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Cardiovascular Risk in Gullah African Americans with High Familial Risk of Type 2 Diabetes Mellitus: Project SuGAR

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Abstract

Objectives—To determine the prevalence of cardiovascular disease, levels of cardiovascular risk factors, and extent of preventive care in Gullah African Americans with a high familial risk of type 2 diabetes mellitus.

Methods—Between 1995 and 2003, 1321 Gullah African Americans with a high prevalence of diabetes mellitus from the South Carolina Sea Islands consented to and enrolled in the Sea Islands Genetic African American Registry (Project SuGAR). A cross-sectional analysis of cardiometabolic risk, preventive care, and self-reported cardiovascular disease was conducted.

Results—Cardiometabolic risk factor levels were high and vascular disease was prevalent. Among the subjects with diabetes mellitus, the mean disease duration was 10.5 years; approximately one-third reported reduced vision or blindness; and >80% reported numbness, pain, or burning in their feet. Preventive diabetes care was limited, with <60%, <25%, and <40% seeing an ophthalmologist, podiatrist, and dentist, respectively, within the past year. Only 54.4% of women and 39.3% of men reported daily glucose monitoring.

Conclusions—As the largest existing study of Gullah individuals, our study offers insight into not only the level of cardiovascular risk in this population but also the pathophysiological mechanisms central to ancestral differences in cardiometabolic risk in the broader African American population.

Keywords

diabetes complications; African Americans; secondary prevention; public health; community-based participatory research

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[A]What is superscript d?

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Diabetes mellitus disproportionately affects minority populations, with African Americans having a two- to threefold increased risk, an earlier age of onset, and greater years of life lost than whites.[1] For African Americans born in 2000 in the United States, the lifetime risk of developing type 2 diabetes mellitus was estimated to be 40.2% (95% confidence interval [CI] 36.1–44.7) in men and 49.0% (95% CI 44.6–53.7) in women.[1] With projections of nearly one of every two African American women and two of every five African American men developing diabetes mellitus, it is imperative that we have a greater understanding of the causes and consequences of this disease in African American.

Ancestral or ethnic differences in cardiometabolic risk factors are well documented, with hypertension and diabetes mellitus being more common and less controlled in African Americans than whites; however, African Americans have more favorable lipid profiles than whites.[2–13] The literature documenting racial differences in metabolism, particularly between African Americans and whites, is extensive. For example, the Pro12Ala variant in peroxisome proliferator–activated receptor-γ2 has been associated with diabetes and has different allele frequencies depending on racial group.[14,15] Documented racial differences in metabolism include greater insulin resistance, lower resting energy expenditure, greater abdominal subcutaneous fat but decreased visceral fat, lower adiponectin levels, and insulin hypersecretion independent of ambient insulin sensitivity in African Americans compared with whites.[5–7,11,16]

Although African Americans tend to be more insulin resistant,[13] lipid profile clusters are distinct from those of whites.[2,3] One analysis showed that low high-density lipoprotein (HDL) cholesterol and normal triglycerides levels were the most common pattern in both African Americans and Africans from Ghana and Nigeria with the metabolic syndrome.[17] Admixture analyses have shown significant positive correlations between African ancestry and HDL cholesterol and European ancestry and triglycerides, but found no correlation with low-density lipoprotein (LDL) cholesterol.[18,19] Furthermore, studies indicate that the metabolic syndrome, recognized as a cluster of cardiovascular risk factors that frequently coincide with insulin resistance and hyperglycemia,[20,21] may differentially affect cardiovascular risk in African Americans and whites.[17,22]

African Americans living in coastal communities and on the Sea Islands of South Carolina are referred to as Gullah. These individuals are believed to be direct descendants of enslaved Africans who were deported from the “rice or windward” coast of west Africa and transported to the South Carolina Sea Islands because their rice-growing expertise was critical to the culture of this cash crop in colonial America. The Gullah population is unique because of its geographical isolation, cultural identity, large, stable multigenerational families, relatively uniform diet and lifestyle, low levels of genetic admixture, and high relative ancestral homogeneity. Moreover, although no formal population-based epidemiologic studies have been completed in Gullah African Americans, the prevalence of obesity, hypertension, and type 2 diabetes mellitus is perceived to be high in this population. From 1995 through 2003, the Sea Islands Genetic African American Registry (Project SuGAR) recruited Gullah African Americans from families on the South Carolina Sea Islands with a high prevalence of diabetes mellitus.[23–26] The objectives of Project SuGAR were twofold and encompassed science as well as service. With respect to science, the aim

was to study the genetic architecture of diabetes mellitus in the Gullah population, with the hypotheses being that ancestral differences exist in the pathophysiology of the metabolic syndrome and that the increased risk of diabetes mellitus in African Americans has a genetic basis. With respect to service, the aim was to provide free health education and disease screenings, health fairs, and referrals to this underserved community. The objective of this article was to describe the Project SuGAR study population and the phenotypic information collected as it pertains to cardiometabolic risk and preventive care in Gullah African Americans with a high familial risk of type 2 diabetes mellitus.

Methods

Study Population and Design

Our study was conducted with institutional review board approval from the Medical University of South Carolina and adhered to the tenets of the Declaration of Helsinki. We performed a cross-sectional study of cardiometabolic risk factor levels, preventive care, and self-reported cardiovascular disease in the Project SuGAR baseline population. Project SuGAR enlisted medical clinics, churches, and established organizations on the Sea Islands to aid in identifying patients with type 2 diabetes mellitus who belonged to families with multiple affected biological members.[23–26] Inclusion criteria included self-describing as African American with at least one type 2 diabetes mellitus–affected sibling pair, having no more than one biological parent affected with type 2 diabetes mellitus, and having at least one parent still living. Probands and their parents were born and raised in the Low Country of South Carolina. Between 1995 and 2003, 1321 individuals consented to and enrolled in Project SuGAR and had complete information on diabetes mellitus status and age. Of these 1321 participants, 1105 had diabetes mellitus at enrollment and 216 were family members without diabetes mellitus at enrollment.

Clinical Examination and Interviews

Data collected in Project SuGAR included family and medical history, standardized blood pressures, physical examination, body dimensions, and laboratory testing. Information on diabetes management and preventive care was collected in individuals with self-reported diabetes mellitus. Weights were determined using electronic calibrated scales (Detecto, Cleveland, OH) at 8 to 10<sc>am</sc> after voiding and before eating breakfast. Heights were measured with a portable Harpenden statiometer. Waist circumference was recorded using a tension-controlled tape measure (Novel Products, Rockton, IL). Blood pressure was measured three times after patients sat quietly for 5 minutes. Participants were asked to bring all of their medication to the clinical examination, where it was itemized. Laboratory tests included creatinine/blood urea nitrogen, hemoglobin A1C, fasting lipid panel (cholesterol, triglycerides, HDL), circulating islet cell antibodies (among those with diabetes mellitus), and fasting glucose. Lipoprotein subclasses were measured (LipoScience, Raleigh, NC) using nuclear magnetic resonance (NMR) spectroscopy on 776 participants.[27] NMR generates unique spectra for different lipoprotein subclasses based on a bulk lipid signal that reflects particle size; the amplitude is proportional to the lipoprotein subclass particle concentration.[28–30] The NMR spectrum of each plasma sample was modeled as the sum of the signals from 16 discrete subpopulations of lipoprotein particles: chylomicrons, 6 VLDL

(very-low-density lipoprotein), intermediate density lipoprotein, 3 LDL, and 5 HDL. Estimated glomerular filtration rate (eGFR) was calculated with the Modification of Diet in Renal Disease Study equation:

$$\mathrm{eGFR} = 186 \times \text{serum creatinine}\,[\mathrm{S_{Cr}}]^{-1.154} \times \mathrm{age}^{-0.203} \times 1.212\,[\text{if African American}] \times 0.742\,[\text{if female}]$$

.[31] Hypertension was defined as systolic/diastolic blood pressure ≥140/90 mm Hg or treatment with antihypertensive medication.

Participating family members without diabetes mellitus were evaluated using an oral glucose tolerance test or by fasting glucose test. Diabetes mellitus was defined based on having a fasting glucose ≥126 mg/dL, having a 2-hour 75-g oral glucose tolerance test ≥200 mg/dL, or using medication to control their diabetes mellitus.[32] Clinical records and medical history were reviewed to exclude individuals with probable type 1 diabetes mellitus on the basis of time-to-insulin dependence and/or islet cell antibodies.

Statistical Analysis

We conducted a cross-sectional analysis of cardiometabolic risk factor levels, preventive care, and self-reported cardiovascular disease in the Project SuGAR baseline population. Because families rather than individuals were recruited, the assumption of independence was violated and therefore accounted for in the analysis. We used pedigree information from an ongoing genome-wide association study of 1203 Project SuGAR participants and from the self-reporting of 118 individuals who were not part of the genome-wide association study. Of the 1321 participants with pedigree information available, 194 families were singletons; 328 families had two individuals; 77 families had 3 individuals; 29 families had 4 individuals; and 22 families had 5, 6, or 7 individuals per family. As such, 1321 individuals contributed to 650 families. Variance components modeling was used to partition variability as a result of shared genetic liabilities based on pedigree structure and estimates of identity by descent from environmental liabilities. Models were implemented in the Sequential Oligogenic Linkage Analysis Routines package to account for the lack of independence among family members[33] when estimating trait means and standard deviations. Using this approach, we examined age-adjusted mean cardiometabolic risk factor levels and prevalent cardiometabolic disease and lifestyle factors stratified by sex and diabetes mellitus status. In addition, among individuals with diabetes mellitus, we examined age-adjusted diabetes management, preventive care, and comorbidity levels.

Results

More than three-fourths of the study population were female. At enrollment, age ranged from 12 to 97 years in women and from 14 to 84 years in men. The high school completion rate was <70% in men and women with and without diabetes mellitus. The prevalence of smoking and drinking was relatively low overall but higher in men than women. Characteristics of the population stratified by sex and diabetes status are found in Table 1.

Among subjects with diabetes mellitus, the average mean body mass index (BMI) in women approached that of World Health Organization classification of obesity stage II[34] (34.7 kg/m^2 [95% CI 34.1–35.3]), which was slightly higher than that in men (31.4 kg/m^2 [95% CI 30.3–32.5]). Mean BMI was slightly lower in women (33.2 kg/m^2 [95% CI 31.9–34.5])

and men (27.7 kg/m^2 [95% CI 25.6–29.8]) without diabetes mellitus. Mean hemoglobin A1c levels were 8.9% (95% CI 8.7–9.1) in women and 9.1% (95% CI 8.8–9.4) in men with diabetes mellitus, indicating poor glycemic control. Among individuals with diabetes mellitus, the prevalence of hypertension was 76.9% (95% CI 74.0–79.8) in women and 72.0% (95% CI 66.5–77.5) in men, with 65.8% (95% CI 62.6–69.0) of women and 60.7% (95% CI 54.7–66.7) of men taking blood pressure medication. Mean eGFR was 104 (95% CI 102–107) in women and 100 (95% CI 96–105) in men with diabetes mellitus. Finally, among individuals with diabetes mellitus, 12.8% (95% CI 10.5–15.1) of women and 10.7% (95% CI 6.4–15.0) of men were taking some type of psychiatric medication.

Among individuals with diabetes mellitus, HDL cholesterol levels were slightly higher in women (50 mg/dL [95% CI 49–51]) than men (45 mg/dL [95% CI 43–47]), triglycerides were relatively low (ie, 131 mg/dL, women; 145 mg/dL, men), and few individuals used lipid-lowering medication (ie, 16.3%, women; 13.8%, men). The large VLDL particle concentration was marginally higher in men than women with diabetes mellitus and higher in those with diabetes mellitus than those without. The small LDL particle concentration was higher in men than women with diabetes mellitus and higher in those with diabetes mellitus than those without. The large HDL particle concentration was higher in women than in men. HDL particle size was similar in women and men with diabetes mellitus, but it was higher in women than men without diabetes mellitus. LDL particle size was similar in men and women and in those with and without diabetes mellitus.

The prevalence of self-reported cardiovascular disease is detailed in Table 2. The prevalence of angina was 17.4% in women and 21.1% in men with diabetes mellitus as compared with 11.4% in female and 6.0% in male family members without diabetes mellitus. Almost 10% of men with diabetes mellitus reported having had a stroke, as did 8.2% of women, whereas only 5.3% of men and women without diabetes mellitus reported having a stroke. The prevalence of heart attack was 6.6% in women and 8.1% in men with diabetes mellitus, and it was only 3.5% in women and 6.4% in men without diabetes mellitus.

Of the 1105 individuals identified as having diabetes mellitus, 1065 (96.4%) self-reported clinically diagnosed disease (Table 3). The mean duration of disease was 10.5 years (95% CI 9.9–11.1) in women and 10.3 years (95% CI 9.1–11.5) in men. Women were more likely than men to report taking oral medication to control their diabetes mellitus (59.0% vs 48.8%), whereas reports of insulin use were similar in women (48.7%) and men (48.3%) as were reports of medication use overall (80.7% in women and 80.9% in men). More than half of the population reported having attended a dietary management class taught by a dietitian. Fewer than half had seen a dentist in the past year. A total of 79.2% of women and 69.6% of men reported using a machine to monitor glucose; however, only 54.4% of women and 39.3% of men reported daily monitoring of their glucose. Although >80% of men and women reported numbness, pain, or burning in their feet, <25% of the population had seen a podiatrist in the past year. Claudication was reported by 33.2% of women and 31.7% of men. Similarly, although 27.1% of women and 29.8% of men reported having had laser eye surgery, only 57.7% of women and 54.5% of men reported seeing an ophthalmologist in the past year. Approximately one-third of the cohort (29.4% of women and 37.6% of men) reported having reduced vision or blindness.

Discussion

Project SuGAR includes one of the largest assembled cohorts of African Americans with type 2 diabetes mellitus. Studies of mitochondrial and Y-chromosomal markers have determined that the genetic distance between the Gullah and Sierra Leonese tribes is shorter than other African American populations.[35–37] Our prior linkage studies quantified the mean European admixture at <9%, the lowest documented for any African American population.[23] Moreover, the genetic and environmental homogeneity among the Gullah as a result of their relative isolation until recent years is an advantage for identifying risk factors for vascular outcomes among individuals with diabetes mellitus. Our study population, as the largest existing study comprising Gullah individuals, offers insight into not only the prevalence of cardiovascular risk factors and disease in Gullah individuals with diabetes mellitus but also the pathophysiological mechanisms central to ancestral difference in cardiometabolic risk in the broader African American population.

African Americans tend to be more insulin resistant[13] and hypertensive, with a lipid profile that is distinct from whites.[2–12] Ancestral differences in cardiometabolic risk factor levels may explain ethnic or racial patterns in diabetes mellitus complications. Relative to non-Hispanic whites, non-Hispanic blacks with diabetes mellitus are at a higher risk of complications typically related to hypertension, including end-stage renal disease, lower extremity amputation, and blindness.[38] In contrast, compared with non-Hispanic whites, non-Hispanic blacks with diabetes mellitus have similar or lower rates of macrovascular complications, including coronary heart disease and cardiovascular mortality.[38,39]

The National Health and Nutrition Examination Survey (NHANES) was used to examine lipid levels specific to racial and ethnic groups in the US population from 1999 to 2002.[40] Compared with non-Hispanic blacks in NHANES, Project SuGAR men and women with diabetes mellitus had lower HDL cholesterol levels and higher triglycerides levels but similar LDL cholesterol levels (NHANES men and women: HDL, 51 mg/dL [95% CI 50–52] and 57 mg/dL [95% CI 56–58], respectively; triglycerides, 99 mg/dL [95% CI 91–106], and 90 mg/dL [95% CI 85–96]; LDL, 120 mg/dL [95% CI 117–124] and [A] mg/dL [95% CI 117–126]).[40] Moreover, the use of lipid-lowering medication was higher in Project SuGAR participants than in non-Hispanic blacks in the general US population (8.5% and 6.0% in NHANES men and women, respectively).[40] In another NHANES study of cardiovascular risk factor levels in individuals with diabetes from 1999 to 2002,[41] among non-Hispanic blacks unadjusted mean hemoglobin A1c, systolic blood pressure, LDL cholesterol, and BMI levels were 8.0%, 138 mm Hg, 122 mg/dL, and 32.4 kg/m^2, respectively. Focusing on blood pressure control, 33.5% had systolic and diastolic blood pressure levels treated to goal (<130/80 mm Hg)[41] as compared with 30.4% of women and 27.9% of men in the Project SuGAR population. As such, men and women with diabetes mellitus in the Gullah population had higher hemoglobin A1c and were less likely to be treated to goal with respect to blood pressure levels; however, they had similar mean systolic blood pressure levels overall.[41]

[A]LDL for NHANES women number missing. Pls provide.

Insulin resistance and diabetes mellitus have been shown to accelerate an atherogenic profile.[42] When assessed by conventional lipid panel, the dyslipidemia of the metabolic syndrome and type 2 diabetes mellitus is characterized by high triglycerides and low HDL cholesterol, whereas total cholesterol and calculated LDL cholesterol are not consistently affected.[43–46] In contrast and similar to other African American populations with type 2 diabetes mellitus, HDL cholesterol levels in Project SuGAR participants were relatively high and triglyceride levels were low. As such, these participants do not follow the typical pattern of dyslipidemia characterized by the metabolic syndrome and type 2 diabetes mellitus. Alterations in lipoprotein subclasses confer unknown cardiovascular risk in this population and are not captured by the conventional lipid panel. In the general population, increased levels of small dense LDL[47–49] and a preponderance of the small subfraction of HDL[50–52] have been shown to be associated with an increased risk for atherosclerosis. In Project SuGAR, the small LDL particle concentration was higher in men than women with diabetes mellitus and the LDL particle concentration was higher in those with than in those without diabetes mellitus. In Project SuGAR, the large HDL particle concentration was higher in women than men and in women was lower in those with than those without diabetes mellitus. LDL cholesterol levels and particle size were similar in men and women and across diabetes mellitus status.

The strengths of our study include the ancestral and environmental homogeneity in the Gullah population; the extensive cardiometabolic, environmental, and genetic information available; and the information available on diabetes mellitus awareness, management, and preventive care in this unique population. The Sea Islands Genetic Network, a genome-wide association study, included 979 Project SuGAR participants, and a linkage study has been completed within Project SuGAR.[23,24] One limitation of our study is that Project SuGAR does not represent a population-based sample of Gullah individuals, but does comprise Gullah families enriched for type 2 diabetes mellitus who were actively recruited through telephone calls, face-to-face visits, and word of mouth. As a result, familial cardiometabolic risk and community engagement with study staff have been selected for in the study population.

Conclusions

Cardiometabolic risk factor levels and baseline self-reported macro- and microvascular disease are high in Project SuGAR participants. Among those participants with diabetes mellitus, approximately one-third reported reduced vision or blindness and >80% reported numbness, pain, or burning in their feet. Moreover, although preventive screening for breast and prostate cancers was high, preventive care (podiatry, dentistry, ophthalmology) with respect to diabetes mellitus was limited. For instance, <60% reported seeing an ophthalmologist, <25% reported seeing a podiatrist, and <40% reported seeing a dentist during the past year. Overall, 79.2% of women and 69.6% of men reported using a glucose-monitoring machine; however, only 54.4% of women and 39.3% of men reported daily monitoring of their glucose. Our study population is the largest existing study comprising Gullah individuals and offers insight into not only the prevalence of cardiovascular risk factors and disease in Gullah individuals with diabetes but also the pathophysiological mechanisms central to ancestral difference in cardiometabolic risk in the broader African

American population. Findings from this study will be used to inform the design of an educational intervention for residents of the Sea Islands.

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Key Points

- As the largest existing study comprising Gullah individuals, our study population offers insight into not only the prevalence of cardiovascular risk factors and disease in these individuals but also the mechanisms central to ancestral differences in cardiometabolic risk in the broader African American population.
- Cardiometabolic risk factor levels and baseline self–reported macro- and microvascular disease are high in the Sea Islands Genetic African American Registry study population.
- Among subjects with diabetes mellitus, approximately one-third reported reduced vision or blindness and >80% reported numbness, pain, or burning in their feet.
- Preventive care (ie, podiatry, dentistry, ophthalmology) with respect to diabetes mellitus was limited. Fewer than 60% reported seeing an ophthalmologist, fewer than 25% reported seeing a podiatrist, and fewer than 40% reported seeing a dentist during the past year.

Table 1

Cardiometabolic characteristics of the Project SuGAR study population adjusted for age and stratified by sex and diabetes mellitus status (mean or percent [95% CI])

		Diabetes mellitus yes		Diabetes mellitus no	
	All subjects, mean or % (n)	**Females, n = 863**	**Males, n = 242**	**Female, n = 161**	**Males, n = 55**
Age, y*	52.7 (1321)	54.9 (53.9–55.9)	53.8 (51.9–55.7)	44.5 (42.3–46.7)	38.4 (34.6–42.2)
Completed high school, %	62.7 (1205)	62.7 (59.3–66.1)	59.3 (53.3–65.3)	69.7 (62.5–76.9)	52.9 (40.8–65.0)
Lifestyle, %					
Current smoker	17.9 (1300)	16.6 (13.9–19.3)	25.1 (20.2–30.0)	12.4 (6.4–18.4)	25.8 (15.6–36.0)
Current drinker	13.2 (1300)	10.2 (7.8–12.6)	22.7 (18.4–27.0)	11.4 (6.1–16.7)	20.9 (11.8–30.0)
Exercises 3 x/wk	44.3 (1277)	42.5 (39.1–45.9)	50.1 (43.7–56.5)	39.6 (31.8–47.4)	61.4 (47.8–75.0)
Preventive screening, %					
Mammogram	83.1 (916)	84.0 (81.6–86.4)	NA	77.9 (72.2–83.6)	NA
Prostate	73.9 (253)	NA	74.7 (69.4–80.0)	NA	70.6 (58.6–82.6)
Adiposity					
BMI, kg/m^2	33.6 (1202)	34.7 (34.1–35.3)	31.4 (30.3–32.5)	33.2 (31.9–34.5)	27.7 (25.6–29.8)
Waist circumference, cm	104 (1173)	106 (104–107)	105 (102–107)	101 (98–103)	95.4 (91–100)
Blood pressure					
Hypertension, %	75.2 (1104)	76.9 (74.0–79.8)	72.0 (66.5–77.5)	69.3 (61.4–77.2)	67.0 (51.6–82.4)
Self-reported hypertension, %	65.8 (1207)	68.9 (65.7–72.1)	63.9 (58.2–69.6)	56.5 (49.0–64.0)	47.0 (33.4–60.6)
SBP, mm Hg	134 (1180)	135 (134–136)	133 (130–136)	129 (126–132)	129 (124–134)
DBP, mm Hg	81 (1180)	81 (80–82)	82 (81–83)	79 (77–81)	79 (67–73)
BP medication, %	63.7 (1093)	65.8 (62.6–69.0)	60.7 (54.7–66.7)	56.6 (47.5–65.7)	49.0 (30.8–67.2)
SBP/DBP ≥140/90, %	39.2 (1180)	40.5 (37.1–43.9)	39.2 (32.7–45.7)	31.1 (23.3–38.9)	35.8 (22.0–49.6)
SBP/DBP ≥130/80, %	69.1 (1180)	69.6 (66.4–72.8)	72.1 (66.0–78.2)	63.2 (55.8–70.6)	60.1 (47.1–73.1)
Lipid levels					
Total cholesterol, mg/dL	198 (1233)	201 (198–204)	193 (187–199)	193 (185–201)	189 (176–202)
LDL cholesterol, mg/dL	124 (1188)	125 (122–128)	123 (118–128)	118 (111–125)	122 (111–133)
HDL cholesterol, mg/dL	50 (1212)	50 (49–51)	45 (43–47)	55 (53–57)	47 (43–51)
Triglycerides, mg/dL	128 (1217)	131 (123–139)	145 (131–159)	95 (78–112)	117 (89–145)
Lipid medication, %	15.2 (1093)	16.3 (13.7–18.9)	13.8 (9.0–18.6)	10.3 (3.1–17.5)	7.1 (0–21.7)

		Diabetes mellitus yes		Diabetes mellitus no	
	All subjects, mean or % (n)	**Females, n = 863**	**Males, n = 242**	**Female, n = 161**	**Males, n = 55**
Large VLDL PC, nmol/L	3.7 (776)	3.8 (3.4–4.2)	4.6 (3.8–5.4)	2.0 (0.9–3.1)	2.5 (0.4–4.6)
Small LDL PC, μmol/L	518 (776)	529 (498–560)	596 (538–653)	328 (249–406)	377 (221–534)
Large HDL PC, μmol/L	5.3 (776)	5.5 (5.3–5.7)	4.3 (3.8–4.8)	6.5 (5.9–7.1)	4.6 (3.3–5.9)
VLDL particle size, nm[dA]	48.2 (634)	48.2 (47.5–48.9)	49.3 (48.0–50.6)	45.3 (43.3–47.3)	47.3 (43.2–51.4)
LDL particle size, nm[d]	20.9 (776)	21.0 (21.0–21.0)	20.7 (20.6–20.8)	21.2 (21.1–21.3)	21.1 (20.9–21.3)
HDL particle size, nm[d]	9.2 (776)	9.2 (9.2–9.2)	9.1 (9.0–9.2)	9.5 (9.4–9.6)	9.2 (9.0–9.4)
Glycemic control					
HbA1c, %	8.4(1182)	8.9 (8.7–9.1)	9.1 (8.8–9.4)	5.8 (5.4–6.2)	5.7 (5.1–6.3)
Fasting glucose, mg/dL	158 (1233)	173 (167–179)	171 (160–182)	86 (73–99)	85 (63–107)
Renal markers					
eGFR*	102 (1198)	104 (102–107)	100 (96–105)	95.1 (90–100)	92.3 (84–101)
Serum creatinine, mg/dL	1.0 (1198)	0.9 (0.8–1.0)	1.4 (1.2–1.6)	0.9 (0.7–1.1)	1.4 (1.1–1.7)
BUN, mg/dL	14.6 (1199)	14.4 (13.7–15.1)	16.4 (15.2–17.6)	13.0 (11.5–14.5)	15.6 (13.1–18.1)
Psychiatric medication, %	11.7 (1093)	12.8 (10.5–15.1)	10.7 (6.4–15.0)	8.4 (1.9–14.9)	0

BMI, body mass index; BP, blood pressure; CI, confidence interval; BUN, blood urea nitrogen; DBP, diastolic blood pressure; Hb, hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; PC, particle concentration; Project SuGAR, Sea Islands Genetic African American Registry; SBP, systolic blood pressure; VLDL, very-low-density lipoprotein.

*eGFR Modification of Diet in Renal Disease formula: estimated glomerular filtration rate.[31]

Table 2

Self-reported cardiovascular disease history, adjusted for age (percent and 95% CI), in 1207 participants with available information

		Diabetes mellitus yes		Diabetes mellitus no	
	All subjects, %	**Females, n = 803**	**Males, n = 227**	**Females, n = 137**	**Males, n = 40)**
MI	6.2	6.6 (4.8–8.4)	8.1 (4.9–11.3)	3.5 (0–7.6)	6.4 (0–13.8)
CABG	1.5	1.6 (0.8–2.4)	1.3 (0–2.9)	1.8 (0–3.9)	0
MI or procedure*	8.0	7.9 (6.0–9.8)	11.3 (7.8–14.8)	5.1 (0.5–9.7)	5.7 (0–14.1)
Angina	16.9	17.4 (14.7–20.1)	21.1 (16.2–26.0)	11.4 (5.0–17.8)	6.0 (0–17.8)
Stroke	8.1	8.2 (6.3–10.1)	9.9 (6.4–13.4)	5.3 (0.7–9.9)	5.3 (0–13.8)
CHFgestive Heart Failure	3.4	3.4 (2.1–4.7)	4.2 (1.8–6.6)	2.4 (0–5.5)	1.4 (0–7.1)

CABG, coronary artery bypass graft; CHF, congestive heart failure; CI, confidence interval; MI, myocardial infarction.

*Procedure includes CABG or angioplasty.

Table 3

Diabetes management, preventive care, and comorbidities adjusted for age (percentage with 95% CI) among men and women who self-report clinically diagnosed diabetes mellitus

	All subjects, mean or % (n)	Females, n = 831	Males, n = 234
Duration, y	10.5 (1041)	10.5 (9.9–11.1)	10.3 (9.1–11.5)
Management, %			
Diet	73.3 (1065)	74.3 (71.2–77.4)	69.6 (63.9–75.3)
Self-report pills	56.9 (1041)	59.0 (55.5–62.5)	48.8 (42.3–55.3)
Self-report insulin	48.7 (1041)	48.7 (45.2–52.2)	48.3 (41.7–54.9)
Diabetes medication	80.6 (975)	80.7 (77.9–83.5)	80.8 (75.5–86.1)
Preventive care, %			
Dietary class by dietitian	52.2 (1065)	51.1 (47.6–54.6)	56.1 (49.6–62.6)
Ophthalmologist in past year	56.6 (1065)	57.7 (54.2–61.2)	54.5 (48.1–60.9)
Podiatrist in past year	22.4 (1065)	22.0 (19.1–24.9)	23.6 (18.2–29.0)
Dentist in past year	38.2 (1065)	37.8 (34.4–41.2)	39.9 (33.6–46.2)
Glucose-monitoring machine	77.1 (1065)	79.2 (76.3–82.1)	69.6 (64.2–75.0)
Monitored glucose daily	51.3 (1060)	54.4 (50.9–57.9)	39.3 (32.9–45.7)
Peripheral vascular disease, %			
Numbness, pain, or burning in feet	83.1 (599)	83.0 (79.6–86.4)	83.7 (76.9–90.5)
Foot ulcers or sores	8.9 (599)	8.5 (5.9–11.1)	10.8 (5.6–16.0)
Claudication	32.9 (599)	33.2 (29.0–37.4)	31.7 (23.2–40.2)
Amputation	5.2 (599)	4.3 (2.3–6.3)	8.5 (4.5–12.5)
Vascular leg surgery	3.5 (599)	3.3 (1.7–4.9)	4.2 (0.9–7.5)
Eye disease, %			
Reduced vision or blindness	31.1 (614)	29.4 (25.2–33.6)	37.6 (29.6–45.6)
Glaucoma	15.2 (614)	13.4 (10.3–16.5)	22.0 (15.9–28.1)
Cataracts	35.5 (614)	36.6 (32.7–40.5)	32.3 (24.8–39.8)
Laser eye surgery	27.7 (614)	27.1 (23.2–31.0)	29.8 (22.3–37.3)
Diabetic retinopathy	6.4 (614)	6.1 (3.9–8.3)	5.8 (1.6–10.0)
Blurry vision	49.8 (614)	50.7 (46.4–55.0)	47.2 (38.9–55.5)

CI, confidence interval.

*n reflects the number of participants with information available on a given topic (ie, some sections of the questionnaire were only completed by a subset of the study population).