# DIFFERENCES IN THE DIETARY INTAKE HABITS BY DIABETES STATUS FOR AFRICAN AMERICAN ADULTS

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**Background:** African Americans (AA) are 1.8 times more likely to develop type 2 diabetes than non-Hispanic Whites. This increased diabetes risk has been linked to high rates of obesity and poor dietary habits; therefore, the purpose of this study is to identify how the nutrient intake profiles of AA adults differ by diabetes status.

**Methods:** Dietary intakes of AA adults (aged ≥18 years; *n*=2,589) were examined from the 1999–2004 National Health and Nutrition Examination Survey. Individuals were stratified into three groups (normoglycemia, pre-diabetes, and diabetes) based on self-reported previous diagnosis, blood glucose and use of glucose-lowering medications. Dietary intakes were collected using 24-hour recalls; energy-adjusted nutrients intake were compared across diabetes status.

**Results:** Risk for pre-diabetes was 4% higher for every one year increase in age, while the risk for diabetes was 7% higher. Those with diabetes consumed significantly less energy ($P$=.03) and significantly more energy-adjusted protein ($P$=.011) and dietary fiber ($P$<.001) compared to those with normal blood glucose. Mean consumption of carbohydrates were nearly two and a half times the estimated average requirement regardless of diabetes status. Individuals with diabetes had significantly higher intakes of several B-vitamins including thiamin, riboflavin, niacin, folate and B-6 compared to individuals who had normal blood glucose values.

**Conclusion:** This study identifies opportunities for improvement in the dietary habits of African Americans and supports the development of culturally-appropriate diabetes prevention and treatment strategies. (*Ethn Dis.* 2010;20:99–105)

**Key Words:** Minority, Diabetes Mellitus, Diet, African American, Disease Prevention, Nutrition Therapy, Race

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## INTRODUCTION

The prevalence of diabetes is a growing public health concern that disproportionately affects minority populations; African Americans (AA) are 1.8 times more likely to develop type 2 diabetes mellitus than non-Hispanic whites (NHW).[1] The etiology of the increased risk within this population have not been fully elucidated but have been linked to high rates of obesity[2] and poor dietary habits.[3] Previous research has suggested the rates of obesity and type 2 diabetes, in the United States, follow a socioeconomic gradient, with the burden of disease disproportionately affecting people with limited resources, racial-ethnic minorities, and the poor. The association between poverty and obesity may be partially explained by the low cost of energy-dense foods coupled with the high palatability of sugar and fat.[4] More information is needed regarding the current dietary habits to clarify the role of dietary behaviors in the development and progression of diabetes. Moreover, comorbidities related to diabetes including heart disease, hypertension, stroke, and peripheral vascular disease may be controlled with lifestyle and dietary modification.[5,6]

Diabetes is a multifaceted disease whose risk factors and etiologies are just beginning to be understood. Dietary composition may play a role in the etiology as well as the reversal of diabetes. Excessive caloric intake that leads to weight gain, especially abdominal adiposity, is an important determinant of insulin-resistance and represents the most important risk factor for diabetes.[7] Diets higher in dietary fat, especially saturated fat, have been associated with insulin resistance. Insulin resistance causes a reduction in glucose uptake in muscle and fat cells as well as the suppression of postprandial liver glucose production.[8] African Americans have high total fat intakes, exceeding 35% of total calories;[9,10] conversely, long-term intakes of reduced-fat diets have been associated with improved circulating insulin and glucose concentrations.[11,12] Diets high in dietary fiber appear to be associated with modest beneficial effects on insulin sensitivity and are associated with a decreased risk for developing diabetes.[13,14] Epidemiologic studies have failed to show a direct relationship between simple sugar consumption and the development of insulin resistance; however the total amount of carbohydrate in meals or snacks may be more important than the source or type of carbohydrate.[3,13]

Understanding the differences in dietary intake habits of AA will assist in the development of culturally appropriate treatment strategies and help to identify specific concerns related to this population. The purpose of this study was to identify how the nutrient intake profiles of AA adults differ by diabetes status. This is increasingly important because of the potential for culturally-appropriate lifestyle modifications to play a significant role in weight loss and diabetes prevention.

*The purpose of this study was to identify how the nutrient intake profiles of African American adults differ by diabetes status.*

## METHODS

Data from the 1999–2004 National Health and Nutrition Examination Survey (NHANES) were examined to assess the current dietary habits of AA adults with regard to diabetes status. This stratified, multistage probability sample of the civilian non-institutionalized US population is collected by the federal government as a mechanism of continuous nationwide nutrition monitoring of the US population. The NHANES data provides data regarding the lifestyle behaviors of the general population, while also measuring indicators of health and chronic disease. Hard to reach populations, including low-income persons, children, adolescents, the elderly, pregnant women, and racial/ethnic minorities, were over-sampled to ensure adequate representation for nationally-representative estimates.

In-home interviews were used to collect sociodemographic data, while physical examination and laboratory data were collected during mobile examination center visits. Data were collected using two-year cycles of specific protocols. Key variables used in these analyses used consistent methodologies across the three 2-year cycles. More information about the design and data collection of NHANES is available elsewhere.[15]

### Study Participants

A nationally representative sample of 2,589 AA adults (aged ≥18 years, 1,258 males and 1,331 females) were included if they presented dietary intake data, a complete diabetes questionnaire and laboratory data. Women were excluded from the analyses if they were pregnant at the time of the physical examination conducted at the mobile examination center.

### Data Preparation

The pubic-use data files were downloaded from the National Center for Health Statistics website and imported into SPSS for preparation and analysis. Specific data utilized for these analyses included: sociodemographic, body composition, previous medical history, prescription medication use, laboratory analyses for blood glucose, and dietary intakes estimated using a 24-hr dietary recall. Some variables required recoding or categorization to provide useful information for the current study.

#### *Categorizing Diabetes Status*

To establish diabetes status, AA adults were stratified into groups using a three step process: 1) self-reported diabetes or border-line (coded as pre-diabetes) diagnosis by a doctor; 2) use of prescription medication used to treat hyperglycemia (diabetes); and 3) blood glucose levels meeting current diagnostic criteria (5.55–6.94 mmol/L for pre-diabetes, ≥7mmol/L for diabetes).

Individuals with a blood glucose level ≥7mmol/L but with a length of food fast less than 6 hours were considered a potential false positive for diabetes status; these data were not included in the classification of diabetes status. The three groups of diabetes status used for the analyses were normoglycemic, pre-diabetes and diabetes.

### Preparing Dietary Intake Data

The dietary intake data was used to estimate total intake of energy and nutrients from food and beverages that were consumed 24 hours prior to the interview. The trained interviewer used the multiple pass 24 hour dietary interview method to collect detailed information about all foods and beverages. The United States Department of Agriculture Food and Nutrient Database for Dietary Studies was used to code and report the nutrient intake for NHANES 1999–2004 for each individual food consumed and as a total for the day. Nutrients used for these analyses were reported as cumulative totals per day. Dietary intakes reported herein do not include those obtained from dietary supplements.

To account for potential differences in nutrient intakes as a result of differences in energy intakes, energy-adjusted nutrient intakes (nutrient per 1,000 kcals) were computed. Energy-adjusted nutrients were computed using the following equation:[16] Energy adjusted nutrient intakes=(total nutrient/total kcals) * 1,000. By standardizing the energy density for each macronutrient and micronutrient, comparisons were more easily made across the diabetes groups.

Nutrient intakes from the 24 hour recalls were compared to the estimated average requirement (EAR) or adequate intake (AI) values as established by the dietary reference intakes for assessing groups. The percentages of estimated needs were computed for each individual using the following formula: Percent of need=nutrient intake/EAR or AI ×100. To identify the proportions of adults who met EAR or AI recommendations by diabetes status, individuals with an intake of ≥100% of the EAR or AI was categorized as meeting or exceeding the recommended intake level.

### Data Analysis

Analyses of sociodemographic and personal factors were evaluated using the following variables: age, income, waist circumference, marital status, sex and education using odds ratios from a logistic regression analysis predicting diabetes status. The normal glycemic groups served as the reference group. Significant factors related to diabetes status were used as covariates in the analyses of dietary intake data.

**Table 1. Sociodemographic and personal predictors of pre-diabetes and diabetes**

| | Pre-diabetes (*n*=321) | | | Diabetes (*n*=405) | | | |
|---|---|---|---|---|---|---|---|
| | 95% CI | | | 95% CI | | | |
| **Predictor*†** | **OR** | **LL** | **UL** | **OR** | **LL** | **UL** | ***P*** |
| Age (yr) | 1.04 | 1.03 | 1.05 | 1.07 | 1.06 | 1.08 | <.001 |
| Income‡ | 1.10 | .99 | 1.23 | .86 | .75 | .98 | .019 |
| Waist circumference (cm) | 1.03 | 1.02 | 1.04 | 1.05 | 1.04 | 1.05 | .000 |
| Marital status | | | | | | | |
| Married or living as married | 1.0 | Referent | | 1.0 | Referent | | .001 |
| Single, divorced, widowed | 1.42 | 1.0 | 2.01 | .71 | .56 | .92 | |
| Sex | | | | | | | |
| Male | 1.0 | Referent | | 1.0 | Referent | | .079 |
| Female | .81 | .61 | 1.09 | 1.32 | .9 | 1.93 | |
| Education | | | | | | | |
| Completed high school/GED | 1.0 | Referent | | 1.0 | Referent | | .739 |
| Less than high school | 1.01 | .63 | 1.61 | | 1.03 | .71 | 1.47 |
| More than high school | .78 | .48 | 1.28 | | .91 | .61 | 1.36 |

* Model predicted diabetes status from age, income, waist circumference, marital status, sex and education.
† Normoglycemic group as the referent group.
‡ Income expressed as ratio of income to federal poverty rate (1.0=100% federal poverty level).

Differences in dietary intakes by diabetes status were tested using a one-way analysis of covariance. Nutrient estimates compared were the groups' mean intakes total energy and energy-adjusted values, controlled for sociodemographic and personal factors (age, income, waist circumference, marital status, sex and education) across the normal, pre-diabetes and diabetes groups. Statistical analyses were performed using log-transformed nutrient data to improve normality, however, data are presented as non-log transformed values. Statistical significance was set at <0.05.

Data were tabulated and transformed using SPSS (version 17.0, Chicago, IL). SPSS Complex Samples (version 17.0, Chicago, IL) was used to conduct analysis of the NHANES sample. This software uses the provided sampling weights, which allows for the correction of over-sampling of over-sampled populations. These analyses resulted in a nationally-representative sample while also providing appropriate standard errors for statistical analyses.

## RESULTS

To identify the characteristics related to diabetes in AA adults, differences in sociodemographic factors were examined (Table 1). Risk for pre-diabetes was 4% higher for every one year increase in age, while the risk for diabetes was 7% higher. Risk for diabetes was inversely related to income (OR=0.86). For every one centimeter increase in waist circumference, there was a 3% and 5% increased risk for pre-diabetes and diabetes, respectively. Those married or living as married had a greater risk for diabetes.

After adjusting for sociodemographic factors, there was a significant difference in several energy-adjusted nutrients between those with normal blood glucose and those with diabetes, however, few differences were seen with the pre-diabetes group (Table 2). Those with diabetes consumed significantly less total energy ($P$=.03) and significantly more energy-adjusted protein ($P$=.011) and dietary fiber ($P$<.001) compared to those with normal blood glucose. Individuals with diabetes had significantly higher intakes of several vitamins including vitamin E, thiamin, riboflavin, niacin, folate and vitamin B-6 compared to individuals who had normal blood glucose values. Those with normal blood glucose values had significantly lower intakes of many minerals including calcium, iron, magnesium, phosphorus, potassium, and sodium compared to those with diabetes. The mean percent consumption of recommended dietary reference intakes for AA adults by diabetes status was also examined (Table 3). As a group, those with diabetes had significantly lower percentages of recommended intakes of carbohydrate, calcium, sodium, and potassium compared to the group with normal blood glucose values. The proportion of individuals meeting the EAR or AI for selected macronutrients and micronutrients were reported across diabetes status (Table 4). African Americans with normal blood glucose consumed significantly more potassium compared to those with diabetes.

**Table 2. Mean intakes of energy and energy-adjusted nutrients by diabetes status**

| | Normal (*n*=1,863) | | | Pre-diabetes (*n*=321) | | | Diabetes (*n*=405) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 95% CI | | | 95% CI | | | 95% CI | | |
| Nutrients per 1,000 kcals* | Mean | LL | UL | Mean | LL | UL | Mean | LL | UL | *P* |
| Energy (kcal) | 2236 | 2167 | 2305 | 2212 | 2043 | 2381 | 2015 | 1896 | 2135 | .030 |
| Protein (g ) | 37.3 | 36.5 | 38.1 | 38.8 | 36.5 | 41.2 | 39.4 | 37.7 | 41.1 | .011 |
| Carbohydrate (g ) | 124 | 122 | 126 | 123 | 119 | 128 | 125 | 121 | 128 | NS |
| Total sugars (g) | 62.6 | 60.6 | 64.5 | 61.6 | 57.4 | 65.8 | 59.0 | 55.6 | 62.5 | NS |
| Dietary fiber (g) | 6.0 | 5.7 | 6.2 | 6.4 | 5.9 | 6.9 | 7.1 | 6.6 | 7.6 | <.001 |
| Total fat (g ) | 36.9 | 36.1 | 37.6 | 37.0 | 35.8 | 38.2 | 36.9 | 35.7 | 38 | NS |
| Saturated fat (g) | 11.4 | 11.2 | 11.7 | 11.5 | 10.9 | 12.0 | 11.3 | 10.8 | 11.9 | NS |
| Monounsaturated fat (g) | 14.1 | 13.8 | 14.4 | 14.2 | 13.6 | 14.9 | 14.1 | 13.7 | 14.6 | NS |
| Polyunsaturated fat (g) | 8.1 | 7.9 | 8.4 | 8.0 | 7.5 | 8.5 | 8.1 | 7.6 | 8.7 | NS |
| Cholesterol (mg) | 144 | 139 | 148 | 151 | 135 | 166 | 154 | 142 | 167 | NS |
| Vitamin E (mg) | 1.7 | 1.5 | 2.0 | 2.0 | 1.6 | 2.4 | 2.1 | 1.7 | 2.5 | .004 |
| Vitamin C (mg) | 50.4 | 47.5 | 53.3 | 52 | 43.2 | 60.8 | 48.4 | 41.2 | 55.7 | NS |
| Thiamin (mg) | .69 | .67 | .71 | .70 | .66 | .73 | .78 | .73 | .83 | .001 |
| Riboflavin (mg) | .85 | .83 | .87 | .84 | .79 | .89 | .97 | .93 | 1.01 | <.001 |
| Niacin (mg) | 10.9 | 10.7 | 11.1 | 11.2 | 10.5 | 11.9 | 12.0 | 11.3 | 12.7 | .002 |
| Vitamin B-6 (mg) | .82 | .79 | .84 | .85 | .78 | .91 | .93 | .86 | .99 | .002 |
| Total folate (mcg) | 169 | 163 | 176 | 166 | 155 | 176 | 187 | 174 | 200 | .002 |
| Calcium (mg) | 306 | 296 | 315 | 307 | 283 | 331 | 325 | 307 | 343 | .036 |
| Iron (mg) | 6.7 | 6.5 | 6.8 | 6.8 | 6.4 | 7.2 | 7.7 | 7.2 | 8.2 | <.001 |
| Magnesium (mg) | 110 | 107 | 113 | 112 | 107 | 117 | 121 | 115 | 128 | .002 |
| Phosphorus (mg) | 533 | 524 | 542 | 539 | 516 | 562 | 564 | 542 | 587 | .014 |
| Potassium (mg) | 1090 | 1062 | 1118 | 1130 | 1074 | 1186 | 1195 | 1149 | 1241 | <.001 |
| Sodium (mg) | 1567 | 1532 | 1602 | 1661 | 1579 | 1743 | 1663 | 1613 | 1712 | .006 |
| Zinc (mg) | 5.2 | 4.9 | 5.4 | 5.4 | 5.1 | 5.8 | 5.4 | 5.0 | 5.8 | NS |
| Alcohol (g) | 4.7 | 3.8 | 5.6 | 4.0 | 2.9 | 5 | 3.1 | 1.6 | 4.6 | .034 |

* Data presented as mean and 95% confidence interval (LL=Lower Limit, UL=Upper Limit).

## DISCUSSION

The foundation of non-pharmacologic treatment for individuals with diabetes is dietary modification and the regulation of carbohydrate and fat intakes. Medical nutrition therapy (MNT) is an effective strategy for prevention and early treatment of type 2 diabetes. Medical nutrition therapy relies on the integration of organized programs that focus on lifestyle change (including education), reduced energy and fat intake, regular physical activity, loss of excess weight, and regular participant contact with a physician.[17] The primary objective of MNT for diabetes is to create and implement personalized lifestyle modification strategies that will improve glucose control, improve dyslipidemias, and hypertension.

The American Diabetes Association recommends monitoring carbohydrate intakes through either carbohydrate counting or exchanges as an effective strategy for achieving glycemic control.[18] Data from the current study suggest that little differences in dietary habits were evident in macronutrient and micronutrient intakes by diabetes status in AA adults. African Americans in this study had a mean consumption of nearly two and a half times the EAR for carbohydrates, regardless of diabetes status.

Lifestyle behavior modification provides a great potential for impacting insulin resistance and moderating diabetes risk. The Diabetes Prevention Program (DPP) was successful in reducing the progression of pre-diabetes to type 2 diabetes through a program that focused on lifestyle modification and reducing fat intake.[19] The DPP recommends limiting total and saturated fat intakes to less than 30% and 10% of total energy, respectively. Diets higher in dietary fat (35–40% of total energy intake), specifically saturated fat, have been associated with an increase in insulin resistance.[7] African Americans in this study consumed more than 33% of total energy from fat, and more than 10% from saturated fat regardless of diabetes status. Previous research indicates that AA have high total fat intakes, exceeding 35% of total calories.[9,10] Prolonged high dietary fat intakes have been linked to the development of obesity and progression of cardiovascular disease, a chronic complication of diabetes. However, long-term intakes of low-fat diets have been associated with improved circulating insulin and glucose concentrations as well as a sustained modest weight loss.[11,12,20,21]

Dietary habits also play a significant role in glycemic control and the development of long-term complications of diabetes, such as cardiovascular disease.

**Table 3. Mean consumption as a percent of dietary reference intakes by diabetes status**

| Percent of recommended intakes *† | Normal (*n*=1,863) | | | Pre-diabetes (*n*=321) | | | Diabetes (*n*=405) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 95% CI | | | 95% CI | | | 95% CI | | |
| | Mean | LL | UL | Mean | LL | UL | Mean | LL | UL | *P* |
| Carbohydrate | 273 | 264 | 282 | 267 | 244 | 291 | 243 | 231 | 254 | <0.001 |
| Dietary fiber | 54.6 | 51.7 | 57.4 | 57.4 | 51.4 | 63.4 | 58.4 | 54.0 | 62.8 | NS |
| Thiamin | 165 | 157 | 173 | 162 | 148 | 177 | 166 | 153 | 180 | NS |
| Riboflavin | 197 | 189 | 206 | 193 | 175 | 211 | 202 | 189 | 215 | NS |
| Niacin | 209 | 202 | 217 | 210 | 191 | 230 | 213 | 198 | 228 | NS |
| Vitamin B6 | 142 | 135 | 149 | 144 | 130 | 158 | 143 | 131 | 154 | NS |
| Total Folate | 113 | 108 | 118 | 108 | 100 | 116 | 112 | 103 | 122 | NS |
| Vitamin B12 | 245 | 220 | 270 | 309 | 265 | 353 | 241 | 204 | 278 | .034 |
| Vitamin C | 167 | 155 | 179 | 170 | 135 | 206 | 155 | 129 | 181 | NS |
| Vitamin A | 108 | 96 | 120 | 109 | 89 | 129 | 110 | 95 | 126 | NS |
| Vitamin E | 53.5 | 50.5 | 56.5 | 54.2 | 49.8 | 58.5 | 52.2 | 46.1 | 58.2 | NS |
| Calcium | 60.4 | 57.1 | 63.7 | 56.8 | 52.5 | 61.0 | 55.6 | 51.5 | 59.7 | .049 |
| Phosphorus | 201 | 195 | 208 | 198 | 184 | 212 | 193 | 179 | 207 | NS |
| Magnesium | 84.9 | 81.5 | 88.4 | 84.4 | 77.5 | 91.2 | 85.3 | 79.2 | 91.3 | NS |
| Iron | 261 | 251 | 271 | 274 | 249 | 299 | 275 | 253 | 296 | NS |
| Zinc | 157 | 150 | 164 | 164 | 148 | 180 | 153 | 138 | 169 | NS |
| Copper | 167 | 159 | 174 | 166 | 152 | 180 | 157 | 143 | 171 | NS |
| Sodium | 98.8 | 78.0 | 12.0 | 77.6 | 52.3 | 10.3 | 74.5 | 49.6 | 99.3 | .026 |
| Potassium | 20.8 | 16.5 | 25.1 | 15.7 | 10.2 | 21.2 | 16.1 | 11.1 | 21.1 | .036 |
| Selenium | 242 | 231 | 252 | 238 | 218 | 259 | 228 | 212 | 245 | NS |

* Data presented as mean and 95% confidence interval (LL=Lower Limit, UL=Upper Limit).
† Percent of recommended intake levels computed as actual intake/recommendation ×100.

Ma et al[22] indicated that a significant decrease in high-density lipoprotein (HDL) and increase in the total cholesterol-to-HDL ratio was positively related to percentage of calories from carbohydrates, specifically processed carbohydrates. These data suggested that higher total carbohydrate intake or percentage of calories from carbohydrate were related to lower HDL and higher serum triglyceride levels. Similarly, mean carbohydrate intakes that

**Table 4. Proportion of individuals meeting recommended intake levels for selected nutrients**

| Percent Meeting EAR/AI* | Normal (*n*=1,863) | | Pre-Diabetes (*n*=321) | | Diabetes (*n*=405) | | |
|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | *P* |
| Carbohydrate | 1741 | 93 | 290 | 91 | 361 | 90 | NS |
| Dietary fiber | 201 | 11 | 44 | 15 | 55 | 13 | .027 |
| Thiamin | 1330 | 71 | 224 | 72 | 288 | 70 | NS |
| Riboflavin | 1480 | 80 | 243 | 77 | 324 | 80 | NS |
| Niacin | 1562 | 84 | 263 | 83 | 326 | 80 | NS |
| Vitamin B6 | 1155 | 62 | 178 | 58 | 222 | 55 | NS |
| Total Folate | 885 | 46 | 137 | 44 | 166 | 40 | NS |
| Vitamin B12 | 1318 | 72 | 214 | 69 | 267 | 65 | NS |
| Vitamin C | 925 | 48 | 161 | 51 | 194 | 46 | NS |
| Vitamin A | 643 | 34 | 116 | 35 | 142 | 34 | NS |
| Vitamin E | 192 | 10 | 30 | 10 | 28 | 8 | NS |
| Calcium | 294 | 15 | 26 | 9 | 32 | 7 | NS |
| Phosphorus | 1541 | 85 | 257 | 82 | 332 | 82 | NS |
| Magnesium | 544 | 29 | 87 | 29 | 99 | 25 | NS |
| Iron | 1667 | 90 | 287 | 89 | 375 | 92 | NS |
| Zinc | 1191 | 65 | 194 | 64 | 221 | 54 | NS |
| Copper | 1310 | 70 | 217 | 70 | 263 | 65 | NS |
| Sodium | 1782 | 96 | 304 | 95 | 377 | 93 | NS |
| Potassium | 817 | 43 | 107 | 36 | 131 | 36 | .024 |
| Selenium | 1618 | 88 | 274 | 87 | 352 | 86 | NS |

* Data presented as sample *n* (weighted percent); EAR-estimated average requirement; AI-adequate intake.

exceed 51% of total energy intake may have an unfavorable impact on serum triglycerides levels.[23] Data from the present study showed that AA with diabetes consumed approximately 50% of total energy from carbohydrates; however, whole grain intake was well below the current recommendation of ≥50% of total grain consumption obtained from whole grains. There are additional ramifications of the current dietary habits presented herein, as approximately 44.6% and 49.0% of AA men and women, respectively, over the age of 20 years had cardiovascular disease (CVD). Combined with the disproportionate rates of diabetes and CVD in this population, lifestyle behavior modification has the potential to favorably impact long-term health outcomes.

Additional dietary habits that represent areas of need were evident from our data. African Americans were less likely to meet recommended intake levels for several minerals crucial to bone health, including calcium, magnesium, potassium and zinc. Low intakes of these minerals may be due in part to low dairy consumption, but also inadequate fruit and vegetable intakes. Previous research suggests that AA adults have lower intakes of milk[24–26] and fruit and vegetables[27] compared to NHW, with the lowest intakes reported among those with limited incomes. However, this may be due to the higher incidence of lactose intolerance in AAs,[28] upon which there remains a great deal of debate.[29] Furthermore, regular consumption of fruits and vegetables has been shown to offer benefits in the prevention and treatment of obesity, diabetes, cardiovascular disease and other chronic diseases.[20]

In our study, the mean consumption of several minerals critical to bone health were well below recommendations, which may suggest a potential risk for osteopenia and osteoporosis. A meta-analysis of type 2 diabetes and risk of fracture found that type 2 diabetes was associated with an increased risk of hip fracture in both men and women (RR [95% CI] = 2.8 [1.2, 6.6] and 2.1, [1.6, 2.7], respectively).[30] Achemlal et al[31] reported that there was a decreased rate of bone turnover in those with type 2 diabetes, which may result from a decrease in osteoblast mass and function. Also, metabolic abnormalities, which result from poor glycemic control in type 2 diabetes, may contribute to osteopenia; type 2 diabetes is often characterized by elevated bone mineral density, which may impact bone through several mechanisms.[32] Therefore, the synergistic effects of dietary habits and physiological determinants of bone health suggest another key outcome from optimized diabetes control.

Several limitations are inherent with the use of secondary data for the included analyses. The data were collected to assess the health status of the US population, therefore, data for these analyses were limited to information provided in the public-use data files. Assessment of the current dietary intakes of AA adults was limited to the 24-hr recall. Despite the potential intra-individual variability in dietary intakes, standardized interview techniques were used by trained interviewers on a large sample to collect the dietary recalls. The intakes reported as consumed over the past 24 hours may introduce recall bias and may not reflect usual intake patterns. Finally, not all participants in NHANES provided all data of interest. Few participants provided blood glucose data from an 8-hour fast; thus, comparisons across levels of diabetes status may reflect conservative estimates of diabetes status in AA adults.

## CONCLUSIONS AND IMPLICATIONS

The lack of significant differences across levels of diabetes status for most dietary risk factors indicates a need for nutrition education for all African Americans. More research is needed to assess the types of dietary fat and carbohydrates as well as define the major sources of these macronutrients in the AA diet. The specific dietary patterns we found in our study – decreased fruit, vegetable, whole grain, low-fat dairy intakes and increased meat and non-whole grain intakes – are linked to other comorbidities resulting from diabetes. The development of culturally sensitive materials targeting specific nutrient intakes presented herein may help to improve diabetes prevention and management efforts in AA populations.

*The lack of significant differences across levels of diabetes status for most dietary risk factors indicates a need for nutrition education for all African Americans.*

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*Design concept of study:* Scott, Taylor
*Acquisition of data:* Scott, Taylor
*Data analysis and interpretation:* Scott, Taylor
*Manuscript draft:* Scott, McDougle, Schwirian, Taylor
*Statistical expertise:* Taylor
*Administrative, technical, or material assistance:* Taylor