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Dietary habits and leisure-time physical activity in relation to adiposity, dyslipidemia, and incident dysglycemia in the pathobiology of prediabetes in a biracial cohort study

Andrew B. Boucher[a], *E.A. Omoluyi Adesanya*[b], *Ibiye Owei*[a], *Ashley K. Gilles*[a], *Sotonte Ebenibo*[a], *Jim Wan*[c], *Chimaroke Edeoga*[a], *Samuel Dagogo-Jack*[a,*]

[a] *Division of Endocrinology, Diabetes and Metabolism, University of Tennessee Health Science Center, Memphis, TN, USA*
[b] *The Division of Biological Sciences, The University of Chicago, Chicago, IL, USA*
[c] *Department of Preventive Medicine, University of Tennessee Health Science Center, Memphis, TN, USA*

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ABSTRACT

Background. Dietary and exercise data are frequently recorded in clinical research, but their correlation with metabolic measures needs further evaluation.

Objective. We examined the association of food and exercise habits with body size, lipid profile, and glycemia in a prospective biracial cohort.

Methods. The *Pathobiology of Prediabetes in A Biracial Cohort* study followed initially normoglycemic offspring of parents with type 2 diabetes (T2DM) for the occurrence of incident prediabetes, defined as impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT). At enrollment, participants underwent a 75-gram OGTT, anthropometry, measurement of fasting lipids, insulin, and body fat (DEXA), and completed the Food Habits Questionnaire (FHQ), and Modifiable Activity Questionnaire (MAQ). We assessed the relationship between FHQ and MAQ scores and adiposity, cardiometabolic measures, and incident dysglycemia.

Results. Among our cohort of 338 subjects (188 black, 150 white; mean age {±SD} 45.2 ± 10.2 years, BMI 30.3 ± 7.2 kg/m^2), FHQ and MAQ scores were individually correlated with BMI (r = 0.14, −0.12; P = 0.01, 0.03) and waist circumference (r = 0.19, −0.11; P = 0.004, 0.05). Diet-adjusted leisure activity (MAQ/FHQ) was significantly correlated with total body fat (r = −0.20, P = 0.0007), trunk fat (r = −0.20, P = 0.0006), and serum triglycerides (r = −0.17, P = 0.003) and HDL cholesterol (r = 0.11, P = 0.04) levels. During 5.5 years of follow-up, 111 subjects (Progressors) developed prediabetes (n = 101) or diabetes (n = 10) and 227 remained normoglycemic (Non-progressors). Age, BMI, MAQ and MAQ/FHQ values were significant predictors of incident prediabetes/diabetes. Progressors reported similar dietary habits (FHQ

Abbreviations: ANOVA, analysis of variance; BMI, body mass index; DEXA, dual-energy X-ray absorptiometry; FFM, fat-free mass; FHQ, food habits questionnaire; FPG, fasting plasma glucose; GCRC, General Clinical Research Center; HbA1c, hemoglobin A1c; HOMA-B, homeostasis model assessment of beta-cell function; HOMA-IR, homeostasis model assessment of insulin resistance; 2-hrPG, 2-hour plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; MAQ, modifiable activity questionnaire; MAQ/FHQ, diet-adjusted physical activity; MET, metabolic equivalent of task; NCEP, National Cholesterol Education Program; OGTT, oral glucose tolerance test; POP-ABC, Pathobiology of Prediabetes in A Biracial Cohort; REE, resting energy expenditure; T2DM, type 2 diabetes.

* *Corresponding author at:* Division of Endocrinology, Diabetes and Metabolism, 920 Madison Avenue, Suite 300A, University of Tennessee Health Science Center, Memphis, TN, 38163, USA. Tel.: +1 901 448 5318; fax: +1 901 448 5332.
E-mail address: sdj@uthsc.edu (S. Dagogo-Jack).

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score 2.57 ± 0.49 vs. 2.57 ± 0.53) but 30% lower physical activity (MAQ score 15.2 ± 20.5 vs. 22.3 ± 30.5 MET-hr/wk, P = 0.015) compared with non-progressors.

Conclusions. Among African-American and Caucasian offspring of parents with T2DM, self-reported dietary and exercise habits correlated with measures of adiposity and dyslipidemia; however, physical activity, but not dietary recall, significantly predicted incident dysglycemia during 5.5 years of follow-up.

1. Introduction

Responses to standardized questionnaires constitute the primary method for assessing health behaviors in clinical research [1–3]. Several types of questionnaires have been utilized for assessing dietary and exercise practices, and some have formed the basis for national recommendations [1,2,4–6]. Self-reported measures of health behavior have the advantages of being non-invasive and relatively inexpensive to administer. In addition, many questionnaires can be completed online, via the telephone, or by mail. Despite these advantages, self-reported questionnaires have inherent limitations, including different types of biases (e.g., recall bias and social desirability bias) [7–10].

The current epidemics of obesity and diabetes have refocused attention on the importance of lifestyle intervention, especially dietary modification and physical activity [1–3,11,12]. Due to the increasing importance of measuring health behaviors as part of lifestyle intervention programs, it is important to determine to what extent information derived from self-reported instruments reflects objective measures. The *Pathobiology of Prediabetes in A Biracial Cohort (POP-ABC) Study* [13–15], a longitudinal study of incident dysglycemia among initially normoglycemic offspring of parents with type 2 diabetes (T2DM), affords a unique opportunity to assess the relationship between dietary and physical activity habits and metabolic endpoints in a high-risk population.

Here we report the findings of our evaluation of responses to the Food Habits Questionnaire (FHQ) [16] and the Modifiable Activity Questionnaire (MAQ) [17] against objective cardiometabolic measures, including body size, fat mass, lipid profile, energy expenditure, insulin sensitivity, and beta-cell function. We also determined whether FHQ and MAQ scores were significant predictors of incident prediabetes and T2DM during 5.5 years of follow-up.

2. Subjects and Methods

2.1. Study Subjects

The study subjects were participants in the POP-ABC study [13–15]. Healthy adults, aged 18–65 years, who are the offspring of at least one parent with T2DM were eligible for enrollment in the POP-ABC study. Other eligibility requirements included having normal fasting plasma glucose and/or normal glucose tolerance, and lack of exposure to medications that alter blood glucose, insulin sensitivity, insulin secretion, or body weight [13–15,18]. Race/ethnicity was determined by self-identification as a non-Hispanic white (European-American) or a non-Hispanic black (African-American) person, based on the 1990 U.S. Census questionnaire [19]. All study procedures were completed at the University of Tennessee General Clinical Research Center (GCRC). The study protocol was approved by the institutional review board at the University of Tennessee Health Science Center, and all participants gave written informed consent prior the initiation of the study, which was conducted in accordance with the principles of the 1975 Declaration of Helsinki (as revised in 1983).

2.2. Procedures

2.2.1. Clinical Measurements

Participants made outpatient visits to the GCRC, after an overnight fast, for pre-specified assessments [13–15]. The baseline assessments included physical examination, anthropometry, a standard 75-gram oral glucose tolerance test (OGTT), following a schedule as previously described [13–15]. Blood pressure was recorded in the seated position, using an automated sphygmomanometer; the average of two readings was used for calculations. Body weight (in light outdoor clothing) was measured in duplicate on a calibrated balance beam scale. Standing height (without shoes) was determined in duplicate with a standard stadiometer. The body mass index (BMI) was calculated as weight in kilogram divided by the square of the height in meters. Waist circumference was determined to the nearest 0.1 cm at the midpoint between the highest point of the iliac crest and the lowest costal margin in the mid-axillary line, using a Gulick II tape measure [13–15]. Total and trunk fat mass was measured using DEXA (Lunar-DPX-IQ Scanner, Lunar, Madison, WI). Resting energy expenditure (REE) [13] was determined by indirect calorimetry, using an automated ventilated hood system (Deltatrac II, SensorMedics, Yorba Linda, CA). In addition, the participants completed the FHQ [16] and MAQ [17].

2.2.2. Food Habits Questionnaire

Information on dietary habits was obtained using a validated FHQ [16]. The FHQ contains 20 questions pertaining to the subjects' dietary habits over the past month. The FHQ questions assess dietary habits in five subdomains, four of which focus on reduction of fat intake: (1) modifying meats to make them lower in fat, (2) avoiding fat as a seasoning, (3) substituting high fat foods with manufactured lower fat foods, (4) augmenting diet with fruits or vegetables, and (5) replacing high fat foods with low fat foods other than fruits or vegetables [16]. The questions were grouped into major categories, and responses were analyzed on a scale from 1 to 4 (**1** = "usually or always" and **4** = "rarely or never") [16]. A "not applicable" option was available if the subject did not