How many **grandchildren** do/did you have? _____ Don't know N/A
8. How many of your grandchildren have/had diabetes? _____ Don't know N/A

Please circle *Yes, No, or Don't Know* to the following questions.

9. Does/did your **mother** have diabetes? Yes No Don't know
10. Does/did your **father** have diabetes? Yes No Don't know
11. Does/did your **mother's mother** have diabetes? Yes No Don't know
12. Does/did your **mother's father** have diabetes? Yes No Don't know
13. Does/did your **father's mother** have diabetes? Yes No Don't know
14. Does/did your **father's father** have diabetes? Yes No Don't know

Personal Lifestyle

1. Thinking about the things you do ***at work,*** how would you rate yourself as to the amount of physical activity you get compared with other women your age? Please **circle** your answer.

Much more active	Somewhat more active	About the same	Somewhat less active	Much less active	Not applicable.
5	4	3	2	1	8

2. Now, thinking about the things you do ***outside of work*** (such as household chores, child care, family care, volunteer, church activities, etc.)***,*** how would you rate yourself as to the amount of physical activity you get compared with other women your age? Please **circle** your answer.

Much more active	Somewhat more active	About the same	Somewhat less active	Much less active
5	4	3	2	1

Please **circle** your answer to the following questions.

3. Do you regularly engage in strenuous activity or hard physical labor or exercise where you sweat or your heart beats faster?
   Yes (If "*yes*," answer question #4 below.)
   No (If "*no*," skip to question #5.)

4. Do you engage in strenuous activity or hard physical labor or exercise ***at least 3 times a week***?
   Yes
   No

5.	Have you ever smoked cigarettes?	Yes	No
6.	Have you smoked more than 100 cigarettes in your lifetime?	Yes	No
7.	Do you smoke cigarettes now?	Yes	No
8.	Have you ever drunk alcohol? (Alcohol includes beer, malt liquor, wine, wine spritzers, gin, vodka, bourbon, whiskey, mixed drinks, etc.)	Yes	No
9.	In the last ***7 days,*** did you drink any alcohol?	Yes	No
10.	In the last ***8 to 30 days,*** did you drink any alcohol?	Yes	No
11.	In the last ***31 to 90 days (3 months),*** did you drink any alcohol?	Yes	No

12. What is the highest grade or year of school you completed? **(Please circle only one item.)**

08. Grades 1 through 8 (elementary)
11. Grades 9 through 11 (some high school)
12. Grade 12 or GED (high school diploma or equivalency)
13. Technical, vocational, or trade school degree beyond high school
14. Attended college, but did not graduate
15. Associate degree
16. Bachelor degree
18. Graduate degree or advanced professional degree (Master, Ph.D., M.D., J.D., etc.)
99. Not sure

For staff only: Date questionnaire collected: ___ ___/___ ___/20 ___ ___ Who completed questionnaire? 1 2 3 4 5 7

You have finished the questionnaire—*Thank you.*

Note: Please keep this page for your records.

For more information or for a copy of the study report, please contact:

Michelle Harris, MS, RD, MPH
Nutrition Program, University of Maryland
Room 0112 Skinner Hall
College Park, MD 20742
Phone: 202-291-1798 / E-mail: bharris2@umd.edu

Appendix B. Screening Questionnaire

Screener Questionnaire

Study Title: Birthweight and Current Weight Status in African American Women and Their Relationship to Type 2 Diabetes

Thank you for your interest in helping us learn more about how birthweight and current weight relate to type 2 diabetes and other conditions. Please **circle** your answer to each question below.

1.	Are you Black American/African American?	Yes	No	Not sure
2.	Were you born in the United States?	Yes	No	Not sure
3.	Are you between the ages of 40 and 55 years?	Yes	No	Not sure
4.	Are you pregnant now?	Yes	No	Not sure
5.	Were you pregnant any time in the last 12 months?	Yes	No	Not sure
6.	Do you have type 1 diabetes? (also called "juvenile-onset diabetes"or "insulin-dependent diabetes")	Yes	No	Not sure
7.	Do you have type 2 diabetes? (also called "adult-onset diabetes" or "non-insulin-dependent" diabetes)	Yes	No	Not sure

Have you had any of the conditions listed below within *the past 6 months?*

8.	Cancer	Yes	No	Not sure
9.	Liver disease	Yes	No	Not sure
10.	Kidney (renal) disease	Yes	No	Not sure
11.	Heart attack (myocardial infarction)	Yes	No	Not sure
12.	Stroke	Yes	No	Not sure
13.	Hepatitis (hepatitis B, hepatitis C)	Yes	No	Not sure
14.	HIV infection or AIDS	Yes	No	Not sure

15. Please list the medicines you take: _____

_____

_____

First name: _____

Please give us a way to contact you:

_____

To return this form and for more information, please contact:
Michelle Harris, MS, RD, MPH
Nutrition Program, University of Maryland
Room 0112 Skinner Hall
College Park, MD 20742
Phone: 202-291-1798 / E-mail: bharris2@umd.edu

Questionnaire Design Issues

To reduce respondent burden, questionnaire items were assessed as to whether they explicitly addressed the research hypotheses. Questions irrelevant to addressing the research questions were not included. A self-administered questionnaire was selected because the relatively large proposed sample size (n= 540) prohibited the use of interviewers for the study. It was anticipated that the majority of participants for the study would be able to read and write in English. This proved to be true for the sample. Several participants noted that the questionnaire was one of the most straightforward that they ever had completed for a study. After the questionnaire was validated, it seemed that for most items, participants did not face ambiguity. For future studies, the following items should be scrutinized and, perhaps, rewritten or eliminated.

For participants with type 2 diabetes, it must be made clear whether the treatment regimens they follow are what their health care provider prescribed, what they actually practiced, or both. The question on high lipid levels was not understood by many participants. Most of those who were familiar with the term were not aware of their lipid status.

Two of the items concerning menopause were difficult for participants to answer. The questionnaire item asking them whether they had a period within the last 12 months would be sufficient to estimate the menopausal status of participants without subjecting them to the stress of not knowing how to answer the other two questions on menopause.

Breastfeeding has been shown to reduce the risk of type 2 diabetes and other chronic diseases later in life.[132] Many of the study participants did not know whether or not they were breastfed as infants. It was discovered that some women who thought that they had not been breastfed were actually breastfed when they later conferred with their mother, father, or some other relative. Therefore, the prevalence of history of being breastfed was most likely underestimated for this sample.

For family history of diabetes, several participants did not know whether their first-order relatives had diabetes. A participant who was subsequently diagnosed with type 2 diabetes was not aware that her sister had been living with diabetes for 20 years. She discovered her sister's long-term status of having diabetes after her own diagnosis. The investigator concluded that family history of diabetes may be underestimated for this sample given the large number of family history questionnaire items that were answered with "Don't know."

The questions on alcohol consumption proved not to be helpful for the current study. Women who drank only once or twice per year could not be distinguished from women who drank more regularly based on the questionnaire items, especially given that information on quantities of alcohol consumed was not collected. A desire to obtain a more thorough instrument for collecting alcohol must be balanced by the need to keep the instrument short and as non-invasive as possible so that participant burden will be kept low.

The item on education captured women who had attended college for at least one semester. Feedback on this questionnaire item from participants from all stages of the study (focus groups, pilot study, and full study) was positive. The general consensus

was that asking whether they had attended, but had not graduated, college validated the contribution that African-American women who are in their forties and fifties had made towards the increased number of educational opportunities that younger minority women have. However, the questionnaire item on education could have been improved by asking those who did not complete college the actual number of years they had completed.

Appendix C. Variable List and Data Dictionary (Codebook)

Questionnaire and Data Collection items were collected by one investigator between July 2004 and January 2006. Vital Records and State Centers for Health Statistics data were collected between March 2006 and June 2006. The questionnaire was totally self-administered for the majority of the participants. Only 14 of 377 participants received partial or total assistance with completing the questionnaire. The reasons for this assistance included low literacy levels, poor eyesight, or participant request. Data were entered into three text files and were analyzed using SAS version 8.2.

Participants were African American women 38-57 years of age recruited from the Washington, D.C., Metropolitan Area. Very few participants fell outside of this age range. Participants self-declared their race as Black American or African American. Participants were born in the United States, with the exception of one participant who was born on a U.S. Air Force base. Enrollment sites included faith-based organizations (churches, a mosque, a Black Hebrew temple/health cooperative); a health food complex, public and parochial schools, worksites, homes, clinics, a beauty shop, and the University lab.

Data from Questionnaire

Column	Variable Name	Description	Category
1-3 3 columns	ID	Participant Identification Number Located at top of each page.	N/A *Continuous var: use 3 digits.*
4 1 column	HBP	High blood pressure (hypertension) Questionnaire, Page 3, Q1.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
5 1 column	HICHOL	High blood cholesterol (hypercholesterolemia)? Questionnaire, Page 3, Q2.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
6 1 column	HILIP	High blood lipids (hyperlipidemia, high blood fat, high blood triglyceride)? Questionnaire, Page 3, Q3.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
7 1 column	HEARTDX	Heart disease? Questionnaire, Page 3, Q4.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
8 1 column	T2DM	Type 2 diabetes (adult-onset diabetes or non-insulin-dependent diabetes)? Questionnaire, Page 3, Q5.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
9-12 4 columns	YRDIAGN	Year learned had diabetes. Should be 19XX or 20XX, only. ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q6.	N/A YYYY *Continuous var: use 4 digits.* 6666=Refused 7777=Missing 8888=Not applicable 9999=Not sure
13-14 2 columns	AGEDIAGN	Age learned had diabetes. ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q7.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Not sure
15 1 column	WTDIAG	Weight status when learned had diabetes. ***"Not applicable only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q8.	1=Underweight 3=Normal Weight 5=Overweight 6=Refused 7=Missing 8=Not applicable 9=Not sure
16 1 column	ORALMEDS	Controlling diabetes by oral diabetes medications (hypoglycemic agents)? ***"Not applicable only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q9.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure

Column	Variable Name	Description	Category
17 1 column	INSULIN	Controlling diabetes by insulin? ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q10.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
18 1 column	DIET	Controlling diabetes by diet? ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q11.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
19 1 column	EXERCISE	Controlling diabetes by exercise? ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q12.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
20 1 column	LOSEWT	Controlling diabetes through weight loss? ***"Not applicable" only if participant reported does not have diabetes.*** Questionnaire, Page 3, Q13.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
21 1 column	OTHERTRX	Other treatment(s) for diabetes? ***"Not applicable" only if participant reported does not have diabetes.*** Write in Other: _____ Questionnaire, Page 3, Q14.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
22 1 column	GESTDM	Ever have gestational diabetes (diabetes while pregnant)? ***"Not applicable" only if participant never pregnant.*** Questionnaire, Page 3, Q15	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
23 1 column	BIGBABY	Ever have baby who weighed over 9 pounds at birth? ***"Not applicable" only if participant never pregnant.*** Questionnaire, Page 3, Q16.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable 9=Not sure
24-28 5 columns	WT25	Weight at 25 years of age. If participant indicates a range, take midpoint (average) age. To nearest 0.5 pound. Example: "133.5" pounds Questionnaire, Page 4, Q17.	N/A *Continuous var: use 4 digits. Place decimal point in fourth column. If range is given, use midpoint value rounded to nearest whole number.* 666.6=Refused 777.7=Missing 999.9=Not sure
29 1 column	WTLOSS	Weight loss within last 6 months? Questionnaire, Page 4, Q18.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure

Column	Variable Name	Description	Category
30 1 column	TRYLOSE	Trying to lose weight within last 6 months? Questionnaire, Page 4, Q19.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
31-32 2 columns	LOSTAMT	How much weight lost within last 6 months? If participant not sure of weight loss for Q18, fill in "not sure" for pounds lost for Q20. If a range is given, take midpoint. Round to nearest whole lb., up to 99 lbs. Example: "42" pounds. Questionnaire, Page 4, Q20.	N/A *Continuous var: use 2 digits.* *No decimal.* *If range is given, use midpoint value rounded to nearest whole number.* 66=Refused 77=Missing 88=Not applicable 99=Not sure
33 1 column	WTGAIN	Weight gain within last 6 months? Questionnaire, Page 4, Q21.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
34 1 column	TRYGAIN	Trying to gain weight within last 6 months? Questionnaire, Page 4, Q22.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
35-36 2 columns	GAINAMT	How much weight gained within last 6 months? If participant not sure of weight gain for Q21, fill in "not sure" for pounds gained for Q23. If a range is given, take midpoint. Round to nearest whole lb., up to 99 lbs. Example: "19" pounds. Questionnaire, Page 4, Q23.	N/A *Continuous var: use 2 digits.* *No decimal.* *If range is given, use midpoint value rounded to nearest whole number.* 66=Refused 77=Missing 88=Not applicable 99=Not sure
37 1 column	MNPASNOW	Going through menopause now? (For some analyses, will have to combine Q24, 25 and 26.) Questionnaire, Page 4, Q24.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
38 1 column	MENOPAUS	Gone through menopause (the change)? (For some analyses, will have to combine Q24, 25 and 26.) Questionnaire, Page 4, Q25.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
39 1 column	HYSTEREC	Had a hysterectomy (uterus removed)? For some analyses, will have to combine Q24, 25 and 26.) Questionnaire, Page 4, Q26.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
40 1 column	PERIOD	At least one period (menstrual cycle) within past 12 months? (This is the main question that will be used to define menopause.) Questionnaire, Page 4, Q27.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure

Column	Variable Name	Description	Category
41 1 column	HRT	On **H**ormone **R**eplacement **T**herapy? Questionnaire, Page 4, Q28	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
42 1 column	BREASTFD	Ever breastfed? Questionnaire, Page 4, Q29.	0=No 1=Yes 6=Refused 7=Missing 9=Not sure
43-44 2 columns	MONTHSBF	How long breastfed? Questionnaire, Page 4, Q30.	00=Never breastfed 03=1-3 months 06=4-6 months 09=7-9 months 12=10-12 months 13=More than 12 months 66=Refused 77=Missing 99=Not sure
45-46 2 columns	BROTHERS	How many brothers do/did participate have? Example: "12" brothers Questionnaire, Page 5, Q1.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 99=Don't know
47-48 2 columns	BRODM	How many brothers of participant have/had diabetes? Example: "12" brothers Questionnaire, Page 5, Q2.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Don't know
49-50 2 columns	SISTERS	How many sisters do/did participate have? Example: "12" sisters Questionnaire, Page 5, Q3.	N/A *Continuous var: use 2 digits* 66=Refused 77=Missing 99=Don't know
51-52 2 columns	SISDM	How many sisters of participant have/had diabetes? Example: "12" sisters Questionnaire, Page 5, Q4.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Don't know
53-54 2 columns	CHILDREN	How many children does/did participate have? Example: "12" children Questionnaire, Page 5, Q5.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 99=Don't know
55-56 2 columns	CHILDDM	How many children of participant have/had diabetes? Example: "12" children Questionnaire, Page 5, Q6.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Don't know

Column	Variable Name	Description	Category
57-58 2 columns	GRANDS	How many grandchildren does/did participant have? Example: "12" grandchildren Questionnaire, Page 5, Q7.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Don't know
59-60 2 columns	GRANDSDM	How many grandchildren of participant have/had diabetes? Example: "12" grandchildren Questionnaire, Page 5, Q8.	N/A *Continuous var: use 2 digits.* 66=Refused 77=Missing 88=Not applicable 99=Don't know
61 1 column	MOMDM	Does/did mother of participant have diabetes? Questionnaire, Page 5, Q9.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
62 1 column	DADDM	Does/did father of participant have diabetes? Questionnaire, Page 5, Q10.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
63 1 column	MOMMOMDM	Does/did mother's mother (maternal grandmother) of participant have diabetes? Questionnaire, Page 5, Q11.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
64 1 column	MOMDADDM	Does/did mother's father (maternal grandfather) of participant have diabetes? Questionnaire, Page 5, Q12.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
65 1 column	DADMOMDM	Does/did father's mother (paternal grandmother) of participant have diabetes? Questionnaire, Page 5, Q13.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
66 1 column	DADDADDM	Does/did father's father (paternal grandfather) of participant have diabetes? Questionnaire, Page 5, Q14.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
67 1 column	PAJOB	At work, how participant rates self as to amount of physical activity she gets compared with other women about her same age? ***"Not applicable" if does not have a job.*** **Note:** Check data entry carefully since using consecutive numbering. Questionnaire, Page 6, Q1.	5=Much more active 4=Somewhat more active 3=About the same 2=Somewhat less active 1=Much less active 7=Missing 6=Refused 8=Not applicable 9=Don't know

Column	Variable Name	Description	Category
68 1 column	PAOUTJOB	Outside work (household chores, child care, family care, volunteer, and church activities, and so on), how participant rates self as to amount of physical activity she gets compared with other women about her same age? **Note:** Check data entry carefully since using consecutive numbering. Questionnaire, Page 6, Q2.	5=Much more active 4=Somewhat more active 3=About the same 2=Somewhat less active 1=Much less active 6=Refused 7=Missing 9=Don't know
69 1 column	STRENU	Engage in strenuous activity or hard physical labor where sweat or heart beats faster? Questionnaire, Page 6, Q3.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
70 1 column	STRENU3	Exercise or labor at least 3 times a week? Questionnaire, Page 6, Q4.	0=No 1=Yes 6=Refused 7=Missing 8=Not applicable (when "No" to previous question) 9=Don't know
71 1 column	EVRSMOKE	Ever smoked cigarettes? Questionnaire, Page 6, Q5.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
72 1 column	SMOKE100	Ever smoke more than 100 cigarettes in lifetime? Questionnaire, Page 6, Q6.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
73 1 column	SMOKENOW	Smoke cigarettes now? Questionnaire, Page 6, Q7.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
74 1 column	EVRDRINK	Ever drink alcohol? Questionnaire, Page 6, Q8.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
75 1 column	DRINK7	In last 7 days, drink alcohol (beer, malt liquor, wine, wine spritzer, gin, vodka, bourbon, whiskey, mixed drinks, etc.)? Questionnaire, Page 6, Q9.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
76 1 column	DRNK8_30	In last 8-30 days, drink alcohol (beer, malt liquor, wine, wine spritzer, gin, vodka, bourbon, whiskey, mixed drinks, etc.)? Questionnaire, Page 6, Q10	0=No 1=Yes 6=Refused 7=Missing 9=Don't know
77 1 column	DRNK31PL	In past 31-90 days, drink alcohol (beer, malt liquor, wine, wine spritzer, gin, vodka, bourbon, whiskey, mixed drinks, etc.)? Questionnaire, Page 6, Q11.	0=No 1=Yes 6=Refused 7=Missing 9=Don't know

Column	Variable Name	Description	Category
78-79 2 columns	SCHOOL	Highest grade or year of school completed? Questionnaire, Page 6, Q12.	08=Grades 1-8 (elementary) 11=Grades 9-11 (some h.s.) 12=Grade 12 or GED (h.s. diploma or equivalency) 13=Technical, trade, or vocational school ***beyond high school.*** 14=Attended college, but did not graduate 15=Associate degree 16=Bachelor's degree 18=Graduate or advanced professional degree (Master's, MD, PhD, JD, etc. 66=Refused 77=Missing 99=Don't know
80-87 8 columns	DATEQUES	Date questionnaire data collected. Questionnaire, shaded part at bottom of Page 6.	N/A *MM/DD/YYYY*
80-81 2 columns	MONTHQUE	Month questionnaire collected. Questionnaire, shaded part at bottom of Page 6.	N/A *MM*
82-83 2 columns	DAYQUES	Day (date) questionnaire collected. Questionnaire, shaded part at bottom of Page 6.	N/A *DD*
84-87 4 columns	YEARQUES	Year questionnaire collected. Questionnaire shaded part at bottom of Page 6.	N/A *YYYY*
88 1 column	QUESTCOM	Who completed questionnaire? Questionnaire, Page 6, shaded part at bottom of page.	1=Participant alone 2=Participant with help from study staff 3=Participant with help from someone other than study staff 4=Study staff read all items to participant 5=Someone other than study staff read all items to participant 6=Refused 7=Undetermined or missing
		Begin new codes at 369	

Codes for Data Collection Form Data

Column	Variable Name	Description	Category
89-91 3 columns	SBP1	Systolic blood pressure, measure 1 To nearest mm Hg Example: "157/" Data Collection Form	N/A *Continuous var: use 3 digits.*
92-94 3 columns	DBP1	Diastolic blood pressure, measure1 To nearest mm Hg Example: "/83" Data Collection Form	N/A *Continuous var: use 3 digits.*
95-97 3 columns	SBP2	Systolic blood pressure, measure 2 To nearest mm Hg Example: "157/" Data Collection Form	N/A *Continuous var: use 3 digits.*
98-100 3 columns	DBP2	Diastolic blood pressure, measure 2 To nearest mm Hg Example: "/83" Data Collection Form	N/A *Continuous var: use 3 digits.*
101-103 3 columns	SBP3	Systolic blood pressure, measure 3 To nearest mm Hg Example: "157/" Data Collection Form	N/A *Continuous var: use 3 digits.*
104-106 3 columns	DBP3	Diastolic blood pressure, measure 3 To nearest mm Hg Example: "/83" Data Collection Form	N/A *Continuous var: use 3 digits.*
107-109 3 columns	SBP4	Systolic blood pressure, measure 4 To nearest mm Hg Example: "157/" Data Collection Form	N/A *Continuous var: use 3 digits.*
110-112 3 columns	DBP4	Diastolic blood pressure, measure 4 To nearest mm Hg Example: "/83" Data Collection Form	N/A *Continuous var: use 3 digits.*
113-117 5 columns	HT1	Height, measure 1, in centimeters To nearest 0.1 centimeter Example: "101.34" kg Data Collection Form	N/A *Continuous var*
118-122 5 columns	HT2	Height, measure 2, in centimeters To nearest 0.1 centimeter Example: "101.34" kg Data Collection Form	N/A *Continuous var*
123-127 5 columns	HT3	Height, measure 2, in centimeters To nearest 0.1 centimeter Example: "101.34" kg Data Collection Form	N/A *Continuous var*
128-132 5 columns	HT4	Height, measure 2, in centimeters To nearest 0.1 centimeter Example: "101.34" kg Data Collection Form	N/A *Continuous var*
133-138 6 columns	WT1	Weight, measure 1, in kilograms To nearest 0.01 kg Example: "101.34" cm Data Collection Form	N/A *Continuous var*
139-144 6 columns	WT2	Weight, measure 2, in kilogram To nearest 0.01 kg Example: "101.34" cm Data Collection Form	N/A *Continuous var*

145-150 6 columns	WT3	Weight, measure 2, in kilogram To nearest 0.01 kg Example: “101.34” cm Data Collection Form	N/A *Continuous var*
151-156 6 columns	WT4	Weight, measure 2, in kilogram To nearest 0.01 kg Example: “101.34” cm Data Collection Form	N/A *Continuous var*
354 1 column	TAPE	Tape measure	1=Tape measure 1 used for all circumference measures 2=Tape measure 2 used for all circumference for all circumference measures 3=Tape measure 2 used for circumference measures, then tape 1 used to duplicate all circumference measures 8=Missing or not applicable
157-161 5 columns	WAIST1	Waist circumference, smallest circumference, measure 1 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
162-166 5 columns	WAIST2	Waist circumference, smallest circumference, measure 2 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
167-171 5 columns	WAIST3	Waist circumference, smallest circumference, measure 2 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
172-176 5 columns	WAIST4	Waist circumference, smallest circumference, measure 2 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
177-181 5 columns	WAISTUM1	Waist circumference, one inch above umbilicus, measure 1 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
182-186 5 columns	WAISTUM2	Waist circumference, one inch above umbilicus, measure 2 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
187-191 5 columns	WAISTUM3	Waist circumference, one inch above umbilicus, measure 1 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*
192-196 5 columns	WAISTUM4	Waist circumference, one inch above umbilicus, measure 1 To nearest 0.1 cm Example: “101.34” cm Data Collection Form	N/A *Continuous var*

197-201 5 columns	WAISTCR1	Waist circumference, midway between iliac crest and lower rib, measure 1 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
202-206 5 columns	WAISTCR2	Waist circumference, midway between iliac crest and lower rib, measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
207-211 5 columns	WAISTCR3	Waist circumference, midway between iliac crest and lower rib, measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
212-216 5 columns	WAISTCR4	Waist circumference, midway between iliac crest and lower rib, measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
217-221 5 columns	HIP1	Hip circumference measure 1 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
222-226 5 columns	HIP2	Hip circumference measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
227-231 5 columns	HIP3	Hip circumference measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
232-236 5 columns	HIP4	Hip circumference measure 2 To nearest 0.1 cm Example: "101.34" cm Data Collection Form	N/A *Continuous var*
237 1 column	FASTING	Anything to eat or drink (except water) within last 8 hours? Data Collection Form	0=Fasting 1=Non-fasting 7=Missing
238-239 2 columns	AMTFLUID	Amount of fluid drunk in last 24 hours (in cups or glasses). If a range is given, take midpoint. Round to nearest cup. Do not count drinks that contain caffeine (colas, coffee, regular tea.) Example: "28" cups Data Collection Form	N/A *Continuous var: 2 digits, no decimal, maximum 64 cups (which equals 4 gallons).* *Do not count caffeine-containing beverages or alcohol.* *If range is given, use midpoint value rounded to nearest whole number.* 66=Refused 77=Missing 99=Don't know
240-242 3 columns	FPG1	Fasting plasma glucose from glucometer reading, in mg/dL, at time of collection of body and blood pressure measures. Data Collection Form	N/A *Continuous var*

243-250 8 columns	DATEFPG1	Date FPG1 collected Example: 09/12/2004 Data Collection Form	*MM/DD/YYYY*
243-244 2 columns	MFPG1	Month FPG1 collected Data Collection Form	*MM*
245-246 2 columns	DFPG1	Day (date) FPG1 collected Data Collection Form	*DD*
247-250 4 columns	YFPG1	Year FPG1 collected Data Collection Form	*YYYY*
251-253 3 columns	FPG2	Fasting plasma glucose from glucometer reading, in mg/dL, at time of collection of body and blood pressure measures. Data Collection Form	N/A *Continuous var*
254-261 8 columns	DATEFPG2	Date FPG2 collected Example: 09/16/2004 Data Collection Form	N/A *Continuous var* *MM/DD/YYYY*
254-255 2 columns	MMFPG2	Month FPG2 collected Data Collection Form	N/A *Continuous var* *MM*
256-257 2 columns	DDFPG2	Day (date) FPG2 collected Data Collection Form	N/A *Continuous var* *DD*
258-261 4 columns	YYFPG2	Year FPG2 collected Data Collection Form	N/A *Continuous var* *YYYY*
262-264 3 columns	NONFAST	Nonfasting plasma glucose form glucometer reading in mg/dL. If had something to eat, will still have finger stick blood measured for casual plasma glucose, but will be asked to return for fasting blood glucose within 7 days. Data Collection Form	N/A *Continuous var*
265 1 column	DIABETES	Classified as having diabetes for this study based on FPG levels No = FPG <126 mg/dL Yes = FPG ≥126 mg/dl Data Collection Form	0=No 1=Yes 7=Undetermined
266 1 column	VSELFRPT	Self-report of physician diagnosis, with verification via prescription of insulin and/or oral hypoglycemic agent. Data Collection Form	0=No 1=Yes 7=Missing 8=N/A 9=Not sure
267 1 column	ANEMIA	Self-report of iron-deficiency anemia. Data Collection Form	0=No 1=Yes 7=Missing/Undetermined 9=Not sure
268-275 8 columns	DATEFORM	Date data collected for blood pressure, anthropometrics, and non-fasting plasma glucose (if applicable) Page 6, shaded part at bottom of page.	N/A *MM/DD/YYYY* *Continuous var: 2 digits.*
268-269 2 columns	MONTHFRM	Month data collection form completed	*MM*
270-271 2 columns	DAYFORM	Day (date)data collection form completed	*DD*
272-275 4 columns	YEARFORM	Year data collection form completed	*YYYY*

276 1 column	DAYMEAS	Day of week measurement data collected Data Collection Form	1=Sunday 2=Monday 3=Tuesday 4=Wednesday 5=Thursday 6=Friday 7=Saturday
277-278 2 columns	SITE	Data collection site Data Collection Form	01-39=Faith-based organization *01=Saint Martin's* *02=Our Lady of Perpet. Help* *03=Gethsemane UMC* *04=Queen's Chapel UMC* *05=People's Congregational* *06=St. George's Episcopal* *07=Everlasting Life, MD* *08=Everlasting Life, DC* *09=Zion Baptist Church* *10=Mt. Zion Pentecostal* *11=New Born Church* *12=Masjid Muhammed* *13=Eastern Star/Mason* *14=Johnson Memorial Bapt.* 40-41=Health Units *40*=Job Site Health Center *41*=Civista Women's HC 50-59=University of Maryland *50=Skinner 0109* *51=Skinner 0112A* *53=UMBC* 60-69; 80-89=Other *60=Other, Private home* *61=Other, Job site* *62=Other, Parochial School* *63=Other, Public School* *64=Other, PGCC* *65=Other, Public Housing* *66=De Place* *67=House of Lydia* *68=Charles Houston Rec. Ctr.* *69=Two Macs Barber/Salon* *80=Georgetown University* 77=Missing

279-282 4 columns	TIMEMEAS	Start time (military time) for measurement data collection 05:00 a.m. to 13:59 p.m., only Data Collection Form	N/A *Continuous var: 4 digits.*
283 1 column	MEDS	Self-reported medications. Screener Form	0=None 1=Takes meds, but none on restricted list 2=Takes meds on restricted list, but included in study 3=Takes meds on restricted list; not included in main analyses. 4=Takes meds on restricted list; totally excluded from study. X=Not yet coded
284-289 6 columns	MOMCODE	**State** in which mother was born plus **mother's first name** plus **mother's surname at birth**. Example: Mother was born in Washington, **D.C.,** and was named **Sa**ndra **Jo**nes at birth. **DCSAJO** Questionnaire, Page 2, Q4 and Q6	See list of state abbreviations. 66=Refused 77=Missing 99=Don't know
		Begin new codes at 369	

Codes for Self-Reported Birth Data

Column	Variable Name	Description	Category
290-294 5 columns	BWLBS_SR	Self-reported birthweight in pounds (to nearest quarter pound). Example: "11.25" pounds. Self-Reported Birth Data Form.	99.99=Don't know
295-299 5 columns	BWOZS_SR	Self-reported birthweight in ounces (to nearest quarter ounce, when applicable) Example: "14.25" ounces. Self-Reported Birth Data Form	N/A *Continuous* 99.99 0.50# = 8 oz; 0.25# = 4 oz
355-359 5 columns	BWLB_SR2	Second self-reported birthweight in pounds (to nearest quarter pound). Gathered at least 2 months after enrollment. Example: "11.25" pounds. Self-Reported Birth Data Form. If guessing and second report seems vaguer than first in terms of ounces), use first report.	99.99=Don't know
360-364 5 columns	BWOZ_SR2	Second self-reported birthweight in ounces (to nearest quarter ounce, when applicable). Gathered at least 2 months after enrollment. Example: "14.25" ounces. Self-Reported Birth Data Form	N/A *Continuous* 99.99 0.50# = 8 oz; 0.25# = 4 oz
365 1 column	BW_INFO	Source of second self-reported birth weight. Document could be birth certificate, hospital discharge card, or entry in Bible or other written record. If source is document or mother, use document code. Guess is noted when participant states that she is guessing or when she gives a wide range (>½ pound).	0 = Guess 1 = Document 2 = Mother 3 = Father 4 = Sibling 5 = Aunt 6 = Uncle or Other Relative 7 = Missing 8 = Mother's Friend 9 = Don't know
300-303 4 columns	BWGMS_SR	Self-reported birthweight in grams (to nearest 0.1 gram) Example: "2700" grams Self-Reported Birth Data Form	N/A ***Continuous*** 8888=Not applicable 9999=Don't know
304-305 2 columns	GEST_SR	Self-reported gestational age at birth to the nearest whole week. Example: "31" weeks (Note: use "40" months for report of "full term." Self-Reported Birth Data Form Adapted from: http://unstats.un.org/unsd/demographic/products/dyb/DYBNat/NotesNatStatTab12.htm	N/A *Continuous* "27" = 0-6 months= <28 weeks "31" = 7 months = 28-31.9 weeks "35" = 8 months = 32-36.9 weeks "40" = 9 months = 37.0-40.9 wks "41" = 10 months = ≥41 77=Missing 99=Don't know
306 1 column	PREMI_SR	Self-reported prematurity status at birth. Self-Reported Birth Data Form	0=No 1=Yes 7=Missing 9=Don't know

Codes for Self-Reported Birth Data

Column	Variable Name	Description	Category
366-367 2 columns	GEST_SR2	Second self-reported gestational age at birth to the nearest whole week. Example: "31" weeks (Note: use "40" months for report of "full term." Self-Reported Birth Data Form Adapted from: http://unstats.un.org/unsd/demographic/products/dyb/DYBNat/NotesNatStatTab12.htm	N/A *Continuous* "27" = 0-6 months= <28 weeks "31" = 7 months = 28-31.9 weeks "35" = 8 months = 32-36.9 weeks "40" = 9 months = 37.0-40.9 wks "41" = 10 months = ≥41 77=Missing 99=Don't know
368 1 column	PREM_SR2	Second self-reported prematurity status at birth. Self-Reported Birth Data Form	0=No 1=Yes 7=Missing 9=Don't know
307 1 column	MOMDIAB	Did your mother have any type of diabetes during her pregnancy with you? Self-Reported Birth Data Form	0=No 1=Yes 7=Missing 9=Don't know
308 1 column	TWINMORE	Twin, triplet, or multiparous level at birth? Self-Reported Birth Data Form	0=No 1=Yes 7=Missing 9=Don't know
		Begin new codes at 369	

Codes for Official Vital Records Birth Data

Column	Variable Name	Description	Category
309-316 8 columns	DATETOVR	Date birth data request sent to Vital Records Office Official Birth Data Collection Form	N/A *Character variable. Enter 8 digits.* *MM/DD/YYYY*
317-324 8 columns	DATEFRVR	Date birth data request obtained from Vital Records Office Official Birth Data Collection Form	N/A *Character variable. Enter 8 digits.* *MM/DD/YYYY*
325-332 8 columns	DOB	Date of birth. Official Birth Data Collection Form and Questionnaire, Page 2, Q8.	N/A *MM/DD/YYYY*
325-326 2 columns	MONTHDOB	Month of birth. Official Birth Data Collection Form and Questionnaire, Page 2, Q8.	N/A *MM* *Continuous var: 2 digits.*
327-328 2 columns	DAYDOB	Day of birth. Official Birth Data Collection Form and Questionnaire, Page 2, Q8.	N/A *DD* *Continuous var 2 digits.*
329-332 4 columns	YEARDOB	Year of birth. 19XX Official Birth Data Collection Form and Questionnaire, Page 2, Q8.	N/A *YY* *Continuous var: last 2 digits entered.*
333-334 2 columns	STATE	State where born. See attached list. Study includes only women who were born in one of the 50 states, or the District of Columbia, of the U.S.A. Official Birth Data Collection Form and Questionnaire, Page 2, Q8.	N/A *Character var.*
335-339 5 columns	BWLBS_VR	Birthweight in pounds (to nearest quarter pound) and ounces (to nearest quarter ounce, when applicable) Example: "11.75" pounds. Official Birth Data Collection Form	N/A *Continuous* 0.50# = 8 oz; 0.25# = 4 oz
340-344 5 columns	BWOZS_VR	Birthweight in ounces (to the nearest quarter ounce) Example: "14.25" ounces.	N/A *Continuous*
345-348 4 columns	BWGMS_VR	Birthweight in grams (to nearest 1 gr.) Example: 2116 grams Official Birth Data Collection Form	N/A *Continuous*
349-350 2 columns	GEST_VR	Gestational age at birth to the nearest whole week. For 1-3 days, average down. For 4-6 days, average up. Official Birth Data Collection Form	N/A *Continuous* "27" = 0-6 months= <28 weeks "31" = 7 months = 28-31.9 weeks "35" = 8 months = 32-37.0 weeks "40" = 9 months = 37.1-40.9 wks "41" = 10 months = ≥41 77=Missing
351 1 column	PREMI_VR	Premature at birth? Born before completion of 37 weeks gestation? Official Birth Data Collection Form	0=No 1=Yes 7=Missing

Column	Variable Name	Description	Category
352 1 column	MOMDM_VR	Did mother have any type of diabetes during pregnancy with participant? Official Birth Data Collection Form	0=No or Not Indicated on Official Birth Document 1=Yes 7=No Official Document
353 1 column	TWIN_VR	Twin, triplet, or other multiparous level at birth? Official Birth Data Collection Form	0=No 1=Yes 7=Missing
		Begin new codes at 369	

Codes for Calculated Data Fields

Column	Variable Name	Description	Category
	DURATION	YEARFORM – YRDIAGN	N/A *Continuous*
	SBPAVG	Average systolic blood pressure Calculated	N/A *Continuous*
	DBPAVG	Average diastolic blood pressure Calculated	N/A *Continuous*
	HTAVG	Average height in centimeters Average weight in kilograms Calculated	N/A *Continuous*
	WTAVG	Average weight in kilograms Calculated	N/A *Continuous*
	BMI	Body mass index based on average of height and weight, kg/m^2 Calculated	N/A *Continuous*
	OBESALL	Overall obesity based on BMI Calculated	1=Normal weight (≤24.9) 2=Overweight (25.0 to 29.9) 3=Obesity (≥30.0)
	WAISTAVG	Average waist circumference, to nearest 0.1 cm, based on measures at smallest diameter of waist Calculated	N/A *Continuous*
	WCUMAVG	Average waist circumference, to nearest 0.1 cm, based on measures 1 inch above umbilicus. Calculated	N/A *Continuous*
	WCCRAVG	Average waist circumference, to nearest 0.1 cm, based on measures midway between iliac crest and lower rib. Calculated.	N/A *Continuous*
	HIPAVG	Average hip circumference, to nearest 0.1 cm Calculated	N/A *Continuous*
	WHR	Average waist circumference (WAISTAVG) divided by average hip circumference (HIPAVG), to one decimal place. Based on measures at smallest diameter of waist. Calculated	N/A *Continuous*
	WHRUM	Average waist circumference (WAISTAVG) divided by average hip circumference (HIPAVG), to one decimal place. Based on measures at smallest diameter of waist. Calculated	N/A *Continuous*
	WHRCR	Average waist circumference (WAISTAVG) divided by average hip circumference (HIPAVG), to one decimal place. Based on measures at smallest diameter of waist. Calculated	N/A *Continuous*
	OBESWC	Abdominal obesity (WC ≥88 cm) Based on measures at smallest diameter of waist. Derived	0=No 1=Yes
	OBESWCUM	Abdominal obesity (WC ≥88 cm) Based on measures 1 inch above umbilicus. Derived	0=No 1=Yes
	OBESWCCR	Abdominal obesity (WC ≥88 cm) Based on measures midway between iliac crest and lower rib. Derived	0=No 1=Yes

Column	Variable Name	Description	Category
	OBWHR	Abdominal obesity (WHR >0.80). Based on measures at smallest diameter of waist. Derived	0=No 1=Yes
	OBWHRUM	Abdominal obesity (WHR >0.80). Based on measures 1 inch above umbilicus. Derived	0=No 1=Yes
	OBWHRCR	Abdominal obesity (WHR >0.80). Based on measures midway between iliac crest and lower rib. Derived	0=No 1=Yes
	SFPG	Fasting plasma (blood) glucose converted to International Standard Measurements, in mmol/L Calculated value: (FPG/18)	N/A
	SFPG7	Fasting plasma (blood) glucose <7 mmol/L. Calculated conversion to International Standard Measurements? Calculated value.	0=No 1=Yes
	BWLB_CVSR	Birth weight in pounds. Calculated value. Use to convert birth weight reported by participant in grams to pounds.	N/A *Continuous*
	BWGM_CVSR	Birth weight in grams. Calculated value. Use to convert birth weight reported by participant in pounds to grams.	N/A *Continuous*
	BWLB_CVVR	Birth weight in pounds. Calculated value. Use to convert birth weight reported by vital records in pounds to grams.	N/A *Continuous*
	BWGM_CVVR	Birth weight in grams. Calculated value. Use to convert birth weight reported by vital records in grams to pounds.	N/A *Continuous*
	WCUMAVG	Waist average, in inches. Based on diameter of waist one inch above umbilicus.	N/A *Continuous*
	WAISTAVIN	Waist average, in inches. Based on smallest diameter of waist. 1 inch = 2.54 cm Calculated	N/A *Continuous*
	WCUMAVGIN	Waist average, in inches. Based on measures 1 inch above umbilicus. 1 inch = 2.54 cm Calculated	N/A *Continuous*
	WCCRAVGIN	Waist average, in inches. Based on measures midway between iliac crest and lower rib. 1 inch = 2.54 cm Calculated	N/A *Continuous*
	HIPAVGIN	Hip average, in inches. 1 inch = 2.54 cm Calculated	N/A *Continuous*
	HTAVGIN	Height average, in inches. 1 inch = 2.54 cm Calculated	N/A *Continuous*
	WTAVGLB	Weight average, in pounds. Calculated	N/A *Continuous*
	WT25KG	WT25/2.2 Weight at 25 years of age, in kilograms. Calculated	N/A *Continuous*

Column	Variable Name	Description	Category
	GDMRISK	Risk of developing T2DM from history of + and/or big baby. Calculated	gdmrisk: 1 if gestdm = **1** and bigbaby = **1** 1 if gestdm = **1** and bigbaby = **0** 1 if gestdm = **1** and bigbaby = '.' 0 if gestdm = **0** and bigbaby = **0** 1 if gestdm = **0** and bigbaby = **1** 0 if gestdm = **0** and bigbaby = '.' 1 if gestdm = '.' and bigbaby = **1** 0 if gestdm = '.' and bigbaby = **0** '.' if gestdm = '.' and bigbaby = '.'
	BWCATEG1	Combined birth weight variable (BW_SR) as categorical variable Calculated	bwcateg1: 1 if bw_sr <= **5.5000** 2 if **5.5001** < bw_sr < **9.0** 3 if bw_sr >= **9**
	BWCATEG2	Combined birth weight variable (BW_SR2) as categorical variable Calculated	bwcateg2: 1 if bw_sr2 <= **5.5000** 2 if **5.5001** < bw_sr2 < **9.0** 3 if bw_sr2 >= **9.0**
	BWCATEG3	Combined birth weight variable (BW_VR) as categorical variable Calculated	bwcateg3: 1 if birthwt_vr <= **5.5000** 2 if **5.5001** < birthwt_vr < **9.0** 3 if birthwt_vr >= **9.0**
	BWCATEG4	Combined birth weight variable (BW_COMBO) as categorical variable Calculated	bwcateg4: 1 if bw_combo <= **5.5000** 2 if **5.5001** < bw_combo < **9.0** 3 if bw_comb >= **9.0**
	BWCATEG5	Combined birth weight variable (BW_COMBO2) as categorical variable Calculated	bwcateg5: 1 if bw_combo2 <= **5.5000** 2 if **5.5001** < bw_combo2 < **9.0** 3 if bw_comb2 >= **9.0**
	BWCATEG6	Combined birth weight variable (BW_VALID) as categorical variable Calculated	Bwcateg6: 1 if bw_valid <= **5.5000** 2 if **5.5001** < bw_valid < **9.0** 3 if bw_valid >= **9.0**
	bw_combo_gm	= bw_combo * 453.5	N/A; Continuous
	bw_combo2_gm	=bw_combo2 * 453.5	N/A; Continuous
	bw_sr_gm	= bw_sr * 453.5	N/A; Continuous
	bw_sr2_gm	= bw_sr2 * 453.5	N/A; Continuous
	birthwt_vr_gm	= birthwt_vr * 453.5	N/A; Continuous
	bw_valid_gm	= bw_valid * 453.5	N/A; Continuous
	bw_combo	Birthweight from vital records, verified self-reported birth weight, or birth weight collected at enrollment. Order of preference: vital records>verified self-report>enrollment self-report.	N/A; Continuous
	bw_combo2	Self-reported birth weight that was verified with a document or a relative or some other source.	N/A; Continuous
	bw_sr	Birth weight collected at enrollment.	N/A; Continuous

Column	Variable Name	Description	Category
	bw_sr2	Self-reported birth weight that was verified with a document or a relative or some other source.	N/A; Continuous
	birthwt_vr	Birth weight obtained from Vital Records Offices or State Centers for Health Statistics.	N/A; Continuous
	BW_VALID	Validated birth weights Consists of vital records or a self-reported birth weight that was verified with a document or a relative or some other source.	N/A; Continuous
	FAMDM	Participant reported that at least one parent and/or one sibling has/had diabetes. Derived	1 = yes 0 = no 9 = Not sure
	SMOKE	Categories of smoking based on questionnaire items Q5, Q6, Q7, page 6. Derived	**1**='Non-smoker **2**='Former smoker' **3**='Current smoker' **7**='Missing'
	AGE	Age calculated from date of birth and date that participant was enrolled in study; that is, when anthropometric and blood pressure/blood glucose collected. Calculated	age = yearform – yeardob
	AGE_YR	Age in year (THIS VARIABLE IS NOT NEEDED FOR THIS STUDY. ACTUALLY DIVIDES CURRENT AGE BY 12 MONTHS.) Calculated	age_yr = age/12
	COLLEGE	Derived from SCHOOL variable.	1 = some college or greater, including advanced degrees 0 = no college; includes high school or less and vocational /trade/technical school after high school.
	SMOKECAT	Derived from SMOKE variable.	1 = 'Non-smoker or former smoker' 0 = 'Current smoker'
	WHR_100	WHR * 100. Addresses issues surrounding OR for WHR.	N/A; Continuous
	SBPCAT		if sbpavg <120 sbpcat = 0 if sbpavg >= 120 sbppcat = 1
	DBPCAT		if dbpavg <80 dbpavg = 0 if dbpavg >= 120 dbpcat = 1
	SBPCATHI		if sbpavg <140 sbpcathi = 0 if sbpavg >= 140 sbppcathi = 1
	DBPCATHI		if dbpavg <90 dbpcathhi = 0 if dbpavg >= 90 dbpcathi = 1

KEY

6, 66, 6666, etc. = Refused

7, 77, 7777, etc.= Missing

8, 88, 8888, etc. = Not applicable

9, 99, 9999, etc. = Unknown, "Don't know," "Not sure"

Medications Data from Screening Questionnaire

Column	Variable Name	Description	Category
1-3 3 columns	ID	Participant Identification Number Located at top of each page.	N/A *Continuous var: use 3 digits.*
4 1 column	DM_STATUS	Diabetes status. Screening Questionnaire.	0=No 1=Yes
5 1 column	DM_MED	Diabetes medications. Screening Questionnaire. ***"Not applicable" only if participant reported does not have diabetes.***	0=No diabetes meds 1= Oral medications, only 2= Insulin, only 3= Oral medication + insulin 4=Not taking prescribed dm meds 5= MD order to discontinue dm meds 8=N/A, has no diagnosis of diabetes
6 1 column	MED_FREE	Takes no medication of any kind. Screening Questionnaire.	0=No 1=Yes
7 1 column	BP_MED	Takes medication for high blood pressure. Screening Questionnaire.	0=No 1=Yes
8 1 column	OTHER_MED	Takes medication other than for diabetes or for high blood pressure. Screening Questionnaire.	0=No 1=Yes
9 1 column	SUPPLEMENT	Takes vitamin, mineral, or other dietary supplement whether prescription or over-the-counter. Screening Questionnaire.	0=No 1=Yes

Note: All information in this section of the Data Dictionary (Codebook) is by self-report from Screening Questionnaire.

Appendix D. Selected Recruitment Materials and Resources

DC CHARTERED FAMILY HEALTH CENTER

Taking Care of All of Your Health Needs in One Place

by MONICA Z. UTSEY

Finding adequate health care in Ward 7 can be a challenge. Once you find it, following up with all of the lab work, prescriptions, and x-rays, can be downright impossible to do without costing a fortune in transportation fees. This is what makes the DC Chartered Family Health Center (DCCFHC) such a benefit to the community. "We are a full service medical center," said Dr. Levenda Orr, CEO and Medical Director. "We are a one-stop shopping health center."

April 2: Open House Health Fair

Free BMI testing, glucose screenings, and children 1-12 can receive free dental screenings on the Colgate mobile unit. 1:00-4:00 pm

April 16: Asthma Health Fair
11:00 am-3:00 pm

Members of the DCCFHC can take the baby to get a check up, fill a prescription, get lab work done, have their teeth cleaned, get new eye glasses, and take a health education class all at the same location. For families without cars and limited incomes, this kind of convenience is priceless.

In addition, DCCFHC offers in-patient hospital services, home health services, maternity and pre-natal care, transportation for Medicaid members, immunizations, emergency care, out-patient medical services, health education classes, and 24-hour medical advice.

When patients are still unable to get to the center, there is a health van that will come to them. The Wellness Promotion Van makes rounds in the community to bring free health education screenings and health information to area residents.

The DCCFHC is also big on preventive health measures as well. There are programs which address some of the diseases that plague the African-American community, including the big three: high blood pressure; diabetes; and heart disease. There are free health education classes on high blood pressure, diabetes, asthma, nutrition and weight loss, and smoking cessation. In addition, the DCCFHC offers a prenatal class called Ready, Set, Go, and aerobic exercise classes.

The prenatal classes are designed to help expectant mothers learn to properly care for themselves and their babies, including videos, teaching aids, interactive games and discussion/instruction. The nutrition and weight management class focus is on changing unhealthy eating behaviors, learning how to incorporate exercise, how to get the proper nutrients, how to read food labels, how to prepare foods in a healthy way, and how to make healthy food selections based on a limited budget. In addition, members are able to attend two free sessions each week at the Union Center Health Club in Northeast. For overweight children ages 10 to 15, there is the Eagle's Circle Program. It is a unique eight-week wellness program that helps young people improve their health, fitness, and self-esteem. If a member's needs cannot be met through one of the many services offered, then one-on-one counseling can be arranged.

"We've served the DC community for 16 years and have been a leader in providing quality health care," said Ron Joiner, program specialist for DCCFHC. "Our prenatal care program is one of the most well-attended health education classes that we offer, and the asthma clinic has helped cut down on patients going to the emergency room for asthma issues."

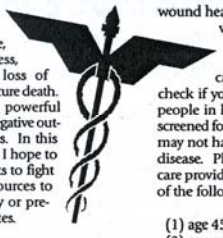
The Chartered Health Plan was incorporated in September 1986, and is a private sector minority owned and operated Health Maintenance Organization. The Chartered Health Plan was also responsible for developing a system of managed health care for families receiving Medicaid and assistance for needy families. Chartered Health Plan's provider network includes over 1,400 community-based Providers, 54 primary care sites and 10 hospitals.

For more information:
DC Chartered Family Health Center
3924 Minnesota Ave., NE
Washington, DC 20017
202.398.8683
www.chartered-health.com
Mon.-Fri., 9:00 am–5:00 pm; Sat., 9:00 am –1:00 pm.

DIABETES: THE "INVISIBLE" DISEASE

by B. MICHELLE HARRIS, M.S., R.D., M.P.H., L.D.

According to the National Institutes of Health (NIH), diabetes is an epidemic in the African-American community. Like hypertension, diabetes is a "silent killer" or an "invisible disease." One of every three persons with diabetes does not know that he or she has it. We sometimes feel that "what we don't know can't hurt us." With diabetes, this way of thinking can be deadly. It can expose us to risks for problems such as heart disease, stroke, blindness, kidney disease, loss of limbs, and premature death. Information is a powerful tool against the negative outcomes of diabetes. In this month's column, I hope to arm you with facts to fight diabetes and resources to help you to delay or prevent type 2 diabetes.



What is diabetes?

The National Diabetes Education Program defines diabetes as "a chronic metabolic disease in which the body does not produce or properly use insulin, a hormone that is needed to convert sugar, starch, and other food into energy." Chronic means that the condition is long-term and that it will not go away quickly like a cold or measles. In fact, diabetes may never "go away." Metabolic refers to metabolism or the production of energy in our bodies. Sugar, starch, protein, and fats provide our bodies with energy. People with diabetes do not get enough energy from their food because their body does not produce enough insulin or the insulin that is produced does not work well to move glucose (a sugar) from the blood to cells in the muscle and other tissues that need glucose as fuel.

Diabetes is known by many names. How many of these names have you heard diabetes called? Names like (for type 1 diabetes) juvenile diabetes, insulin-dependent diabetes, sugar; or (for type 2 diabetes) adult-onset diabetes, noninsulin-dependent diabetes, sugar; or (for prediabetes) borderline diabetes, "a touch of sugar." According to the American Diabetes Association (ADA) and the World Health Organization (WHO), the accurate terms for diabetes and its related condition (prediabetes) are bolded. This is because the other terms may not fit all who are put in those categories. For example, some people with type 2 diabetes need insulin shots to control their blood sugar, especially if they have had diabetes for years. Likewise, people as young as 16, 12, and even eight years are being diagnosed with type 2 diabetes, a condition once diagnosed exclusively in people over 40 years of age. In the United States, of those who have diabetes, 90 percent have type 2 and 10 percent have type 1.

How do we know we have diabetes?

Not everyone with diabetes has the "classical" symptoms of diabetes. The ADA and NIH list the following as diabetic symptoms: frequent urination (running to the bathroom to pee); excessive thirst; extreme hunger; unusual weight loss; increased fatigue (feeling tired all the time); irritability; and blurry vision. An often-overlooked symptom for diabetes is poor wound healing, and for women, chronic vaginal infections (and itching). If you have any of these symptoms, please see a health care provider immediately to check if you have diabetes. In addition, people in high-risk categories should be screened for diabetes, especially since they may not have symptoms until late in the disease. Please get screened by a health care provider for diabetes if you have any of the following risk factors:

(1) age 45 years or older
(2) overweight
(3) family history of diabetes (mother, father, sister, brother)
(4) history of gestational diabetes (diabetes during pregnancy or delivering a "large baby")
(5) membership in a high-risk ethnic or racial group (African-American, Native American, Latin American, Asian American; Pacific Islander)
(6) inactive lifestyle
(7) high blood pressure (140/90 or higher)
(8) high total cholesterol, low HDL-cholesterol, high triglycerides levels

A new risk factor being examined is low birthweight. The African-American Women's Health Study seeks to shed light on the relationship between birthweight and type 2 diabetes in African-Americans. By participating in studies such as the African-American Women's Health Study, we can give input into health policies and programs designed for our community. Another study, the Diabetes Prevention Program (DPP), is a national study that showed that we can prevent or delay type 2 diabetes. For many, lifestyle changes in the form of a healthy diet, losing a little weight, and moderate physical activity (30 minutes a day, five days per week) can help control diabetes. In the District of Columbia, to connect with the Diabetes Prevention and Control Program, call 202.727.1000 or visit www.dchealth.gov. You can also visit www.diabetes.org or www.medlineplus.gov to learn more about diabetes.

Let us take the blinders off and fight diabetes through becoming informed. Learn your risk status through reading and through having a conversation with your health care provider. Take action and change lifestyle habits that contribute to type 2 diabetes. Stop making diabetes an "invisible" disease and a "silent killer" in our community.

B. Michelle Harris is a Registered Dietitian whose focus is public health and community health through education, information, and research. Ms. Harris seeks US-born African-American women aged 38-57 for a study titled, "Birthweight and Current Weight Status and Their Relationship to Type 2 Diabetes." Call her at 202.291.1798 to volunteer for this study.

Visit www.capitalcommunitynews.com for a larger version of this article.
(*East of the River* newspaper, April 2005)

WASHINGTON
City Paper
WASHINGTON'S FREE WEEKLY VOL.25, NO.9 MARCH 4–10, 2005

Classifieds

Volunteers

AFRICAN-AMERICAN WOMEN'S HEALTH study seeking AA women 38-57y.o. to volunteer one-visit/one-hour. Study examines birthweight and Type 2 diabetes. $10 gift certificate. Contact Michelle, 202/291-1798, bharris2@umd.edu.

ARCHDIOCESE OF WASHINGTON

CATHOLIC STANDARD

YOUR FAMILY'S CATHOLIC NEWSPAPER

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Researcher looking for African-American women for diabetes study

Michelle Harris, a doctoral student in the nutrition program of the University of Maryland, College Park, is looking for African-American women for a research study on diabetes. The study will help gain additional insight about African American women's health.

"The purpose of this study is to examine the relationship between type 2 diabetes and birthweight and current weight status in African-American women 38-57 years of age," said Harris, investigator for the study.

Previous studies have shown that being born small, in combination with obesity later in life, puts a person at an increased risk for developing chronic diseases such as type 2 diabetes. However, African-American women, a population that is at high risk for developing this form of diabetes, were not the focus of prior research for this question.

"If this research validates the previous studies, public health interventions can be created to help decrease the incidence of type 2 diabetes in African-American women," said Harris. She is a registered dietitian who holds a master of science degree in nutrition from Framingham State College and a master of public health degree from Harvard. She has worked extensively with African Americans and other minority populations at the community and public health levels.

Participants in this study should be between the ages of 38 and 57, born in the United States, and should live or work in the Washington metropolitan area. During the study, participants will have their blood pressure, body measurements and blood sugar levels taken. For more information about the study or to volunteer, contact Michelle Harris at (202) 291-1798 or email her at *bharris2@umd.edu.*

Study Flyer, Microsoft Word Version

The Nutrition Program of the University of Maryland is looking for African American Women for a Research Study on Birthweight and Diabetes

- You must be 38-57 years of age to participate.
- **You must *have* type 2 diabetes.**
- You must have been born in the United States.
- You will receive a $10 gift certificate and a nutrition/exercise booklet as a "thank you."
- We expect this study to take less than 1 hour of your time.
- This study will involve minimal risk to you.
- Call to find a location most convenient for you to join the study.
- All information is private and confidential

Co-Investigator: B. Michelle Harris, MS, RD, MPH
Principal Investigator: Mira Mehta, PhD
African American Women's Health Study (AAWHS)
University of Maryland Nutrition Program

You will be asked to:

- Have your blood pressure taken.
- Have your height, weight, waist, and hip measurements taken.
- Have blood sugar measured (finger prick). Fast for 8 hours (overnight fast—*can* drink water).
- Bring a list of the medicines you take.
- Give your written consent to obtain your birth weight and other birth facts from your birth certificate.
- Fill out a questionnaire.

For more information or to volunteer contact,

Michelle Harris, MS, RD, MPH
bharris2@umd.edu
Phone: 202-291-1798

http://www.agnr.umd.edu/aawhs

Recruiting through mid-January 2006

Print Advertisements, Announcements, and Articles

Printed Recruitment Materials: Ads, Articles, Church Bulletins, Flyers

East of the River

The Washington Informer

The Washington City Paper

The Archdiocese of Washington Catholic Standard

The District Chronicles

The Afro

The Prince Georges Gazette

The Washington Post Metro Express

Various Church Bulletins
Saint George's Episcopal Church
Saint Martin's Catholic Church
Our Lady of Perpetual Help Catholic Church
Saint John's Catholic Church
Queen's Chapel Church
Masjid (Mosque) Mahammed
Zion Baptist Church
Newborn Church
Etc.

Online Recruitment: Ads, Blogs, Listserves, Study Website

Craigs List
http://washingtondc.craigslist.org
October 12, 2005
DIABETES. African-American women 38-57 years with type 2 diabetes needed for study, one-visit/one-hour. Participants must live and/or work in the Greater Washington Metropolitan Area, including the District of Columbia; Prince George's and Montgomery Counties, Maryland; Northern Virginia. Free $10-gift card. Flexible morning schedule. Contact Michelle at 202-291-1798. Study scheduled to be completed by end of November 2005.

Penny Saver Wired
http://www.mdpennysaver.com
October 2005
African-American women 38-57 years with type 2 diabetes, one-visit/one-hour study. $10-gift card. Michelle 202-291-1798, bharris2@umd.edu

Petworth News Blog
October 2005
http://petworthnews.blogs.com

University of Maryland Outlook Online
October 18, 2005
http://www.outlook.umd.edu

Washington City Paper
February 27, 2005 to January 2006
http://washingtoncitypaper.com/

Study Website
Beginning January 2005
http://extension.umd.edu/nutrition/AAWHS/index.cfm

Various Listserves
October 2004 to December 2005

Department of Nutrition and Food Science
0112 Skinner Building
University of Maryland
College Park, Maryland 20742

November 3, 2004

Pastor XXXXXX
XXXXXXXXXX
Washington, DC 200xx

Dear Pastor XXXXXXX:

Greetings. I need your help. I am a Ph.D. Candidate at the University of Maryland, College Park. My dissertation research project is entitled, "Birthweight and Current Weight Status and Their Relationship to Type 2 Diabetes in African American Women." I need to enroll 540 U.S.-born women who live or work in the Greater Washington Metropolitan Area, including Alexandria. For this study, 270 women (the controls) will not have diabetes and 270 women (the cases) will have type 2 diabetes. I can enroll women only during morning hours given that this study includes a fasting blood glucose test from a finger stick. Thus, participants should not have eaten for eight hours before their appointment. Ideally, I would reach the goal of enrolling all my study participants before Christmas 2004. For this, I really do need your support and the support of others who could help me to access a large number of African American women between the ages of 40 to 55 years of age (plus or minus two years, so actually 38-57). If enough women are willing to support this project by volunteering less than one hour of their time, then I will be able to conduct a successful project that would benefit the African American community where type 2 diabetes has reached the level of an epidemic nationwide. Each participant will receive a ten-dollar gift certificate for their participation in this study.

Please note that participants have the choice of reporting to my lab located on the campus of the University of Maryland, College Park. Another option they have is for me to report to wherever it is convenient for them: church. However, this second option is only available if at least four or five women are will enroll during a session that would run from about 7 a.m. until around noon, with each women donating less than one hour of her time. Appointments for this study can be made for any day of the week.

I have enclosed a study flyer that describes all the steps involved for the study participants. I have also enclosed a copy of the form from the University of Maryland's Institutional Review Board (IRB) that authorizes me to conduct this study. I ask that you post the study flyer and that you include my study in your announcements and in your weekly church bulletin. I would be happy to meet with you and with members of your congregation to answer any questions that you may have regarding this study and/or to set up dates for me to conduct the study at your church. Please call me at 202-291-1798 (Study number) or 301-405-0775 (Office number) if you are interested in supporting this project. I would love to include you or your church, with your permission, as supporters of this research project.

Thank you for your consideration.

Sincerely,

B. Michelle Harris, Ph.D. Candidate

African American Women's Health Study

Appointments

Sunday, August 22, 2004

Time	Name	Contact Information (Telephone/E-mail)
7:00		
7:00		
7:00		
8:00		
8:00		
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12:00		

Study Benefits to Participants

A brief individual nutrition education session was an incentive for enrolling in the study. The nutrition education component also proved to be a great tool for word-of-mouth recruitment. Several participants stated either during the enrollment session or at a later date that they were motivated to change their lifestyle because of the interaction they had with the investigator and/or because of the nutrition education materials that they read and shared with their families. The ten-dollar gift card to a supermarket or health food complex was an incentive that allowed participants to apply their knowledge of selection of nutritious foods. Initially, gift cards were only provider for redemption at a supermarket. However, in response to health-conscious participants, a choice was added for gift cards that could be redeemed at a health food store. Despite the prominent placement of the incentives on the study flyer, several participants at enrollment seemed surprised to learn that they would receive health education and a gift card. This may be because many participants were recruited through word-of-mouth.

Appendix E. Informed Consent Form and IRB Approval Memorandum

Informed Consent Form

Study Title	Birthweight and Current Weight Status in African American Women and Their Relationship to Type 2 Diabetes
Statement of Age	I state that I am over 18 years of age and wish to take part in a research study conducted by B. Michelle Harris of the Nutrition Program of the University of Maryland, College Park.
Purpose	The purpose of this study is to help us to learn more about how birthweight and current weight relate to type 2 diabetes and other conditions. This study will involve African American women 40 to 55 years of age.
Procedures	I understand that this study will involve less than one hour of my time. • First, my blood pressure will be measured. • Second, I will be weighed. • Third, my height, waist, and hips will be measured. • Fourth, one drop of blood will be taken after my finger tip is pricked. • Fifth, I will fill out a questionnaire about my own health history, my family's history of diabetes, and my lifestyle. • Last, I will be asked to allow the researcher to collect information on my own birth outcome. This will include my birthweight and whether I was born premature.
Confidentiality	I understand that information I provide is confidential. My name will not be revealed at any time. My information will be grouped with others' for any reports. My information will be stored in a locked drawer in the Nutrition Department of the University of Maryland. Only the researchers will be able to open this locked drawer. At the end of the study, this information will be destroyed.
Risks	I understand that there is very little risk to me in being part of this study. There is a very small chance of infection from the finger prick. The researcher has been trained and will follow Universal Precautions (hand washing, gloves, etc.) to decrease these risks.
Benefits	I understand that this research will not help me personally, but that it will aid in the design of a study that will help with learning more about the health of African American women. I will receive facts about high blood pressure, physical activity, and diabetes. I will receive a ten-dollar gift certificate if I am part of this study.

Medical Care

I understand that the University of Maryland does not provide any medical or hospitalization insurance coverage for participants in this research study. The University will not provide me with any compensation for any injury I may sustain as a result of my being part of this research study, except as required by law.

Freedom to Withdraw

I know that I can take as much time as I need to ask any questions and to discuss this study with the research team, or with my family, my friends, or my health care provider before I decide to take part in this study.

I understand that I am free to ask questions or to withdraw from being part of this study at any time without penalty.

Principal Researchers

B. Michelle Harris, M.S., R.D., M.P.H.
Doctoral Candidate
202-291-1798
bharris2@umd.edu

Contact Information

Mira Mehta, Ph.D.
Faculty Supervisor (Principle Investigator)
301-405-1006
mmehta@umd.edu

Graduate Program in Nutrition, Room 0102 Skinner Building
University of Maryland, College Park, Maryland 20742

If I have questions about my rights as a research participant or if I wish to report a research-related injury, I know that I can contact:

Institutional Review Board Office
University of Maryland
College Park, Maryland 20742
E-mail: irb@deans.umd.edu
Telephone: 301-405-4212

IRB APPROVED
VALID UNTIL
MAY 19 2006
UNIVERSITY OF MARYLAND
COLLEGE PARK

Printed Name _____

Signature of Participant _____

Date _____

Witness _____ **Date** _____

IRB APPROVAL STAMP

UNIVERSITY OF MARYLAND
INSTITUTIONAL REVIEW BOARD

2100 Lee Building
College Park, Maryland 20742-5121
301.405.4212 TEL 301.314.1475 FAX

Reference: IRB HSR Identification Number 04-0270

May 19, 2004

MEMORANDUM

Notice of Results of Final Review by IRB on HSR Application

TO: Dr. Mira Mehta
Ms. B. Michelle Harris
Department of Nutrition and Food Science

FROM: Dr. Phylis Moser-Veillon, Co-Chairperson
Dr. Marc Rogers, Co-Chairperson
Institutional Review Board

PROJECT ENTITLED:
"Birth-weight and Current Obesity Status in African American Women and their Relationship to Type 2 Diabetes. Phase 1: Survey Instrument Validation Using Focus Groups. Phase 2: Pilot Study. Phase 3: Full Study"

The Institutional Review Board (IRB) concurs with the departmental Human Subjects Review Committee's (HSRC's) preliminary review of the application concerning the above referenced project. The IRB has approved the application and the research involving human subjects described therein. We ask that any future communications with our office regarding this research reference the IRB HSR identification numberindicated above.

We also ask that you not make any changes to the approved protocol without first notifying and obtaining the approval of the IRB. Also, plese report any deviations from the approved protocol to the Chairperson of your departmental HSRC. If you have any questions or concerns, please do not hesitate to contact us at irb@deans.umd.edu.Thank you.

ADDITIONAL INFORMATION REGARDING IRB/HSRC APPROVALS

EXPIRATION OF IRB APPROVAL—Approval of non-exempt projects expires one year after the. Official date of IRB approval; approval of exempt projects expires three years after that date. If you expect to be collecting or analyzing data after the expiration of IRB approval, please contact the HSRC Chairperson in your department about submitting a renewal application. **(PLEASE NOTE: If you are not collecting data from human subjects and any on-going data analysis does notincrease the risk to subjects, a renewal application would not be necessary.)**

STUDENT RESEARCHERS—Unless otherwise requested, the IRB will send copies ofapproved paperwork to the supervising faculty researcher (or advisor) of a project. We askthat such persons pass on that paperwork or a copy to any student researchers working on that project. That paperwork may be needed by students in order to apply for graduation. **PLEASE BE ADVISED THAT THE IRB MAY NOT BE ABLE TO PROVIDE COPIES OF THAT PAPERWORK, particularly if several years have passed since the date of the original approval.**

Enclosures (where appropriate), will include stamped copy of informed consent forms included in application and any copies of the application not needed by the IRB; copies of this memorandum and any consent forms to be sent to the Chairperson of the Human Subjects Review Committee.

Appendix F. Sample Size Estimation (A Priori)

The sample size calculations based on the Equation is conservative and may overestimate the sample size given that the sample population for the current study is restricted to one gender (female), one race (African American), and a relatively narrow age range (38 to 57 years). The sample size generated from Equation 1 is 244 per group. This value is very close to the value obtained using the UCLA on-line calculator.[133] From a table generated from the Equation, with α set at 0.05 (two-sided) and β set at 0.20, and a probability, p_0, equal to approximately 0.15, the sample size estimated to detect a two-fold risk (R = 2.0) is 207 per group. If the probability, p_0, were 0.10, the sample size estimate would be 282. The mean of these two estimates is 245, which can be considered an extrapolation for the .13 probability for low birth weight in the study population.

Equation

$$n = [z_\alpha (2\bar{p}\bar{q})^{1/2} + z_\beta (p_1q_1 + p_0q_0)^{1/2}]^2 / (p_1 - p_0)^2$$

$z_\alpha = 1.96$
$z_\beta = 0.84$

$\bar{p} = ½ (p_1 - p_0) = ½ (0.23 + 0.13) = ½ (0.36) = 0.18$

$\bar{q} = 1 - \bar{p} = 1 - 0.18 = 0.82$
$p_0 = 0.13$
$p_1 = p_0R/ [1 + p_0 (R-1)] = 0.13 (2) / [(1 + 0.13) (2-1)] = 0.26 / 1.13 = 0.23$
$q_1 = 1 - p_1 = 1 - 0.23 = 0.77$
$q_0 = 1 - p_0 = 1 - 0.13 = 0.87$

$$n = [1.96 (2 * 0.18 * 0.82)^{1/2} + 0.84 \{(0.23 * 0.77) + (0.13 * 0.87)\}^{1/2}]^2 / (0.23-0.13)^2 = 244$$

Note: The above equation is Equation 6.1 of Schlesselman, p. 145.[134]

Appendix G. Study Equipment: Scales, Blood Pressure Device, Glucometer

The equipment used in the study was portable and feasible for a study that involved several enrollment sites. The Seca self-calibrating electronic scale is a research-level tool and accommodated the weight of all but one participant who described herself as "grossly obese." The investigator used the weight that was recorded by this participant's health care provider five days before her enrollment in the study.

The Road Rod stadiometer proved to be problematic at times for taking heights for adult women. This stadiometer had the tendency to sway; thus, the investigator had to be especially diligent in assuring that standardized procedures were followed to maintain internal validity. Participants whose study heights seemed to be as much as one-half or one inch different from their heights measured at medical examinations, often several years before their participation in the study, were reminded that heights measured in medical facilities might not always be collected in a standardized manner and that height may decrease for middle-age women due to bone loss. Maintaining a dialogue with each participant seemed to put them at ease, encouraged them to comment on the study, and made them true collaborators on this study.

Pilot testing equipment and procedures are important for any study. For the current study, though the investigator received intensive training with measuring blood pressure on the electronic blood pressure device, the pilot study helped her to identify the need for an extra-large cuff to accommodate extremely large women.

The Hemocue 201 glucometer compares favorably to clinical laboratory glucometers.[74] Analyzing blood glucose levels using the electronic digital glucometer was quick and convenient. Participants appreciated the ease of donating a small drop of blood. The pilot study proved to be important for the investigator to develop competence with operating the glucometer. For instance, pilot study participants routinely exhibited blood glucose levels below 70 mg/dL. From repeated measures on selected participants, it was discovered that not enough blood was drawn into the microcurvette for the first several participants who enrolled in the pilot study.

Accuracy in plasma glucose measurements was maintained throughout the study through testing a control sample at the beginning of each study day. The investigator received training on the Hemocue glucometer system through an on-site training session conducted by a company representative. A CD-ROM on proper use of the Hemocue glucometer helped the investigator to master and maintain proper techniques. It is suggested that investigators utilize all the support that companies can provide them in order to increase the accuracy and reliability of measurements.

Collecting duplicate measures for all measurements except plasma blood glucose for each participant helped to identify unreliable measures.

SCALES
Seca: http://www.seca.com

Weight
Seca Model 770
Capacity: 200 kg (440 pounds)
Graduation: 100 g (0.2 pounds)
Platform: 320 x 300 mm
Weight: 6.5 kg
Power Supply : Batteries

Height
Seca Model 214 (Road Runner™)
Measuring Range: 25-200 cm (10-78 inches)
Graduation: 1 mm (1/8 inch)
Dimensions 14 x 83¼ x 16½
Weight: 6 pounds

BLOOD PRESSURE DEVICE
ADC: http://www.adctoday.com/
American Diagnostic Corporation (ADC) Model 6014
Advantage™ Advanced Blood Pressure Digital Device
Power: Batteries and AC Adapter
Latex-Free Cuff

BLOOD GLUCOSE DEVICE
Hemocue: http://www.hemocue.com
Hemocue Blood Glucose Test System
Hemocue Glucometer Model 201

Appendix H. Focus Groups: Selected Findings and Forms

The input of focus group participants helped to improve study instruments, including the Screening Questionnaire, Study Questionnaire, Birth Data Collection Form, Study Flyer, and the Informed Consent form. In addition, focus group participants selected blood pressure/diabetes handouts from among a variety of possible choices. They also provided feedback on the gift card incentive. Focus group participants were between the ages of 25 and 79 years (Table H1). The majority had attended college, with several earning bachelor or graduate degrees.

A total of five focus group sessions were held. The first was conducted in a Midwestern city and consisted of 11 women. Much of their information was gathered through a survey with several open-ended questions. These focus group survey instruments are included in Appendix G. Four other focus groups, involving a total of 25 women, were held in the Washington, D.C., Metropolitan Area. Notes were recorded from these four sessions using the focus group survey instrument as a guide to spark discussion.

The focus groups found that the screening and full study questionnaires were clear as a whole, but could use some improvement. Wording and/or order of a few questions were changed. The format of the questionnaire was changed to leave more space between items so that participants could see the grouping of questions more easily. In addition, the study flyer was modified slightly to make it clear that the study needed women without diabetes in addition to women with type 2 diabetes.

The issue of fear of identity theft was raised by several focus group participants. One participant stated that the study's "confidentiality disclosures made

people feel more comfortable answering personal questions." She added, "Without confidentiality disclosures, the questions would seem invasive and possibly make people a little scared to answer questions because of identity theft." A few other women reported that other women would be reluctant to participate in the study or to give their personal information for fear of identify theft. Women reported that they were relieved that their Social Security numbers were not collected for the study.

Focus group participants selected the handouts to be used in the study. One participant stated, "[I] prefer the blood pressure sheet with the heart on it. The charts reinforce the information." Focus group participants reported that the supermarket gift card was "practical" and "a good thank you."

Table H1. Demographics for Focus Group Participants
U.S.-Born African-American Women 25-79 Years, *N*=36

	Frequency, *n*
Age (years)	
20-29	5
30-39	5
40-49	4
50-59	18
60-69	2
≥70	2
Region Where Focus Group Conducted	
Greater Washington, D.C., Area	25
Urban Midwestern Area	11
Education	
Less than high school	2
High school or technical/trade/vocational school	8
Some college associate, bachelor, graduate degree	26

Note. One focus group participate participated in more than one focus group meeting.
All data in this table were based on self-report.

Focus Group Protocol

Part 1: Introductions

Hi, my name is Michelle Harris. I am a Ph.D. Student in the Nutrition Department of the University of Maryland, College Park. I am the facilitator of this group interview today. _____ will assist me by taking notes of what you share here today.

Thank you for taking part in this group interview this evening [morning/afternoon]. You will be helping us to improve a form that will be used in a future study. That future study will be on how birthweight and adult weight may affect our risk for type 2 diabetes. I will be the lead researcher for that study.

There are no right or wrong answers. You will be asked to complete a form on what you recall about your health, your family's history of diabetes, and your birth information. After you complete each section of the form, I will ask you about the questions in that section. I will ask you if the question is clear as it is written. If you feel that a question is not written clearly, please suggest other ways for me to write the question so that it will be clearer for others.

We will review nine (9) pages. One form is the separate Screener Questionnaire that will be used to see if a woman is eligible to take part in the study. We will then review the four (4) sections of the Diabetes Study Questionnaire and a separate Birth Data Collection Form. We will also review the Cover Sheet for the Diabetes Study Questionnaire. Finally, we will review the Recruitment Flyers. Depending on the time, we may or may not get through all of the items, but that is okay. If we run out of time, you may contact me later to give your opinions about the other items. These pages that we will review are:

1. Screener Questionnaire
2. Cover Sheet for the Diabetes Study Questionnaire
3. Birth Information Form
4. Personal Health History Form
5. Family Diabetes History Form
6. Personal Lifestyle Form
7. Birth Data Collection Form
8. Recruitment Flyers (two)

The information you provide is private and confidential. Your name will not be shared. Your information will be grouped with others' for any reports. Your information will be stored in a locked cabinet in a locked office. There will be no taping or other electronic recording of this interview. Written notes will be destroyed by shredding within two years after the first report is published or two years from today, whichever comes last. By no means will these notes be kept for more than three years from today.

To help maintain the privacy and confidentiality of everyone here today, I ask that you not release the names of any participants to anyone outside this meeting.

This interview is scheduled to last for up to two hours. You are free to withdraw from being part of this interview at any time without penalty. If you think of something to add to your

comments after this interview ends, please feel free to contact me by phone, e-mail, letter, or in person. My contact information is listed below:

Home:	**Office:**
Michelle Harris 4505 Fifth Street, N.W. Washington, D.C. 20011 Phone: 202-291-8885 E-mail: bmharris@starpower.net	B. Michelle Harris Department of Nutrition Room 0112 Skinner Building University of Maryland College Park, MD 20742 Phone: 301-405-0775 E-mail: bmhmcq@wam.umd.edu

If you wish to contact Dr. Mira Mehta, the Principal Investigator, or the University of Maryland Institutional Review Board with any issues about this study, please refer to your Informed Consent Form.

If you want a copy of any reports that result from this focus group interview, please contact me.

Now, I will ask that you re-read the Informed Consent Form. I will then answer any questions that you may have about this study or about the Consent Form. I will need you to sign the Consent Form before we begin.

Thank you.

Feel free to eat or drink anything we have here before, during, or after the interview begins.

Please introduce yourselves, first names, only.

Part 2: Ice Breaker Activity

Please write the first 2-3 words that come to mind when you think about diabetes. Write them down on the paper that is in front of you. You do not have to write your name on the paper. When you finish, please pass the paper to me. I will share with the group what everyone wrote.

Part 3: Review of Questionnaires

We will now review each of the pages separately. As you answer the questions, please pretend that you are a woman who is participating in the full study. Please stop me at any time to ask any questions that you might have.

A. Screener Questionnaire

Please fill out this first form. I will then ask you about each question separately. Next, I will ask you about the form as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. **Type size:**
   What do you think about the type size?

2. **Reading level:**
   What do you think about the reading level?

3. **Clearness (clarity) of questions:**

Questions to Participants	**Notes for Facilitator**
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. **Order of questions:**
   What do you think about the order of the questions?

5. **Overall appearance of form:**
   What do you think about the appearance of this form?

6. **Other comments:**
   What other comments and suggestions do you have about this form?

B. Cover Sheet for Diabetes Study Questionnaire

Please read this page. I will then ask you your opinion about it. Your opinions are important to me. Remember, there are no right or wrong answers.

1. **Type size:**
What do you think about the type size?

2. **Reading level:**
What do you think about the reading level?

3. **Clearness (clarity) of questions:**
What do you think about the clearness of this page?

4. **Order of questions:**
What do you think about the order of the text?

5. **Overall appearance of form:**
What do you think about the appearance of this page?

6. **Other comments:**
What other comments and suggestions do you have about this page?

C. Birth Information Form

Please fill out this first page of the second form. I will then ask you about each question separately. Next, I will ask you about this page as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. **Type size:**
   What do you think about the type size?

2. **Reading level:**
   What do you think about the reading level?

3. **Clearness (clarity) of questions:**

Questions to Focus Group Participants	**Notes for Facilitator**
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. **Order of questions:**
   What do you think about the order of the questions?

5. **Overall appearance of this page:**
   What do you think about the appearance of this page?

6. **Other comments:**
   What other comments and suggestions do you have about this page?

D. Personal Health History Form

Please fill out this next page. I will then ask you about each question separately. Next, I will ask you about this page as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. **Type size:**
   What do you think about the type size?

2. **Reading level:**
   What do you think about the reading level?

3. **Clearness (clarity) of questions:**

Questions to Focus Group Participants	**Notes for Facilitator**
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. **Order of questions:**
   What do you think about the order of the questions?

5. **Overall appearance of this page:**
   What do you think about the appearance of this page?

6. **Other comments:**
   What other comments and suggestions do you have about this page?

E. Family Diabetes History Form

Please fill out this next page. I will then ask you about each question separately. Next, I will ask you about this page as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. **Type size:**
   What do you think about the type size?

2. **Reading level:**
   What do you think about the reading level?

3. **Clearness (clarity) of questions:**

Questions to Focus Group Participants	**Notes for Facilitator**
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. **Order of questions:**
   What do you think about the order of the questions?

5. **Overall appearance of this page:**
   What do you think about the appearance of this page?

6. **Other comments:**
   What other comments and suggestions do you have about this page?

F. Personal Lifestyle Form

Please fill out this first form. I will then ask you about each question separately. Next, I will ask you about the form as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. **Type size:**
   What do you think about the type size?

2. **Reading level:**
   What do you think about the reading level?

3. **Clearness (clarity) of questions:**

Questions to Focus Group Participants	**Notes for Facilitator**
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. **Order of questions:**
   What do you think about the order of the questions?

5. **Overall appearance of this page:**
   What do you think about the appearance of this page?

6. **Other comments:**
   What other comments and suggestions do you have about this page?

G. Birth Data Collection Form

Please fill out this first form. I will then ask you about each question separately. Next, I will ask you about the form as a whole. Please answer the best that you can. Later, I will ask you to give your opinion on how the questions might be asked in a better way.

1. Type size:
What do you think about the type size?

2. Reading level:
What do you think about the reading level?

3. Clearness (clarity) of questions:

Questions to Focus Group Participants	Notes for Facilitator
How clear or unclear are the instructions for Item 1? How clear or unclear is the wording of Item 1? How clear or unclear is the meaning of Item 1? What else is unclear about Item 1? What do you suggest that I should do to improve Items 1? How clear or unclear are the instructions for Item 2? How clear or unclear is the wording of Item 2? How clear or unclear is the meaning of Item 2? What else is unclear about Item 2 What do you suggest that I should do to improve Items 2? Etc.	Read question and stem.

4. Order of questions:
What do you think about the order of the questions?

5. Overall appearance of this page:
What do you think about the appearance of this page?

6. Other comments:
What other comments and suggestions do you have about this form?

H. Recruitment Flyers

Please examine this flyer. I will then ask you your opinion about it. Your opinions are important to me. Remember, there are no right or wrong answers.

1. **Clearness (clarity) of messages:**
   What do you think about the clearness of the messages of this flyer?

2. **Order of items:**
   What do you think about the order of the text in this flyer?

3. **Overall appearance of form:**
   What do you think about the overall appearance of this flyer?

4. **Power to recruit women into the study:**
   How useful do you think that this flyer will be for inviting Black American women 40-55 years of age into the Diabetes Study?

5. **Type size:**
   What do you think about the type size?

6. **Reading level:**
   What do you think about the reading level?

7. **What age range would you say the woman in this poster belongs? Why?**

8. **Other comments:**
   What other ideas and suggestions do you have that would make this a more useful flyer for recruiting women into the study?

Focus Group Demographic Form

1. What is your age? _____

2. Do you have diabetes? (Please circle one.): Yes No

3. What is the highest grade or year of school you completed? **(Please circle only one item.)**

a. Grades 1 through 8 (elementary)

b. Grades 9 through 11 (some high school)

c. Grade 12 or GED (high school diploma or equivalency)

d. Technical or vocational degree beyond high school

e. Attended college, but did not graduate

f. Associate degree

g. Bachelor's degree

h. Graduate degree or advanced professional degree (Master, Ph.D., M.D., J.D., etc.)

i. Not sure

1. What is your age? _____

2. Do you have diabetes? (Please circle one.): Yes No

3. What is the highest grade or year of school you completed? **(Please circle only one item.)**

a. Grades 1 through 8 (elementary)

b. Grades 9 through 11 (some high school)

c. Grade 12 or GED (high school diploma or equivalency)

d. Technical or vocational degree beyond high school

e. Attended college, but did not graduate

f. Associate degree

g. Bachelor's degree

h. Graduate degree or advanced professional degree (Master, Ph.D., M.D., J.D., etc.)

i. Not sure

1. What is your age? _____

2. Do you have diabetes? (Please circle one.): Yes No

3. What is the highest grade or year of school you completed? **(Please circle only one item.)**

a. Grades 1 through 8 (elementary)

b. Grades 9 through 11 (some high school)

c. Grade 12 or GED (high school diploma or equivalency)

d. Technical or vocational degree beyond high school

e. Attended college, but did not graduate

f. Associate degree

g. Bachelor's degree

h. Graduate degree or advanced professional degree (Master, Ph.D., M.D., J.D., etc.)

i. Not sure

Appendix I. Vital Records and Measurements Forms

Birth Data Collection Form (Data from Vital Records Offices)

Participant's Birth Name: _____

State of Participant's Birth: _____

Variable	Value*	Comments
Participant's date of birth (DOB)		
Participant's birth weight		
Participant's gestational age at birth		
Participant premature at birth?	No ☐ Yes ☐	Premature is defined as born before 37 weeks gestation.
Participant was/is a twin, triplet, or other multiparous level?	No ☐ Yes ☐	"No" is for a singleton birth.
Participant's mother had T1DM or T2DM or GDM during pregnancy?	No ☐ Yes ☐	Please circle, if known. T1DM = type 1 diabetes T2DM = type 2 diabetes GDM = gestational diabetes

Vital Records Office Comments:

Blood Pressure, Current Weight, Height, Body Mass Index (BMI), Waist Circumference, Hip Circumference, Waist-to-Hip Ratio (WHR), Glucose Test

Variable	Value		Comments
Blood pressure 1 (Systolic/Diastolic)	/		mm Hg, ≥ 5 minutes after first measurement. Measure while participant is seated.
Blood pressure 2 (Systolic/Diastolic)	/		mm Hg, ≥ 5 minutes after first measurement. Measure while participant is seated.
Height 1 (cm)			To the nearest 0.1 cm
Height, duplicate measure (cm)			
Height, average (cm)			
Weight 1 (kg)			To the nearest 0.01 kg
Weight, duplicate measure (kg)			
Weight, average (kg)			
Body Mass Index , BMI			Based on average of height and weight, kg/cm^2
Overall obesity, based on BMI			☐ Normal weight: BMI≤24.9 ☐ Overweight: BMI 25.0 to 29.9 ☐ Obesity: BMI ≥30.0
Waist circumference 1 (WC) (cm)			To the nearest 0.1 cm
WC, duplicate (cm)			
WC, average (cm)			
Hip circumference 1 (cm)			To the nearest 0.1 cm
Hip circumference, duplicate (cm)			
Hip circumference, average (cm)			
Waist-to-hip ratio (WHR)			Based on average waist circumference/average hip circumference
Abdominal obesity, based on WC	Yes	No	Obesity: WC >88 cm
Abdominal obesity, based on WHR	Yes	No	Obesity: WHR >0.80

Diabetes Status

Variable	Value	Source of Measurement
Did you have anything to eat or drink (except water) within the last 8 hours?*		1. ☐ No ☐ Yes
In the last 24 hours, how much fluid did you drink (Do not include alcohol, coffee, or colas)?*		2. _____ cups or glasses
FPG** (mg/dL)		3. ☐ Glucometer reading
Diabetes	☐ Yes ☐ No ☐ Undetermined	4. ☐ Self-report with verification via prescription of insulin and/or oral hypoglycemic agent **or** 5. ☐ FPG** ≥ 126 mg/dL

*The measurer will ask participant this question before collecting blood. **FPG, Fasting Plasma Glucose.

Personal Measurements Form

ID Number: ___ ___ ___ Date: _____ Time: _____

Blood Pressure 1:

Blood Pressure 2:

Height1:

Height 2:

Weight 1:

Weight 2:

Waist Circumference 1 (smallest diam.): Waist Circumfer. 3 (1" above umbilicus):

Waist Circumference 2 (smallest diam.): Waist Circumfer. 4 (1" above umbilicus):

Hip Circumference 1:

Hip Circumference 2:

Fasting plasma-equivalent glucose:

Non-fasting plasma equivalent glucose:

Normal: <100 mg/dL Prediabetes = 100 to less than 126 mg/dl Diabetes $\geq$ 126 mg/dL
Notes:

Appendix J. Data Protection Protocol

Protocol for Obtaining Birth Data from Vital Records and Vital Statistics Departments

The following is an outline of procedures for collecting and protecting all birth data. It addresses both physical security and security through electronic media of all birth data.

1. The investigator will have obtained the requisite approval of the Institutional Review Board (IRB) of the University of Maryland before making any formal requests for birth data. In addition, approval by the IRBs of specific states will be obtained, where required.
2. Data requested from Vital Records and Vital Statistics Department will be limited to the following variables: a) weight at birth (required), b) length at birth (if available), c) length of gestation (if available), d) singleton vs. twin or greater birth status, e) diabetes status of mother during pregnancy with study participant (if available).
3. Each Vital Statistics Office will be provided with a list of participants born in their respective state. Piece-meal queries will be avoided as much as possible. De-identification will occur immediately upon receipt of birth data from a Vital Statistics Office.
4. Study participants will not incur any expense or inconvenience for the obtainment of their birth data. The onus for obtaining documented birth data will be strictly on the investigator.
5. Individual informed consent will be obtained from each study participant for permission to access personal data from their Vital Records files. They will be informed that any data collected on them from Vital Records or from any other source will be confined to the stated purposes of this study.
6. The birth data collected for this study will not be used for any purposes other than for this study. Raw data will not be shared with anyone other than with those involved in the study. Even then, all personal data will be de-identified. Unique identifiers for each participant will be stored separately from any data that might be publicized.
7. HIPAA guidelines will be followed to assure that all data collected for this study are adequately de-identified (Citation of HIPAA).
8. The data file that contains unique identifiers will be stored on a removable disk drive (zip disk). It will at no time be saved on a hard disk or transmitted electronically to anyone, including to the investigator, herself. Zip disks and floppy disks that contain unique identifiers will also be stored under lock and key.
9. Hard-copy files with unique identifiers and the removable disk will be stored together in a locked file cabinet that is only accessible to the investigator. This locked file cabinet will be housed in a room that is only accessible to authorized staff of the Department of Nutrition and Food Science, University of Maryland, College Park. Zip disks and floppy disks that contain unique identifiers will also be stored under lock and key.
10. All raw birth data connected to identifiers will be kept under lock and key for the time required by law. Access will only be available to the investigator. Electronic copies (zip disk, floppy disks) also will be destroyed as soon as allowed by law. Hard-copy data will be destroyed through shredding by the investigator.
11. For publication purposes, all raw data will be de-identified.

Appendix K. Pilot Study Descriptive Tables

Table K1. Relationship Between Self-Reported Personal Health History and Type 2 Diabetes:Pilot Study
U.S.-Born African-American Women 26-86 Years, with and Without Type 2 Diabetes, *N*=21

Health History, Self-Reported	Cases, *n*(%) *n*/3	Controls, *n*(%) *n*/18
High blood pressure[a]	2(67)	6(33)
Heart disease[a]	0	0
Life Cycle Stage		
Had at least one period within the past 12 months	0	10(56)
Breastfed as infant or child	3(100)	11(61)
Premature Birth[b]	0	1(33)
Twin	0	1(33)
Family History of Diabetes	2(67)	14(78)

Note. All data were based on self-report.
[a]Self-report of physician diagnosis of this condition
[b]Self-report: Frequency and percent for 11 participants who reported "Don't know" are not shown.

Table K2. Age, Body Measurements, and Blood Pressure Measurements: Pilot Study Women 26-84 Years, *N*=21		
Age and Measurements	Mean (*SD*), *N*	Minimum-Maximum
Age, years	49.3(5.92) *n*=21	26-84
Current weight, kg	79(21.6) *n*=21	57-133
Height, cm	162(5.6) *n*=21	154-172
Body mass index	30(7.4) *n*=21	22-49
Waist, smallest diameter, cm	89(14.1) *n*=21	72-134
Hip, cm	111(14.7) *n*=21	92-150
Waist-to-hip ratio, smallest diameter	0.80 (0.601) *n*=21	0.67-0.91
Systolic blood pressure, mm Hg	128(17.1.) *n*=20	100-168
Diastolic blood pressure, mm Hg	75(9.7) *n*=20	59-96

Note. All measurements were taken at enrollment in study.

Body mass index was calculated by dividing weight in kilogram by height in meters squared.

Waist-to-hip ratio was calculated by dividing waist (cm) by hip (cm) circumference

57-133 kg = 125-293 pounds

154-172 cm = 61-68 inches; 72-134 cm = 28-53 inches; 92-150 cm = 36-59 inches

Table K3. Weight at Age 25 Years: Pilot Study Women 26-84 Years		
Self-Reported Measurement	Mean (*SD*), *n=20*	Minimum-Maximum
Weight at 25 years, kg [a]	6616.22)	45-114

Note. By self-report: One participant was not included in analysis since she could not respond to this questionnaire item.

45-114 kg = 99-251 pounds

[a]Not reported by one participant

Questionnaire item: "About how much did you weigh ***when you were 25 years of age?*** ___ pounds"

Table K4. Age at Diagnosis and Years Duration of Diabetes, Obesity at Diagnosis, and Methods for Controlling Diabetes: Pilot Study Women 26-84 Years, with Type 2 Diabetes, *n*=3			
Self-Reported Diabetes-Related Variable	Cases (*n*=3)		
	A	B	C
Age at diagnosis of type 2 diabetes (years)	70	52	50
Duration of diabetes at enrollment (years)	15	5	6
Weight at diagnosis	Overwt	Overwt	Normal
Methods for controlling diabetes			
Oral diabetes medications	Yes	Yes	Yes
Insulin	No	No	No
Diet change/Diet Plan	No	Yes	Yes
Exercise	No	No	Yes
Lose weight	No	Yes	Yes
Other	No	No	No
Note. All data in this table were based on self-report.			

Table K5. Lifestyle Indicators: Pilot Study Women 26-84 Years			
Self-Report Lifestyle Behavior	All *N*=21	Cases *n=3*	Controls *n*=18
Current Smoker	4(19)	0(0)	4(22)
Regular Strenuous Activity/Hard Labor[a,b]	6(29)	0(0)	6(33)
Note. All data in this table were based on self-report. [a]Engage in strenuous activity or hard physical labor where sweat or heart beats faster? [b]A response was missing for one participant.			

Appendix L. Vital Records Obtained, by State

Table L1. Enrollment by State and Percentages of Vital Records Obtained by State

State Code[a]	Original Enrollment Per State[b]	Final Sample Per State[c]		Vital Records Per State	Vital Records, %Original Enrollment Per State	Vital Records, %Final Sample Per State
	N	*N*	(%)[d]	*N*		
1	205	151	74%	0	0%	0%
2	33	29	88%	19	58%	66%
3	20	19	95%	18	90%	95%
4	18	10	56%	0	0%	0%
5	17	14	82%	0	0%	0%
6	11	7	64%	0	0%	0%
7	7	5	71%	0	0%	0%
8	6	3	50%	0	0%	0%
9	4	4	100%	4	100%	100%
10	4	4	100%	3	75%	75%
11	4	4	100%	3	75%	75%
12	3	3	100%	0	0%	0%
13	3	3	100%	0	0%	0%
14	3	2	67%	2	67%	100%
15	3	2	67%	1	33%	50%
16	3	2	67%	0	0%	0%
17	2	2	100%	2	100%	100%
18	2	2	100%	2	100%	100%
19	2	2	100%	2	100%	100%
20	2	2	100%	0	0%	100%
21	2	2	100%	0	0%	100%
22	1	1	100%	1	100%	100%
23	1	1	100%	1	100%	100%
24	1	1	100%	1	100%	100%
25	1	1	100%	1	100%	100%
26	1	1	100%	1	100%	100%
27	1	1	100%	1	100%	100%
28	1	1	100%	1	100%	100%
29	1	1	100%	0	0%	100%
30	1	1	100%	0	0%	100%
31	1	0	0%	0	0%	0%
32	1	0	0%	0	0%	0%
Total	365	281	100%	63		

Note. [a]States were coded to protect identity of participants. Thirty-two State Centers for Health Statistics/Vital Records Offices were involved in this study. Vital records birth weights obtained from 17 states. Collection of vital records birth weights was through July 2006. [b]Original enrollment consisted of 365 women. [c]The final sample included women for whom verified birth weights could be obtained (*n*=281). [d]Percent of final sample participants from original enrollment.

Appendix M. Vital Statistics: National and District of Columbia

Tables M1 to M3 were compiled from data extracted from documents published by the Department of Health, Education, and Welfare (HEW) and, later, from the National Center for Health Statistics (NCHS).[135]

Table M1. Low Birth Weight[a] Rates and Ratios Among Blacks and Whites, by Year—United States and the District of Columbia, 1950 to 1970 and 1972

	United States				District of Columbia[b]			
Year	Non-White[c]	White	Ratio	All Races	Non-White[c]	White	Ratio	All Races
1950	10.3	7.1	1.5	7.6	---[d]	---[d]	---[d]	---[d]
1951	10.1	6.6	1.5	7.1	17.0	11.2	1.5	13.9
1952	10.7	6.6	1.6	7.8	15.1	9.1	1.7	11.9
1953	10.9	6.6	1.7	7.2	12.1	7.1	1.7	9.9
1954	11.0	6.4	1.7	7.1	12.8	7.8	1.6	10.4
1955	11.4	6.5	1.8	7.2	12.9	7.7	1.7	10.6
1956	11.7	6.4	1.9	7.2	13.0	7.1	1.8	10.7
1957	12.2	6.5	1.9	7.4	14.0	7.4	1.9	11.6
1958	12.7	6.5	2.0	7.5	14.4	8.9	1.6	12.5
1959	12.8	6.8	1.9	7.7	14.1	8.1	1.7	12.1
1960	12.8	6.8	1.9	7.7	14.4	8.2	1.8	12.5
1961	12.9	6.9	1.9	7.8	13.8	8.9	1.6	12.3
1962	13.0	7.0	1.9	8.0	13.8	8.6	1.6	12.3
1963	13.5	7.1	1.9	8.1	14.0	8.3	1.7	12.3
1964	13.8	7.1	1.9	8.1	14.1	8.1	1.7	12.6
1965	13.7	7.2	1.9	8.3	13.5	6.1	2.2	11.5
1966	13.8	7.2	1.9	8.3	14.9	7.0	2.1	13.4
1967	13.5	7.1	1.9	8.2	14.3	7.0	2.0	12.9
1968	13.6	7.1	1.9	8.2	15.3	7.6	2.0	14.1
1969	14.4	7.0	2.1	8.1	14.2	8.5	1.7	13.3
1970	13.8	6.8	2.0	7.9	13.2	8.9	1.5	12.5
1972	13.5	6.5	2.1	7.7	13.4	6.6	2.0	12.5

Notes. Based on a sample of 50% of all live births. Births by place of residence. From 1950-1952, birth weight data for births in Connecticut and Massachusetts were not available. From 1953-1958, birth weights were not available for births in Massachusetts, only. Beginning in 1960, brith weight data included Alaska and Hawaii. For 1962-1963, figures by color excluded data for residents of New Jersey because this State did not require reporting of the item. Birth weights were computed on the basis of original units of pounds and ounces and rounded to nearest 10 g.

[a]Low birth weight was defined as 2,500 g or less, 1950-1972. Low birth weight was defined as 2,499 g or less beginning in 1973.

[b]The District of Columbia did not gain home rule until the Home Rule Act passed in Congress in 1973. A mayor and council were voted into office in 1974.[136] The Federal Government exercised stewardship over the District of Columbia Vital Records Office until then.

[c]Definition of *Non-White* changed over time. For 1950-1967 the term *Non-White* was used. For 1968-1969, the term *All Other* was used. For 1970-1972 the term *Negro* used. From 1980s-2001, the term *Black* was used.

[d]Birth weights for individual states were not reported by NCHS until 1951.

Source: http://www.cdc.gov/nchs/products/pubs/pubd/vsus/1963/1963.htm [131]

Table M2. Low Birth Weight Rates and Ratios Among Blacks and Whites, by Year—United States, 1980 to 2002				
Year	Black	White	Ratio	All Races
1980	12.7	5.7	2.2	6.8
1981	12.7	5.7	2.2	6.8
1982	12.6	5.6	2.3	6.8
1983	12.8	5.7	2.2	6.8
1984	12.6	5.6	2.3	6.7
1985	12.6	5.7	2.2	6.8
1986	12.8	5.7	2.2	6.8
1987	13.0	5.7	2.2	6.9
1988	13.3	5.7	2.3	6.9
1989	13.3	5.7	2.4	7.0
1990	13.5	5.7	2.3	7.0
1991	13.3	5.8	2.3	7.1
1992	13.6	5.8	2.3	7.1
1993	13.3	6.0	2.2	7.2
1994	13.2	6.1	2.2	7.3
1995	13.1	6.2	2.1	7.3
1996	13.0	6.3	2.1	7.4
1997	13.0	5.5	2.0	7.5
1998	13.0	6.5	2.0	7.6
1999	13.1	6.6	2.0	7.6
2000	13.0	6.5	2.0	7.6
2001	13.6	6.7	2.0	7.7
2002	13.4	6.9	1.9	7.8

Note. Birth weights were computed on the basis of original units of pounds and ounces and rounded to nearest 10 grams.
Source: Infant Mortality and Low Birth Weight Among Black and White Infants --- United States, 1980—2000 MMWR July 12, 2002/51(27);589-592[23]

Table M3. Population by Race and Hispanic Origin—United States and the District of Columbia,1940-1990

United States

Census year	Total population	Race, %[a]					Hispanic origin (of any race)	White, not of Hispanic origin
		White	Black	American Indian, Eskimo, and Aleut	Asian and Pacific Islander	Other race		
	Number							
2003	290,810,000	80.5	12.8					
2000[e]	281,422,000	81.1	12.7					
1990[b]	248,709,873	80.3	12.1	0.8	2.9	3.9	9.0	75.6
1980[b]	226,545,805	83.1	11.7	0.6	1.5	3.0	6.4	79.6
1970[b]	203,211,926	87.5	11.1	0.4	0.8	0.3	(NA)	(NA)
1960[c,d]	179,323,175	88.6	10.5	0.3	0.3	--	(NA)	(NA)
1950[d]	150,697,361	89.5	10.0	0.2	0.2	--	(NA)	(NA)
1940[d]	131,669,275	89.8	9.8	0.3	0.2	(X)	(NA)	(NA)

Notes. "–" Represents zero or rounding to 0.0. (X) Not applicable. (N/A), Not available. [a]Totals to 100% of population. [b]Hispanic origin based on Spanish language. [c]Includes Alaska and Hawaii for first time. [d]Hispanic origin based on the White population of Spanish mother tongue. [e]In thousands, rounded to the nearest one thousand for 2000 and 2003, only. [f]Data for 2003 are preliminary.
Source: U.S. Census Bureau.[135]

Washington, D.C.

Census year	Total population	Race, %[a]					Hispanic origin (of any race)	White, not of Hispanic origin
		White	Black	American Indian, Eskimo, and Aleut	Asian and Pacific Islander	Other race		
	Number							
2003								
2000	572,059	30.8	60.0	0.3	2.8	3.8	7.9	
1990[b]	606,900	29.6	65.8	0.2	1.8	2.5	5.4	27.4
1980[b]	638,333	26.9	70.3	0.2	1.0	1.6	2.8	25.7
1970[b]	756,510	27.7	71.1	0.1	0.7	0.4	(NA)	(NA)
1960[c]	763,956	45.2	53.9	0.1	0.6	0.2	(NA)	(NA)
1950[c]	802,178	64.6	35.0	--	0.4	--	(NA)	(NA)
1940[c]	663,091	71.5	28.2	--	0.2	(X)	(NA)	(NA)

Notes. "–" Represents zero or rounding to 0.0. (X) Not applicable. (N/A), Not available. [a]Totals to 100% of population. [b]Hispanic origin based on Spanish language. [c]Hispanic origin based on the White population of Spanish mother tongue. [d]Data for 2003 are preliminary.
Source: U.S. Census Bureau.[135]

The District of Columbia holds a unique position in that its vital records functions were administered by the Federal Government until the mid-1970s when the District was granted Home Rule.[136] Therefore, state and local decisions regarding birth certificates were under the domain of outsiders until then. The relative autonomy that the District of Columbia now holds should contribute to increased access to its birth data for future researchers.

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