Hostility, Race, and Glucose Metabolism in Nondiabetic Individuals

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OBJECTIVE — The present study was designed to determine whether hostility is differentially related to measures of glucose metabolism in African-Americans and Caucasians.

RESEARCH DESIGN AND METHODS — The relationship of hostility, as measured by a subset of the Cook-Medley hostility scale (CMHOST) inventory items, to various parameters of glucose metabolism were examined in a young, healthy sample of male and female African-American and Caucasian volunteers. Fasting blood samples were collected during an inpatient admission, at which time the CMHOST was also administered.

RESULTS — In the entire sample, the CMHOST was found to be significantly correlated with fasting glucose and insulin sensitivity, as measured by the homeostatic model assessment (HOMA). However, the relationship of hostility to these parameters of glucose metabolism was different in African-American and Caucasian subjects. Hostility was significantly related to fasting glucose in African-Americans and to insulin sensitivity and fasting insulin in Caucasian subjects. The relationship of hostility to insulin sensitivity and fasting insulin was partially dependent on BMI in Caucasians, but the relationship of hostility to fasting glucose was unrelated to BMI in African-Americans.

CONCLUSIONS — Our data suggest that the relationship of hostility to measures of glucose metabolism is mediated differently in these two ethnic groups. Therefore, hostility seems to be part of a constellation of risk-related behaviors related to BMI in Caucasians but independently related to fasting glucose in African-Americans.

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Hostility is a personality construct (1–4) that has been shown to be a risk factor for coronary artery disease (CAD). A number of studies provide support for hostility as a predictor of coronary events (5–8) and premature mortality from all causes (5). Hostility also has been found to be a correlate of subclinical atherosclerosis (9–11), coronary risk profiles (12), and harmful health behaviors (13). The importance of hostility for health now has been generally confirmed in the literature (14).

Although the mechanism by which hostility may increase risk of CAD is not known, it is generally believed that hostility may increase cardiovascular risk either through risk-related behaviors or neuroendocrine risk factors. These two alternatives have been conceptualized in terms of a health behavior model, a constitutional vulnerability model, and stress moderation models (15). The health behavior model suggests that hostility is associated with high-risk behaviors such as cigarette smoking, high caloric intake, and exercise habits. In contrast, the constitutional vulnerability model implies fundamental physiological differences for hostile individuals, perhaps at the genetic level, that place them at increased risk for disease. Stress moderation models suggest that hostile individuals may be constitutionally more reactive to stress, with their exaggerated stress response leading to an increased risk of disease. Furthermore, hostile individuals may have more stressful social environments because of the nature of their social interactions.

There is some evidence that hostility may also be related to variations in glucose metabolism. Hostility, as measured by the Cook-Medley hostility scale (CMHOST) (2), has been positively correlated with an increase in visceral adiposity and fasting insulin in a sample of American postmenopausal women (16,17), whereas hostility, as measured by the Profile of Mood States (18), was significantly related to average blood glucose, as measured by HbA_{1c} in a sample of Japanese adult men (19). Most recently, small but statistically significant correlations were found between the Hostile Attribution and Aggressive Responding subscales of the CMHOST and fasting plasma insulin in a sample of 1,081 older white men (mean age 63 years) (20). Pathologic analysis suggested that these relationships could be accounted for by the relationship of hostility to BMI. This explanation was consistent with the known relationship of hostility to caloric intake and waist-to-hip ratio.

If hostility is related to abnormal glucose metabolism, this relationship may help explain why hostility is a risk factor for CAD. Higher levels of fasting glucose and insulin and decreased insulin sensitivity themselves are significant risk factors for cardiovascular disease in both diabetic and nondiabetic populations (21–33). Elevated levels of HbA_{1c} in nondiabetic individuals have been shown to be an independent risk factor for increased mortality after myocardial infarction (32), and HbA_{1c} was shown to be a

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Abbreviations: CAD, coronary artery disease; CMHOST, Cook-Medley hostility scale; HOMA, homeostatic model assessment.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Study variables*

	African-American		Caucasian	
	Women	Men	Women	Men
N	35	28	21	14
Glucose	79.1 ± 10.9	81.9 ± 8.7	80.8 ± 7.4	88.3 ± 11.3
Insulin	12.2 ± 14.2	9.2 ± 5.4	8.4 ± 8.1	9.0 ± 3.5
HOMA	32.1 ± 2.17	28.1 ± 1.86	23.8 ± 1.97	32.6 ± 1.57
BMI	27.9 ± 6.7	27.9 ± 6.6	27.1 ± 5.5	27.2 ± 2.4
CMHOST	10.3 ± 4.7	12.3 ± 5.2	8.2 ± 5.3	11.8 ± 4.5

Data are means ± SD.

continuously related factor for death from cardiovascular disease as well as all other causes in a population of ~5,000 men from the European Prospective Investigation into Cancer and Nutrition (33).

Hostility is related to both gender and race; higher values are found in men and African-Americans (34–36). In addition, African-Americans are at increased risk for type 2 diabetes; the prevalence rate is almost twice that in the Caucasian population at most ages (37). However, none of the studies reviewed examined the relationship of hostility to metabolic parameters in African-Americans or compared these relationships among ethnic groups. Three of the studies reviewed above were limited to Caucasians (16,17,20), whereas the fourth studied Japanese men exclusively (19). The present study was designed to determine whether hostility might be a factor in the racial disparity in diabetes prevalence by determining whether higher levels of hostility are differentially associated with higher fasting glucose and insulin levels in an African-American and Caucasian population.

RESEARCH DESIGN AND METHODS

Subjects

A total of 98 men and women aged 18–48 years were recruited through advertisements in the local media, flyers distributed in supermarkets and other public locations, and outreach screening at civic organizations meetings and other public events. The subjects comprised 35 black women, 21 white women, 28 black men, and 14 white men; mean age was 33.2 years (SD 8.9). Subjects included in this study were part of a larger study (38). Ethnicity was self-reported; therefore, a social definition of ethnicity was used. Recent immigrants and non-English speakers were excluded, independent of ethnic status. All data were collected between 6 October 1999 and 14 September 2001.

Procedures

After informed consent was obtained, subjects were screened by a psychiatrist to exclude those with medical and/or psychiatric disorders (Diagnostic and Statistical Manual of Mental Disorders, 4th edition criteria) or current chronic use of medication (psychotropic drugs, aspirin, nonsteroidal anti-inflammatory drugs, etc.). To study the relationship of hostility to glucose metabolism in a healthy population, subjects with a history of AIDS, diabetes, heart disease, cancer, epilepsy, kidney disease, or psychiatric disorder and those who were pregnant or hypertensive were not eligible. These criteria were also part of those from the larger study for which subjects were initially recruited (38). Subjects reported to the General Clinical Research Center during the afternoon of the day before blood sampling. They underwent lumbar puncture for collection of cerebral spinal fluid samples for another study (38) and completed the 27-item version of the CMHOST (1,2). Subjects remained in the hospital overnight. They were given a snack at bedtime and fasted for 8 h. Blood samples were drawn by venipuncture the following morning for assessment of glucose and insulin. Plasma glucose was measured by the Beckman Glucose Analyzer (Beckman Instruments, Chicago, IL) and plasma insulin by the Linco immunoassay kit (Linco Labs, St. Louis, MO).

Homeostatic model assessment. The homeostatic model assessment (HOMA) was used to estimate insulin sensitivity (39). This model uses fasting glucose and insulin values to calculate a derived estimate of insulin resistance by the formula R_{HOMA} = glucose (mg/dl) × insulin (μU)/22.5 and produces a reasonable estimate of insulin sensitivity as derived from clamp techniques (40). The higher the HOMA score, the lower the insulin sensitivity. HOMA values were logarithmically transformed for the analyses.

Hostility measure. The most widely used hostility scale in health research is the CMHOST (2) from the Minnesota Multiphasic Personality Inventory (MMPI). It has excellent stability with test-retest correlations of 0.84 across a 4-year period (6) and 0.74 across a 10-year interval (7). The original scale contains 50 items, but a rational analysis of item content revealed that some are not good reflections of hostility (2). In the present study, we administered an abbreviated version of the scale using the 27 items identified in that analysis as indicators of cynicism, hostile affect, and aggressiveness. This briefer scale (CMHOST), which yields a single summary score, has been found to be a better predictor of health outcomes than the full CMHOST scale (2,41).

Data analysis. The relationships between the measures of hostility and the measures of glucose metabolism were tested by simple correlation and by partial correlation including statistical controls for variations in BMI. Statistical analysis was performed using SAS version 8.0 (SAS Institute, Cary, NC). Statistical significance was declared for P values ≤ 0.05.

RESULTS — The descriptive statistics for the variables in the study are shown in Table 1. There were few differences across gender and ethnic groups. Women reported lower hostility ($P < 0.01$) and tended to have lower glucose levels ($P = 0.05$). There was also a trend for African-Americans to have lower glucose levels ($P = 0.08$), but none of the other tests of main effects or interactions were close to significance.

Table 2 shows the associations between CMHOST and the various measures of glucose metabolism in the complete sample. There were significant correlations between CMHOST and all three measures. None of them were substantially altered by adjustments for BMI. Nonparametric correlations were also computed to evaluate the possibility that the statistics reported in Table 2 were unduly affected by outliers, particularly one

Table 2—*Correlations of CMHOST with indexes of glucose metabolism*

	Glucose	Insulin	Ln HOMA
Simple	0.27‡	0.22	0.26‡
Adjusted	0.26†	0.20*	0.25†

*$P \leq 0.10$; †$P \leq 0.05$; ‡$P \leq 0.01$.

African-American woman with an extreme insulin value. The nonparametric correlations did not differ substantially from the Pearson correlations.

The potential moderating influences of gender and ethnicity were also explored. Table 3 shows the correlations when the sample was stratified by gender or ethnicity and the tests for gender or ethnic differences between those correlations. The relationships of CMHOST to insulin were significantly stronger in women than in men in the simple correlations, but adjustment for BMI weakened this difference. The gender differences in the associations of CMHOST with Ln HOMA were also significant in both the simple and adjusted correlations. There was one indication of moderation of the effects by ethnicity. The association of CMHOST with glucose was strong in African-Americans, but it was absent in Caucasians. The difference between the magnitudes of the associations was not significant for the simple correlations, but the comparison were significant after adjustment for BMI.

Further analyses explored the possibility that there were more complicated effects due to the interaction of ethnicity and gender. None of these tests were statistically significant.

CONCLUSIONS — Hostility has long been known to be a risk factor for CAD, although the mechanism by which hostility increases this risk is unknown. Recent studies have reported small but significant correlations between various measures of hostility and indexes of glucose metabolism, but most of these studies were not adequately designed to assess such relationships. In the present study, the relationships of hostility, as measured by the CMHOST (40) to various parameters of glucose metabolism, were examined in young, healthy, multiracial subjects. The CMHOST was found to be significantly correlated with fasting glucose and insulin sensitivity, as measured by HOMA (39). These relationships were independent of BMI, which has previously been associated with hostility (12).

Whereas previous studies have looked at the relationship between hostility and metabolic parameters in relatively restricted populations, our study used a subject pool composed of both men and women and both black and white individuals. Our results suggest that the relationship of hostility to several different parameters of glucose metabolism is different in men and women and in African-American and Caucasian subjects. Hostility was significantly related to fasting glucose in African-Americans and to fasting insulin in women and in Caucasians. This supports the findings of previous investigations that hostility related to fasting insulin was found only in Caucasian subjects (16,20). As in one previous study, the relationship of hostility to fasting insulin seemed to be at least partially dependent on BMI in Caucasians (20). Our data also suggest that hostility, as measured by the CMHOST, is negatively related to insulin sensitivity in women and Caucasians in general but that this relationship is partially mediated by BMI. However, in African-Americans, hostility is strongly positively related to fasting glucose and not to fasting insulin. Furthermore, this relationship is robust and cannot be accounted for by BMI. Therefore, hostility may be an important and independent risk factor for diabetes in the African-American population. Although we did not find an interaction between race and gender, our sample size may not have been large enough to detect one if it had been present.

Several explanations of how hostility can affect health have been conceptualized: a health behavior model, a constitutional vulnerability model, and a stress moderation model (15). The health behavior model suggests that hostility is associated with high-risk behaviors that subsequently contribute to onset of disease. This model may explain, at least in part, the relationship between hostility, fasting insulin, and insulin sensitivity in Caucasians, because these relationships seem to be mediated, at least in part, by BMI. BMI is associated with many behaviors, such as caloric intake and exercise habits, and is known to be independently related to hostility (12,13). However, because taking BMI into account does not affect the relationship of hostility to fasting glucose that we observed in African-Americans, the relevance of the health behavior model is less apparent in this group. The constitutional vulnerability hypothesis suggests that both hostility and illness are products of underlying third variables. The stress moderation model proposes that, relative to individuals low in hostility, hostile individuals display heightened neuroendocrine reactivity in response to stress. Furthermore, an extension of this model proposes that hostile individuals also experience more stress because they interpret their environments as threatening and tend to engage in conflictive social interactions. Consistent with this model, hostility has been linked to increases in the activity of

Table 3—*Correlations of CMHOST with indexes of glucose metabolism by sex and ethnicity sample*

	Women	Men	*P*	African-American	Caucasian	*P*
Glucose						
Simple	0.29†	0.14	NS	0.41‡	0.09	0.11
Adjusted	0.22	0.15	NS	0.41‡	−0.09	0.02
Insulin						
Simple	0.39‡	−0.16	0.01	0.18	0.32*	NS
Adjusted	0.30†	−0.05	0.09	0.18	0.17	NS
Ln HOMA						
Simple	0.50‡	−0.14	0.001	0.22*	0.32†	NS
Adjusted	0.41‡	−0.02	0.03	0.24*	0.16	NS

*$P \leq 0.10$; †$P \leq 0.05$; ‡$P \leq 0.01$.

the hypothalamic-pituitary-adrenal axis (42,43). Cortisol, a product of adrenal cortical activity, is a major neuroendocrine mediator of hepatic glucose production, whereas sympathetic neural input to the pancreas can inhibit insulin secretion (44). There is some evidence that cortisol responsivity may be related to hostility. Investigations of individuals with high levels of hostility have shown that they exhibit greater diurnal cortisol fluctuations (15) and poorer recovery after exposure to stressful circumstances (42,43). Therefore, individuals high in hostility may exhibit greater cortisol and catecholamine elevations in response to stress and a slower return to baseline cortisol levels. Increases in circulating cortisol can mediate an increase in hepatic glucose production, and at the same time, increases in norepinephrine levels can limit the ability of the pancreas to secrete insulin. As noted above, hostility is positively correlated to fasting glucose but not to fasting insulin in African-Americans, suggesting that hepatic glucose is elevated and that pancreatic function is relatively compromised in African-Americans with high levels of hostility. Therefore, the psychophysiological reactivity model of how hostility affects health could be more relevant for this population. It is also possible that certain groups, such as African-Americans, might be both more metabolically vulnerable to stress as well as more exposed to stressful environmental stimuli. This might help explain the racial disparity in diabetes observed in this ethnic group. Further research incorporating a direct test of this hypothesis is required.

Hyperglycemia associated with diabetes has long been known to increase risk of CAD, but more recent studies have shown that this relationship exists in nondiabetic individuals as well. Fasting glucose (21,27,29), fasting insulin (21,28), and average blood glucose as measured by HbA_{1c} (32,33) have all been related to risk of CAD. In addition, both fasting glucose and insulin have been shown to be related to cardiac vagal tone, which is a risk factor for cardiac death (45). Average blood glucose as measured by HbA_{1c} has been related to increased risk of death from cardiovascular disease and from all-cause mortality as well (33). HbA_{1c} values are normally distributed in the population. Men with HbA_{1c} values in the highest quartile of the nondiabetic population have 2.5 times the relative risk of death from cardiovascular disease compared with individuals in the lowest quartile. Given this relationship between levels of blood glucose and risk for cardiovascular disease, the strong relationships found between hostility and variations in glucose metabolism suggest that glucose metabolism may mediate the relationship between hostility and CAD. Fasting blood glucose, fasting insulin, and insulin sensitivity have been shown to be risk factors for development of type 2 diabetes (46,47) as well as for CAD.

In summary, this study supports previous findings in which hostility has been related to hyperinsulinemia and insulin sensitivity in women and in Caucasian populations. Furthermore, our data show that hostility is strongly related to fasting glucose in African-Americans. Given that multiple parameters of glucose metabolism have been shown to be risk factors for development of cardiovascular disease, the results of the present study suggest that the relationship of hostility to cardiovascular disease may be mediated, in part, by impaired glucose metabolism. Because higher levels of fasting glucose and fasting insulin as well as decreased insulin sensitivity are risk factors for type 2 diabetes, hostility may also be a risk factor for diabetes. Data from the present study suggest that the relationship of hostility to glucose metabolism is mediated differently in Caucasian and African-American populations. Because little is known about differences in the pathophysiology of type 2 diabetes in these ethnic groups, further study of these differences may contribute to understanding the mechanisms of the significant racial disparity in the prevalence of diabetes in African-Americans.

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References

1. Cook W, Medley D: Proposed hostility and pharisaic virtue scales for the MMPI. *J Appl Psychol* 38:414–418, 1954
2. Barefoot JC, Dodge KA, Peterson DL, Dahlstrom WG, Williams RB Jr: The Cook-Medley Hostility Scale: item content and ability to predict survival. *Psychosom Med* 51:46–57, 1989
3. Dimsdale JE: A perspective on type A behavior and coronary disease. *N Engl J Med* 318:110–112, 1988
4. Williams RB, Barefoot JC: Coronary prone behavior: the emerging role of the hostility complex. In *Type A Behavior Pattern, Current Trends and Future Directions*. Houston BK, Snyder CR, Eds. New York, John Wiley & Sons, 1988, p. 189–210
5. Barefoot JC, Dahlstrom WG, Williams RB: Hostility, CHD incidence, and total mortality: a 25-year follow-up study of 255 physicians. *Psychosom Med* 45:59–63, 1983
6. Shekelle RB, Gale M, Ostfeld AM, Paul O: Hostility, risk of coronary heart disease, and mortality. *Psychosom Med* 45:109–114, 1983
7. Barefoot JC, Larsen S, von der Lieth L, Schroll M: Hostility, incidence of acute myocardial infarction, and mortality in a sample of older Danish men and women. *Am J Epidemiol* 142:477–484, 1995
8. Hecker M, Chesney MA, Black GW, Frautschi N: Coronary-prone behaviors in the Western Collaborative Group Study. *Psychosom Med* 50:153–164, 1988
9. Iribarren C, Sidney S, Bild DE, Liu K, Markovitz JH, Roseman JM, Matthews K: Association of hostility with coronary artery calcification in young adults: the CARDIA study: Coronary Artery Risk Development in Young Adults. *J Am Med Assoc* 283: 2546–2551, 2000
10. Julkunen J, Salonen R, Kaplan GA, Chesney MA, Salonen JT: Hostility and the progression of carotid atherosclerosis. *Psychosom Med* 56:519–525, 1994
11. Matthews KA, Owens JF, Kuller LH, Sutton-Tyrrell K, Jansen-McWilliams L: Are hostility and anxiety associated with carotid atherosclerosis in healthy postmenopausal women? *Psychosom Med* 60: 633–638, 1998
12. Siegler IC, Peterson BL, Barefoot JC, Williams RB: Hostility during late adolescence predicts coronary risk factors at mid-life. *Am J Epidemiol* 136:146–154, 1992
13. Scherwitz LW, Perkins LL, Chesney MA, Hughes GH, Disney S, Manolio TA: Hostility and health behaviors in young adults: the CARDIA study. *Am J Epidemiol* 136:136–145, 1992
14. Miller TQ, Smith TW, Turner CW, Guijarro ML, Hallet AJ: A meta-analytic re-

view of research on hostility and physical health. *Psychol Bull* 119:323–348, 1996
15. Smith TW, Gallo LC: Personality traits as risk factors for physical illness. In *Handbook of Health Psychology*. Baum A, Revenson TA, Singer JE, Eds. Mahwah, NJ: Lawrence Erlbaum Associates, 2001, p. 139–174
16. Raikkonen K, Keltikangas-Jarvinen L, Hautanen A: The role of psychological coronary risk factors in insulin and glucose metabolism. *J Psychosom Res* 38:705–713, 1994
17. Raikkonen K, Matthews KA, Kuller LH, Reiber C, Bunker CH: Anger, hostility, and visceral adipose tissue in healthy postmenopausal women. *Metabolism* 48: 1146–1151, 1999
18. Educational and Industrial Testing Service: *Profile of Mood States*. San Diego, CA, 1989
19. Kawakami N, Akari S, Ohtsu H, Hayashi T, Masumoto T, Yokohama K: Effects of mood states, smoking and urinary catecholamine excretion on hemoglobin A_{1c} in male Japanese workers. *Ind Health* 33: 163–162, 1995
20. Niaura R, Banks SM, Ward KD, Stoney CM, Spiro A, Aldwin CM, Landsberg L, Weiss ST: Hostility and the metabolic syndrome in older males: the normative aging study. *Psychosom Med* 62:7–16, 2000
21. Folsom AR, Szklo M, Stevens J, Liao F, Smith R, Eckfeldt JH: A prospective study of coronary heart disease in relation to fasting insulin, glucose, and diabetes: the atherosclerosis risk in communities (ARIC) study. *Diabetes Care* 20:935–942, 1997
22. Pyorala K: Diabetes and coronary artery disease. *Acta Endocrinol Suppl* 272:11–19, 1985
23. The Diabetes Control and Complications Trial Research Group: The effect of intensive treatment on the development of microvascular complications of diabetes mellitus. *N Engl J Med* 329:977–986, 1993
24. Pan WH, Cedres LB, Liu K, Dyer A, Schoenberger JA, Shekelle RB, Stamler R, Smith D, Collette P, Stamler J: Relationship of clinical diabetes and asymptomatic hyperglycemia to risk of coronary heart disease mortality in men and women. *Am J Epidemiol* 123:504–516, 1986
25. Kuusisto J, Mykkanen L, Pyorala K, Laasko M: NIDDM and its metabolic control predict coronary heart disease in elderly subjects. *Diabetes* 43:960–967, 1994
26. Laakso M: Glycemic control and the risk for coronary heart disease in patients with non-insulin-dependent diabetes mellitus: the Finnish studies. *Ann Intern Med* 124: 127–130, 1996
27. Jensen-Urstad KJ, Reichard PG, Rosfors JS, Lindblad LEL, Jensen-Urstad MT: Early atherosclerosis is retarded by improved long-term blood glucose control in patients with IDDM. *Diabetes* 45:1253–1258, 1996
28. Haffner SM, Miettinen H: Insulin resistance implications for type 2 diabetes mellitus and coronary heart disease. *Am J Med* 103:152–162, 1997
29. Bjornholt JV, Nitter-Hauge S, Erikssen G, Jervell J, Aaser E, Erikssen J, Sandvik L, Thaulow E: Fasting blood glucose: an underestimated risk factor for cardiovascular death. *Diabetes Care* 22:45–49, 1999
30. Fuller JH, Shipley MJ, Rose G, Jarrett RJ, Keen H. Mortality from coronary heart disease and stroke in relation to degree of glycemia: the Whitehall study. *Br Med J (Clin Res Ed)* 287:867–870, 1983
31. Howard G, O'Leary DH, Zaccaro D, Haffner S, Rewers M, Hamman R, Selby JV, Saad MF, Savage P, Bergman R: Insulin sensitivity and atherosclerosis. *Circulation* 93:1809–1817, 1996
32. Chowdhury TA, Lasker SS: Elevated glycated haemoglobin in non-diabetic patients is associated with an increased mortality in myocardial infarction. *Postgrad Med J* 74:480–481, 1998
33. Khaw K-T, Wareham N, Luben R, Bingham S, Oakes S, Welch A, Day N: Glycated haemoglobin, diabetes, and mortality in men in Norfolk cohort of European Prospective Investigation of Cancer and Nutrition (EPIC-Norfolk). *BMJ* 322:1–6, 2001
34. Durel LA, Carver CS, Spitzer SB, Llabre MM, Weintraub JK, Saab PG, Schneiderman N: Associations of blood pressure with self-report measures of anger and hostility among black and white men and women. *Health Psychol* 8:557–575, 1989
35. Barefoot JC, Peterson BL, Dahlstrom WG, Siegler IC, Anderson NB, Williams RB: Hostility patterns and health implications: correlates of Cook-Medley Hostility Scale scores in a national survey. *Health Psychol* 10:18–24, 1991
36. Scherwitz L, Perkins L, Chensney M, Hughes G: Cook Medley Hostility Scale and subsets: relationships to demographic and psychosocial characteristics in young adults in the CARDIA study. *Psychosom Med* 53:36–49, 1991
37. National Center for Health Statistics: *Third National Health and Nutrition Examination Survey, 1988–1994: Reference Manuals and Reports.* Atlanta, GA, Centers for Disease Control and Prevention, 1996
38. Williams RB, Marchuck DA, Gadde KM, Barefoot JC, Grichnik K, Helms MJ, Kuhn CM, Lewis JG, Schanberg SM, Stafford-Smith M, Suarez EC, Clary GL, Svenson IK, Siegler IC: Central nervous system serotonin function and cardiovascular responses to stress. *Psychosom Med* 63:300–305, 2001
39. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC: Homeostasis model assessment insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. *Diabetologia* 28:412–419, 1985
40. Radziuk J: Insulin sensitivity and its measurement: structural commonalities among methods. *J Clin Endocrinol Metab* 85:4426–4433, 2000
41. Helmers KF, Krantz DS, Howell RH, Klein J, Bairey CN, Rozanski A: Hostility and myocardial ischemia in coronary artery disease patients: evaluation by gender and ischemic index. *Psychosom Med* 55: 29–36, 1993
42. Suarez EC, Williams RB: Situational determinants of cardiovascular and emotional reactivity in high and low hostile men. *Psychosom Med* 1:404–418, 1989
43. Suarez EC, Kuhn CM, Schanberg SM, Williams RB, Zimmermann EA: Neuroendocrine, cardiovascular, and emotional responses of hostile men: the role of interpersonal challenge. *Psychosom Med* 60:78–88, 1998
44. Surwit RS, Feinglos MN: Stress and autonomic nervous system in type II diabetes mellitus: a hypothesis. *Diabetes Care* 11: 83–85, 1988
45. Watkins LL, Surwit RS, Grossman P, Sherwood A: Is there a glycemic threshold for impaired autonomic control? *Diabetes Care* 23:826–830, 2000
46. Eriksson J, Franssila-Kallunki A, Ekstrand A, Saloranta C, Widen E, Schalin E, Groop L: Early metabolic defects in persons at increased risk for non-insulin-dependent diabetes mellitus. *N Engl J Med* 321:337–343, 1989
47. Weyer C, Hanson RL, Tataranni PA, Bogardus C, Pratley RE: A high fasting insulin concentration predicts type 2 diabetes independent of insulin resistance: evidence for a pathogenic role of relative hyperinsulinemia. *Diabetes* 49:2094–2101, 2000