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TRAIT ANXIETY AND GLUCOSE METABOLISM IN PEOPLE WITHOUT DIABETES: VULNERABILITIES AMONG BLACK WOMEN

Vera K. Tsenkova, PhD[1], **Michelle A. Albert, MD MPH**[2], **Anastasia Georgiades, PhD**[3], and **Carol D. Ryff, PHD**[4]

[1]Center for Women's and Health Disparities Research, University of Wisconsin-Madison

[2]Divisions of Cardiovascular Diseases and Preventive Medicine, Brigham and Women's Hospital, Harvard Medical School

[3]Department of Psychiatry and Behavioral Sciences, Duke University Medical Center

[4]Institute on Aging, University of Wisconsin-Madison

Abstract

Aims—We examined whether the relationship between anxiety and indicators of glucose metabolism in people without diabetes varies by race and gender.

Methods—Participants were 914 adults (777 white, 137 black) without diabetes in the MIDUS II study. Glucose metabolism was characterized by fasting glucose, insulin, HOMA-IR, and HbA_{1c}. Hierarchical linear regressions stratified by race and gender examined whether anxiety was associated with glucose metabolism.

Results—After adjustment for potential confounders, positive relationships between anxiety and fasting glucose (p=.04), insulin (p=.01), and HOMA-IR (p=.02) but not HbA_{1c}, were observed in black women only.

Conclusions—Our findings extend prior evidence about the links between psychosocial vulnerabilities and impaired glucose metabolism in black women, by documenting significant associations between anxiety and clinical indicators of glycemic control among black women without diabetes. Thus, anxiety might constitute an intervention target in black women, a subgroup disproportionately affected by type 2 diabetes, its complications, and premature mortality.

INTRODUCTION

Much research has documented the importance of mental health for diabetes care: people with diabetes have much higher rates of mental illness than people without diabetes, and having a mental illness such as depression is associated with poorer glycaemic control and increased mortality [1–5]. Compared to people without diabetes, those with diabetes had a 20% higher rate of lifetime diagnosis of anxiety [6], and anxiety disorders are associated with hyperglycemia among people with diabetes [7].

Correspondence: Vera K. Tsenkova, PhD, Center for Women's and Health Disparities Research, University of Wisconsin-Madison, 310 N. Midvale Blvd, Madison, WI 53706, Phone: 608.698.8822, FAX: 608.265.6423, tsenkova@wisc.edu.

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In addition to the research linking mental illness to glycaemic control in type 2 diabetes, mounting evidence demonstrates that psychosocial factors are also independently associated with glucose metabolism and type 2 diabetes risk among people without diabetes. Specifically, depressive symptoms, anger, and hostility are cross-sectionally and prospectively associated with nondiabetic glucose metabolism, particularly among women and black Americans [8–11]. Despite the well-recognized relationship between depression and diabetes and the comorbidity between depression and anxiety [12], the relationship between anxiety and glucose metabolism *in people without diabetes* remains unknown. Thus, we investigated whether trait anxiety is associated with glucose metabolism in people without diabetes, independently of depressive symptoms and other potential confounds, and whether any potential relationship is most pronounced among black women, compared to their male counterparts or white women.

RESEARCH DESIGN AND METHODS

Sample

Analyses are based on data from the biological subsample of the Midlife in the US (MIDUS) national study that included 1255 participants ages 34 to 84 (57% female) which includes an oversample of blacks living in Milwaukee, WI. Details on MIDUS participants and the biological subsample are available elsewhere [13, 14]. We excluded 341 participants for any of the following reasons: self-reported diabetes diagnosis, current use of anti-diabetic medications, HbA_{1c} above 6.5%, fasting glucose above 126 mg/dl, or missing data on any variables in the analyses. Our analysis therefore includes complete data for 914 participants without diabetes.

Measures

Anxiety was measured using the Spielberger Trait Anxiety Inventory [15] and includes items such as “I wish I could be as happy as others seem to be”, “I take disappointments so keenly that I can’t put them out of my mind”, and “I worry too much”. Responses were based on a 4-point scale ranging from “almost never” to “almost always” ($\alpha_{coefficient} = 0.9$). Fasting glucose, insulin, and HbA_{1c} samples were obtained during an overnight stay in a general clinical research center. HOMA-IR was calculated using an established formula [16].

Statistical Methods

Glucose, insulin, and HOMA-IR were log-transformed to achieve normal distributions. All predictor variables included were mean-centered.

First, we evaluated relations between anxiety, glucose metabolism measures, and sociodemographic and health characteristics according to race and gender (black men and women, white men and women) by conducting factorial ANOVA and Tukey’s *post-hoc* tests. Second, hierarchical linear regression analyses stratified by race and gender examined the relationship between anxiety and nondiabetic glucose metabolism. Multivariate analyses controlled for age, body mass index (BMI), waist-to-hip ratio (WHR), total household income (unadjusted for family size), fasting triglycerides, HDL cholesterol, current depressive symptoms [17], lifetime depression diagnosis, current smoker, and engaging in exercise for 20 minutes 3 times a week. All covariates were added to the model simultaneously before trait anxiety.

RESULTS

Table 1 shows subject characteristics by gender and race. Bivariate analyses revealed significant differences between subgroups. Black women were younger, had lower incomes, and reported higher anxiety and current depressive symptoms than whites. Significant subgroup differences existed for all indicators of glucose metabolism.

Hierarchical multiple regression models adjusted for all previously mentioned potential confounders and revealed that trait anxiety was associated with higher glucose (R^2=.378, β=.407, p=.04), insulin (R^2=.410, β=.475, p=.02), and HOMA-IR (R^2=.429, β=.490, p=.01) only for African American women (see Figure 1). Such effects were not evident for HbA_{1c}.

DISCUSSION

Previous research has shown relationships between glucose metabolism and psychosocial risk factors such as depressive symptoms, anger, hostility, and acute stress [8–11, 18] for black women without diabetes. To the best of our knowledge, our study is the first to document an independent relationship between trait anxiety and indicators of glucose metabolism including glucose, insulin and HOMA-IR among black women without diabetes, a relationship evident despite the younger age of black compared to white women in this sample. These data are hypothesis generating and suggest that anxiety likely influences glycaemic control even before type 2 diabetes is fully developed.

Moreover, these results also suggest that black women who have almost double the risk for diabetes compared to their white counterparts (14) might be particularly vulnerable to the effects of anxiety on glucose metabolism. The underlying pathophysiologic mechanism relating anxiety to markers of glucose metabolism is uncertain. However, insight may come from an atherosclerosis study that demonstrated positive associations of trait anxiety with HOMA-IR and leptin/adiponectin ratio [19]. These authors posited that anxiety-related adiposity due to physical inactivity might influence upstream regulators of insulin resistance including heightened production of inflammatory substances. Indeed, although our study also does not address why black women are particularly vulnerable to the influence of anxiety on glucose metabolism, black women have a higher density of β-receptors in omental adipose tissue as compared with white women [20], thereby potentially increasing free fatty acids that negatively impact insulin sensitivity. Additionally, chronic psychological stress, a comorbid condition with anxiety, causes activation of the HPA axis and upregulation of the sympathetic nervous system which also results in impaired glucose handling [21] [22].

Our findings are consistent with a growing literature that links psychosocial vulnerability with dysregulated nondiabetic glucose metabolism in black women. Our results contribute to the existing literature by adding anxiety to the list of psychosocial vulnerabilities linked with glucose metabolism in black women without diabetes. Despite this, there is need for longitudinal population based studies comprised of larger numbers of black individuals than this study that will evaluate the role of anxiety in the preclinical development of diabetes. We also document that multiple indicators of glucose metabolism representing differing components involved in the pathophysiologic progression from no diabetes to diabetes are associated with anxiety. Taken together, the results suggest that anxiety might help facilitate progression to diabetes. From a public health perspective, our results additionally suggest that future studies are necessary to 1) prospectively confirm the role of anxiety in dysregulated glucose metabolism; 2) understand the impact of anxiety on health by race/ethnicity since blacks are substantially less likely to receive mental health specialist care

[23, 24] and 3) to develop interventions that target anxiety along with established risk factors (e.g weight and physical activity) for diabetes risk reduction.

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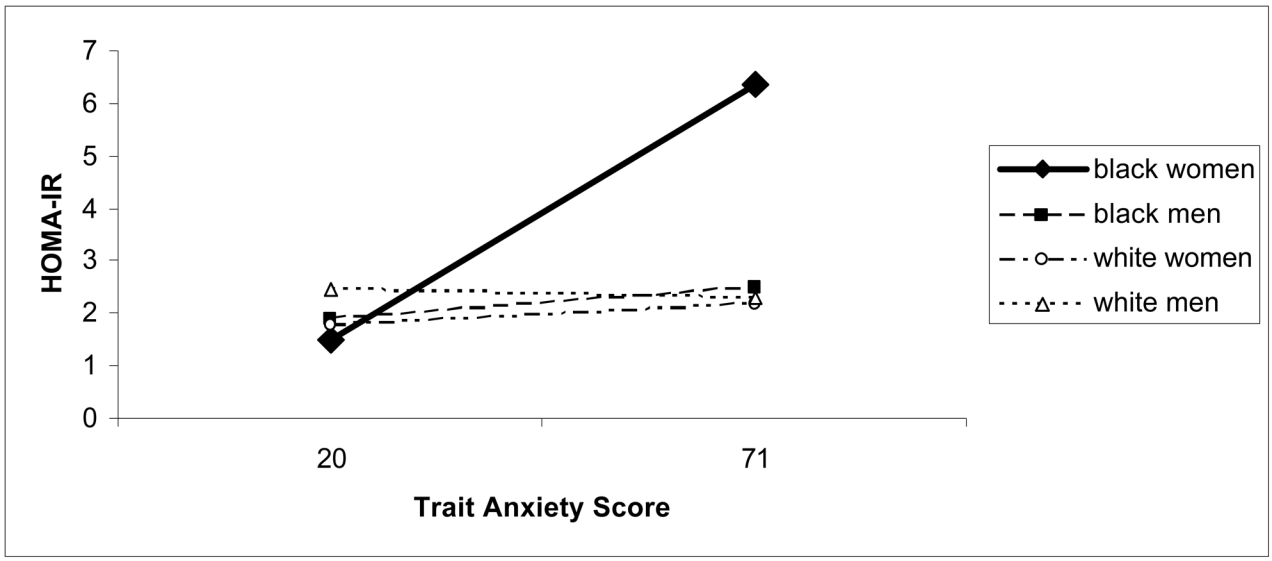

Figure 1. Trait Anxiety is Associated with Higher HOMA-IR among Black Women (*p*<.05)
Trait anxiety is associated with higher HOMA-IR (homeostasis model of assessment – insulin resistance) among black women (P < 0.05). Note: the relationship between anxiety and HOMA-IR is graphed using the full range of anxiety values.

Table 1

Means (and SDs) or Proportions for All Measures Stratified by Race and Gender.

	African American		Caucasian			
	Women[a] (n=86)	**Men[b] (n=51)**	**Women[c] (n=429)**	**Men[d] (n=348)**	***F* statistic (df=3)**	**Significant Subgroup Differences**
Primary Predictor						
Anxiety	39.3 (10.0)	37.8 (10.2)	33.9 (8.9)	32.2 (8.2)	17.87***	ac, ad, bc, bd, cd
Outcomes						
Glucose (mmol/L)	5.3 (0.5)	5.4 (0.5)	5.2 (0.5)	5.4 (0.5)	12.85***	bc, cd
Insulin (uIU/mL)	15.7 (14.8)	12.4 (12.5)	10.4 (7.9)	12.6 (9.6)	8.70***	ac, ad, cd,
HOMA-IR	3.9 (4.0)	3.1 (3.4)	2.5 (2.1)	3.1 (2.4)	8.71***	ac, cd
HbA1c (mmol/mol)	41 (2.0)	39 (3.1)	40 (0.9)	39 (2.0)	5.36**	ad
HbA1c (%)	5.9 (0.4)	5.7 (0.5)	5.8 (0.3)	5.7 (0.4)		
Covariates						
Age (years)	52.6 (10.5)	50.5 (8.0)	57.6 (11.4)	57.6 (11.8)	10.71***	ac, ad, bc, bd,
Income (× 1000)	37.1 (34.1)	49.7 (49.9)	74.8 (61.4)	84.6 (59.9)	18.39***	ac, ad, bc, bd
BMI (kg/m^2)	32.6 (9.0)	28.8 (6.1)	28.1 (5.9)	29.1 (4.6)	14.21***	ab, ac, ad
WHR	.86 (0.1)	.93 (0.1)	.83 (0.1)	.96 (.1)	223.39***	ab, ac, ad, bc, bd, cd
Triglycerides	101.7 (70.8)	117.9 (76.3)	112.2 (64.4)	140.6 (88.5)	11.58***	ad, cd
HDL cholesterol	61.1(18.9)	56.7 (19.3)	63. (17.1)	47.3 (14.6)	60.25***	ad, bd, cd
Current Depressive Symptoms	13.5 (10.4)	11.9 (9.3)	7.9 (7.9)	7.4 (7.4)	16.65***	ac, ad, bc, bd
Depression Diagnosis (1=Yes)	0.30	0.14	0.28	0.17	5.70**	ad, cd
Currently Smoking (1=Yes)	0.29	0.45	0.09	0.12	24.56***	ab, ac, ad, bc, bd
Exercise 3 × week (1=Yes)	0.57	0.82	0.81	0.81	9.70***	ab, ac, ad

Asterisks denote significance level of *F*-statistic, where

** $P < 0.01$ and

*** $P < 0.001$.

Post-hoc comparisons were conducted using ANOVA; significant ($P < 0.05$) subgroup differences are denoted as *ab*: African American women vs. African American men; *ac*: African American women vs. Caucasian women; *ad*: African American women vs. Caucasian men; *bc*: African American men vs. Caucasian women; *bd*: African American men vs. Caucasian men; *cd*: Caucasian women vs. Caucasian men.