

# ACCULTURATION AND PSYCHOSOCIAL STRESS SHOW DIFFERENTIAL RELATIONSHIPS TO INSULIN RESISTANCE (HOMA) AND BODY FAT DISTRIBUTION IN TWO GROUPS OF BLACKS LIVING IN THE US VIRGIN ISLANDS

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The objective of this study was to determine whether acculturation and psychosocial stress exert differential effects on body fat distribution and insulin resistance among native-born African Americans and African-Caribbean immigrants living in the US Virgin Islands (USVI). Data collected from a non-diabetic sample of 183 USVI-born African Americans and 296 African-Caribbean immigrants age > 20 on the island of St. Croix, USVI were studied. Information on demographic characteristics, acculturation and psychosocial stress was collected by questionnaire. Anthropometric measurements were taken, and serum glucose and insulin were measured from fasting blood samples. Insulin resistance was estimated by the homeostasis model assessment (HOMA) method.

The results showed that in multivariate regression analyses, controlling for age, education, gender, BMI, waist circumference, family history of diabetes, smoking and alcohol consumption, acculturation was independently related to logarithm of HOMA (lnHOMA) scores among USVI-born African Americans, but not among African-Caribbean immigrants. In contrast, among USVI-born African Americans psychosocial stress was not significantly related to lnHOMA, while among African-Caribbean immigrants psychosocial stress was independently related to lnHOMA in models that included BMI, but not in those which included waist circumference. This study suggests that acculturation and psychosocial stress may have a differential effect on body fat distribution and insulin resistance among native-born and immigrant blacks living in the US Virgin Islands. (*J Natl Med Assoc.* 2003;95:560-575.)

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Attempts to determine the reasons for population differences in diabetes risk have largely focused on assessing the relative differ-

ences between populations in levels of risk factors such as obesity and physical activity. However, there has been little effort to determine the degree to which chronic psychosocial stress might explain the excess diabetes risk in one population compared to another. A biological model for linking psychosocial stress to glucose intolerance was suggested by Per Bjorntrop who hypothesized that a defeat type response to chronic psychosocial stress might precipitate abnormalities in the function of the hypothalamic-pituitary-adrenal axis (HPA-axis), which lead to poor regulation of cortisol homeostasis, and consequently to the accumulation of abdominal fat and insulin resistance.<sup>1</sup>

If it were hypothesized as in Figure 1 that in any given individual lifestyle behaviors, such as excess caloric intake and physical inactivity, contribute to body fat accumulation (particularly peripherally distributed fat), while chronic psychosocial stress contributes independently to abdominal fat accumulation, then it is possible that either pathway might contribute relatively more to insulin resistance depending on the life circumstances of the individual. While at the individual level, the relative effect of these two pathways on insulin resistance may be difficult to quantify, the differential effects of both pathways may be more evident at the population level.

The processes of migration and acculturation may provide a useful framework for assessing the relative contribution of psychosocial stress and lifestyle behaviors to insulin resistance at the population level in racial, cultural or ethnic groups that share the same environment. It is well documented that ethnic immigrants to a new country are prone to increased levels of psychosocial stress, that are often linked to feelings of disconnection, despair for the future and feelings of economic deprivation.<sup>2</sup> If the migration is to a more economically developed or "westernized" country, then the process of acculturation

might include the adoption of lifestyle practices such as increased dietary fat consumption<sup>3</sup> and reduced levels of physical activity<sup>4</sup> that predispose to the development of obesity and increased diabetes risk. Therefore, if two cultural groups are undergoing the process of lifestyle acculturation and experiencing psychosocial stress in the same environment, it may be possible for lifestyle acculturation to have a greater impact on obesity and diabetes risk in one group while psychosocial stress may be relatively more significant for the other, perhaps the one with the more recent history of migration.

The United States Virgin Islands (USVI), located in the eastern Caribbean approximately 70 miles southeast of the island of Puerto Rico, is unique population where the relative effects of acculturation and psychosocial stress might be evaluated at the population level. After the communist revolution in Cuba, a major effort to develop the USVI as a destination for American tourists resulted in a large influx, between 1960 and 1980, of immigrants (primarily from the former British colonial islands of Dominica, St. Lucia, Antigua and St. Kitts-Nevis) who came to the territory for economic reasons.

These Afro-Caribbean immigrants were not readily embraced by the local black population, and until recent years, the political climate in the USVI helped to perpetuate the feeling among most immigrants of being an "outsider." In this environment, we have shown that when acculturation is assessed as the adoption of United States mainland-oriented values, Afro-Caribbean immigrants are significantly less acculturated than USVI-born African Americans.<sup>5</sup> Therefore, in the current report, we evaluated the hypothesis that for Afro-Caribbean immigrants and USVI-born African Americans who reside in the same environment, psychosocial stress would have a relatively stronger association with insulin resistance in the former while acculturation would have a relatively stronger association with insulin resistance in the latter.

**Table 1. CHARACTERISTICS OF USVI-BORN AFRICAN AMERICANS AND AFRICAN CARIBBEAN IMMIGRANTS**

	<u>African Caribbean Immigrant</u>	<u>USVI-Born African Americans</u>	<u>p value</u>
n	183	296	
Age ( $\pm$ SD)	41.4 ( $\pm$ 16.9)	47.6 ( $\pm$ 13.5)	p < .05
Female (%)	75.1	67.3	p < .05
Education $\geq$ High School (%)	80.4	57.4	p < .05
Psychosocial Stress Score*	21.7 (95% CI: 20.6-22.8)	22.7 (95% CI: 21.9-23.6)	p = NS
Acculturation Score*	11.1 (95% CI=10.7-11.4)	10.6 (95% CI=10.4-10.9)	p < .05
Fasting glucose (mmol/l)*	4.94 (95% CI=4.85-5.03)	5.00 (95% CI=4.94-5.06)	p = NS
Fasting insulin (pmol/l)*	115.4 (95% CI=106.2-124.6)	108.2 (95% CI=101.4-115.2)	p = NS
Waist circumference (cm)*	87.1 (95% CI=85.1-89.1)	87.5 (95% CI=86.1-89.0)	p = NS
BMI (Kg/M <sup>2</sup> )*	28.9 (95% CI=27.8-29.9)	29.1 (95% CI=28.2-29.9)	P = NS

\* Values are age-adjusted.

## RESEARCH DESIGN AND METHODS

### Study Population

The Virgin Islands Diabetes Study is a population-based study of diabetes and cardiovascular disease risk factors that was conducted on the island of St. Croix in the US Virgin Islands. A complete description of the study population and data collection methods has been published elsewhere.<sup>6</sup> However, in summary, the study sample consisted of individuals age 20 and older who were randomly selected from a list of customers (which included approximately 98% of all households on the island of St. Croix), of the Virgin Islands Water and Power Authority. One individual from each household was randomly selected for participation in the study by an in-home interview in which demographic data and information about a medical history of diabetes was also collected. At the time of the interview, participants were scheduled for a visit to the study clinic. Each participant signed a consent form approved by the Biomedical Institutional Review Board of the University of Pittsburgh.

As of December 31, 1999, a total of 1096 non-Hispanic blacks had been recruited for the Virgin Islands Diabetes Study, with a clinic participation rate of 77.2% (847 persons). No significant differences according to demographic characteristics were found between participants and non-participants. Seven hundred eighty (780) of these non-Hispanic black participants were born in the Caribbean, including 280 born in the USVI (USVI-born African Americans) and 500 who were born on other Caribbean islands (African-Caribbean immigrants). For the current analyses we were interested in those individuals who did not have diabetes, therefore those who were identified as having diabetes, either previously diagnosed or newly diagnosed, were removed from further analyses. This number included 51 USVI-born African Americans and 99 African-Caribbean immigrants. An additional 46 USVI-born persons and 105 African-

Caribbean immigrants were excluded because of incomplete data about psychosocial stress.

A comparison of those with missing data and the remaining sample revealed no significant difference in demographic characteristics such as age, percent female or level of education. Therefore, it was determined that the exclusion of these individuals would not significantly alter the relationships among study variables but may result in less power to detect significant differences. The final sample for analysis consisted of 183 USVI-born persons and 296 African-Caribbean immigrants without diabetes.

### Data Collection

At the study clinic, blood samples drawn from participants after an overnight fast of 10 to 12 hours were measured for serum glucose and insulin. Serum glucose determinations were conducted at the Juan F. Louis Hospital and Medical Center on St. Croix using a Kodak Ektachem 700 Analyzer (Eastman Kodak Company, Rochester, NY). Insulin was measured at the Heinz Nutrition Laboratory at the University of Pittsburgh using an RIA procedure (Linco Research Inc.). Cross-reactivity with proinsulin was under 0.02%. Participants with a fasting blood glucose  $\geq 7.0$  mmol/l ( $\geq 126$  mg/dl) were classified as having diabetes according to American Diabetes Association criteria.<sup>7</sup> Insulin resistance was estimated using the homeostasis model assessment (HOMA) method.<sup>8</sup>

Information on acculturation, psychosocial stress, physical activity and dietary patterns was collected by questionnaire. The measurement of acculturation was based on an index, which assessed the degree to which individuals had adopted values and customs more characteristic of the United States mainland than traditional Caribbean norms.<sup>5</sup> Test-retest reliability coefficients for the items on the acculturation index were  $>.8$  and the index showed good content and construct validity.<sup>5</sup> The range for acculturation scores was from 4 to 20.

Measurement of psychosocial stress was based on a summary score of sub-scales of the Roger's Life Attitude Inventory (LAI) questionnaire that assessed feelings of despair and disconnection from community.<sup>9</sup> The LAI was piloted tested in the USVI and the islands of Dominica and Barbados and was found to be equally applicable in all three sites. Items for despair and disconnection on the LAI, as for example "life is unfair" and "it is hard for me to listen carefully to others," respectfully, were graded on a 5-point likert scale with responses ranging from "not agree to "entirely agree." The range for psychosocial scores was from 10 to 50.

Questions that inquired about the number of days each week eating at fast food restaurants and preference for eating outside of the home were used as surrogate measures of dietary patterns that might be associated with excess caloric intake. The number of hours spent watching television each day was used as a surrogate measure of a physically inactive lifestyle.

Anthropometric measurements that were conducted on each participant included height, weight and waist circumference. Weight was measured on a balance-beam scale without shoes. Height was measured with a wall-mounted ruler. The waist circumference was measured with a Gullic tape using standardized procedures.<sup>10</sup> Body mass index, a measure of adiposity, was calculated as weight in kilograms (kg) divided by height in meters squared (kg/m<sup>2</sup>).

### Statistical Analyses

Statistical analyses were performed using SAS software.<sup>11</sup> Univariate associations were examined with Pearson's correlations. Differences between variable means were assessed by the t-test and analysis of variance. The  $\chi^2$  and Fisher's Exact Test were used to compare differences in the frequencies of dichotomous variables. Multiple regression analysis and logistic regression analyses were used to examine multivariate relationships

among selected study variables. The logarithm of the HOMA scores (lnHOMA) was used in all analyses because of the skewed distribution of insulin values.

### RESULTS

The characteristics of the USVI-born African Americans and African Caribbean immigrants are compared in Table 1. These data show that compared to African-Caribbean immigrants, the USVI-born African-American group had a significantly lower mean age, higher percentage of females and a higher high school completion rate. The age-adjusted mean acculturation score was significantly higher for USVI-born African Americans. The age-adjusted mean psychosocial stress score was slightly higher among African Caribbean immigrants but this difference did not achieve statistical significance ( $p=.16$ ). There were no significant differences in age-adjusted mean values for fasting glucose, fasting insulin, waist circumference or BMI between the two groups.

Pearson's correlation coefficients were used to examine the relationship of acculturation score to psychosocial stress score and to the surrogate variables that assessed dietary and physical activity lifestyle behaviors. Among USVI-born African Americans, acculturation score was positively and significantly ( $p<.05$ ) correlated with psychosocial stress score ( $r=.31$ ), hours/day watching television ( $r=.23$ ) and with a preference for eating out ( $r=.18$ ). Similar results were observed for the African-Caribbean immigrants, among whom acculturation score was positively correlated ( $p<.05$ ) with psychosocial stress score ( $r=.22$ ), hours/day watching television ( $r=.17$ ) and with a preference for eating out ( $r=.22$ ). Acculturation score was not significantly related to the number of days per week eating at fast food restaurants in either study group. Using partial correlation analysis to adjust for age, gender and education, acculturation score

remained significantly ( $p < .05$ ) correlated to the number of hours/day watching television and a preference for eating out in both cultural groups.

The correlation coefficients relating acculturation score and psychosocial stress score to the anthropometric variables and insulin resistance (lnHOMA) are presented in Table 2. These results show that, among USVI-born African Americans, acculturation score was significantly correlated with BMI and lnHOMA while psychosocial stress was not significantly correlated to the anthropometric variables or lnHOMA. In contrast, among African-Caribbean immigrants, psychosocial stress score was significantly correlated with waist and lnHOMA, while acculturation score was not significantly correlated with either of the anthropometric variables or lnHOMA.

Multiple regression analyses were conducted to examine if, after controlling for possible confounding factors, acculturation score would remain independently related to BMI and psychosocial stress score would remain independently related to waist circumference among USVI-born African-Americans and African-Caribbean immigrants, respectively. These analyses revealed that after adjusting for age, education, gender, smoking and alcohol consumption, acculturation score remained independently associated with BMI ( $\beta = 0.563$ ,  $p = .0183$ ) among USVI-born African-Americans and psychosocial stress score remained independently associated with waist circumference ( $\beta = 0.167$ ,  $p = .0345$ ) among African-Caribbean Immigrants.

Table 3 shows the results of multiple regression analysis models that assess the association of acculturation score to lnHOMA while controlling for age, gender, education, family history of diabetes, waist circumference and BMI. Because of the strong correlation between waist and BMI these variables were included in separate models. The data show that for USVI-born African-Americans, acculturation score

remained independently related to lnHOMA in both models. Among the African-Caribbean immigrants, acculturation score was not independently related to lnHOMA in either model. These results were not changed when smoking status and alcohol consumption were added as variables to the models (data not shown).

Multiple regression analysis models relating psychosocial stress score to lnHOMA while controlling for age, education, gender, family history of diabetes, waist circumference and BMI are presented in Table 4. These data show that psychosocial stress score was not independently related to lnHOMA among USVI-born African Americans. However, among African-Caribbean immigrants, psychosocial stress score remained independently related to lnHOMA in the model that included BMI as a marker of body fat distribution, but not in the model that included the waist circumference. These results also did not change when smoking status and alcohol consumption were added to the models (data not shown).

In Table 5, both acculturation score and psychosocial stress score were placed together into models, which included BMI as the marker of body fat distribution. The results are consistent with those observed in Tables 3 and 4. Among USVI-born African-Americans, acculturation score is significantly associated with lnHOMA independent of psychosocial stress score, while among African-Caribbean immigrants, psychosocial stress score is significantly related to lnHOMA independent of acculturation score.

Since acculturation score was related to measures of dietary and activity patterns in both cultural groups, we examined whether the dietary and activity variables would show a differential relationship to obesity and lnHOMA in both groups. The results of logistic regression analyses showed that neither the frequency of eating fast food, the preference for eating out, nor the time spent watching television were significantly related to obesity. Likewise, none of these lifestyle variables were signifi-

cantly related to high levels of lnHOMA, based on a median split in either study group.

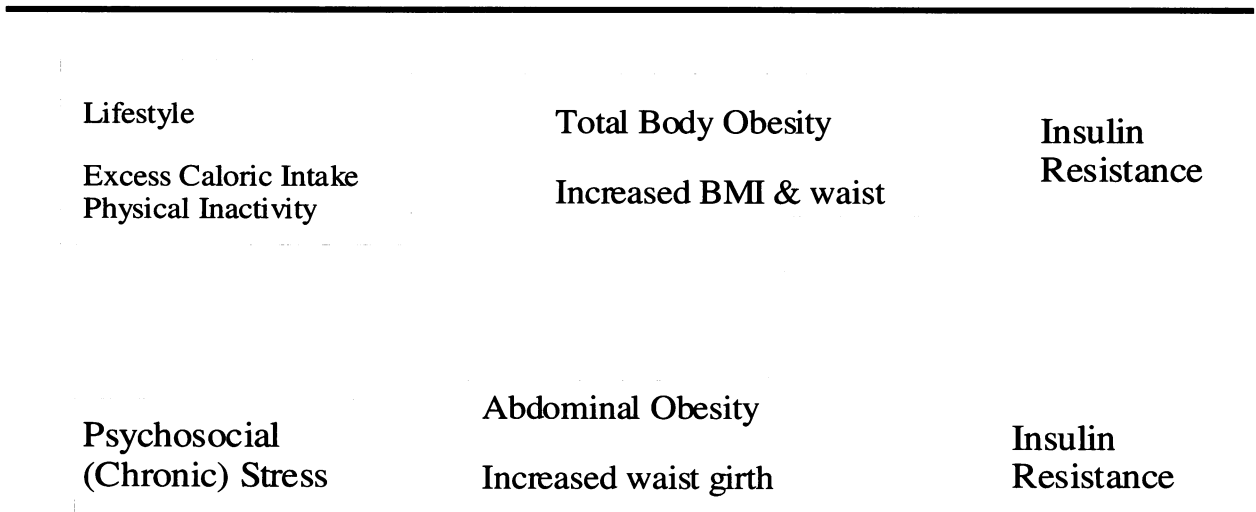
**DISCUSSION**

The current study examined whether acculturation and psychosocial stress would show different relationships to insulin resistance in two groups of blacks who reside in the USVI. The underlying premise was that relative to USVI-born African Americans, African-Caribbean immigrants living in the USVI would, because of status as immigrants, be more likely to manifest the impact of psychosocial stress (assessed as feelings of despair and disconnection) on abdominal fat accumulation ( as measured by waist circumference) and insulin resistance while the USVI-born African Americans who would be more likely to show a stronger relationship of acculturation to body size ( as assessed by BMI) and insulin resistance. Consistent with this hypothesis, the results of the current study showed a significant relationship of psychosocial stress to lnHOMA only among the immi-

grants despite a similar reported mean level of psychosocial stress for the two groups.

It has been hypothesized that it is an individual's poor response (and in particular a defeat type response) to chronic stress that leads to HPA-axis dysregulation with resultant metabolic abnormalities including abdominal fat accumulation and insulin resistance.<sup>12</sup> Therefore, it is possible that the difference in the strength of the association between psychosocial stress and lnHOMA observed between the USVI-born and Afro-Caribbean immigrant group is due to a difference in the nature of the stress experienced (perhaps more chronic among immigrants) and in the response to the stress ( perhaps poorer among the immigrants). Also consistent with study hypotheses was the finding that the association of acculturation to lnHOMA was significant only among USVI-born African Americans. In conjunction with this, the observation that acculturation was significantly related to BMI among USVI-born African Americans but not Afro-Caribbean immigrants suggests the possi-

**Figure 1. MODEL OF STUDY HYPOTHESIS:  
TWO PATHWAYS LEADING TO INSULIN RESISTANCE**



bility, that, for the immigrants, acculturation did not have a strong influence on lifestyle factors which contribute to weight gain or to insulin resistance independent of weight gain.

While these findings are interesting, some caution is suggested in their interpretation. Differences in health status according to place of birth might be explained by such social and biological phenomena as healthy migrant effect or low birth weight that might influence insulin resistance. However, the lack of significant difference by immigration status in the metabolic variables assessed in the current study (i.e. waist circumference, BMI, fasting glucose, insulin) suggests that it is unlikely that these factors could entirely account for the relative influence of acculturation and psychosocial stress on the anthropometric measures of body fat distribution or insulin resistance in the study.

It is also important to note that, the cross-sectional nature of the current study and the limitation of the study instruments for assessing the complete scope of lifestyle behaviors related to acculturation and possible psychosocial stress factors make conclusions as to alternative biological pathways leading to body fat distribution and insulin resistance premature. Moreover, measurement of insulin resistance was based on an algorithm (HOMA) with the inherent limitations of this method. Nevertheless, these results do suggest some intriguing questions that are worthy of further research.

An interesting question posed by the observation that psychosocial stress may have a differential effect on insulin resistance in two groups living in the same country is whether a similar situation might not exist for continental African-Americans compared to European Americans. Recent data from the Third National Health Nutrition and Examination Study showed that when adjustment is made for known risk factors including socioeconomic status, an excess diabetes risk remains

in African-Americans compared to European Americans, particularly among men.<sup>13</sup> Can the case be made that chronic levels of psychosocial stress may account for some of this excess risk? Previous studies among African-Caribbeans have identified a significant positive association of internalized racism with glucose intolerance<sup>14,15</sup> that is confounded in multiple regression analyses by waist circumference but not BMI.<sup>8</sup> The results of the current study support these findings by showing that, among African-Caribbean immigrants in the USVI, the significant relationship of psychosocial stress (measured as feelings of despair and disconnection) to lnHOMA was confounded by waist circumference but not BMI.

With respect to mainland African Americans, Taylor et al.<sup>16</sup> have reported that up to up to 33% of blacks in some communities have high levels of internalized racism. Moreover, a long history of institutionalized racism have left many African Americans feeling disconnected from the general United States society and economically deprived,<sup>17</sup> circumstances not unlike those that result in increased levels of chronic psychosocial stress among immigrants. It is interesting to note that, Robbins et al.<sup>13</sup> reported that in the NHANES III cohort the excess risk in blacks was strongly associated with the poverty income ratio (PIR) and that this relationship was independent of either education or occupational status. Could the PIR be another surrogate measure of chronic psychosocial stress associated with the life circumstances of African Americans? More research in this area is needed, particularly studies designed to examine biological linkages between measures of psychosocial stress such as internalized racism and metabolic abnormalities (eg. insulin resistance) or to identify subsets of the African-American population that may be particularly vulnerable to the metabolic effects of



chronic levels of psychosocial stress.

In the current study, acculturation was associated with the amount of time spent watching television and with a preference for eating out. This finding is consistent with results from other studies that have examined the relationship of acculturation to diet and activity patterns.<sup>18,19</sup> However, in contrast to other reports,<sup>20,21</sup> no association was found between the amount of time spent watching television and obesity in the current study. There also was no significant relationship between the frequency of eating at fast food restaurants and obesity or insulin resistance in the current study, although in other reports the frequency of eating at fast food restaurants was associated with higher fat intake<sup>22</sup> and dietary fat was associated insulin resistance.<sup>23</sup> It is possible that the variables used to assess dietary patterns in the current study may have been to imprecise to assess a relationship between diet and insulin resistance. Harding et al.<sup>23</sup> for example, found that in multivariate models adjusting for anthropometric indices, smoking and alcohol consumption, total fat intake was not significantly related to fasting insulin levels, while the more precise measurement of polyunsaturated to saturated fat ratio and total energy expenditure based on metabolic activity estimates were inversely and positively associated with fasting insulin, respectively. Failure to detect associations between the lifestyle variables and obesity and insulin resistance in the current study may also be due to the small sample sizes of the groups.

The effects of acculturation on some lifestyle behaviors are known to be more prominent in younger age groups,<sup>24</sup> however, sample size limitations in the current study precluded age-group specific analyses. Given the high rates of diabetes and obesity reported in the USVI,<sup>6</sup> additional study of the effects of acculturation on lifestyle behaviors and metabolic abnormalities, using more sensitive

markers of dietary and activity patterns and larger population samples, is recommended.

The Diabetes Prevention Program provided scientific evidence that moderate physical activity and caloric restriction can reduce the incidence of diabetes among those at highest risk.<sup>25</sup> These findings are a source of encouragement for physicians to both identify patients at high risk for diabetes and to recommend lifestyle modification. However, the current study also suggests that psychosocial stress may be a significant risk factor for some individuals and should be considered when lifestyle modifications are being recommended. In the absence of empirical data identifying specific actions to be taken to lessen the impact of stress to reduce diabetes risk, physicians should at least inform their patients about the importance of effectively coping with stress when providing other information about physical activity or dietary change.

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