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Social Relationships and Negative Emotional Traits are Associated with Central Adiposity and Arterial Stiffness in Healthy Adolescents

Aimee J. Midei and
Department of Psychology, University of Pittsburgh

Karen A. Matthews
Department of Psychiatry, University of Pittsburgh

Abstract

Objective—We examined the role of social relationships and negative emotional traits in the development of central adiposity and arterial stiffness in healthy adolescents.

Design—A prospective, longitudinal study examined 213 black and white adolescents (50% black, 51% female); 160 returned for a second assessment approximately 3 years later.

Main Outcome Measures—Psychosocial variables at both assessments were measured with the Measurement of Attachment Qualities, Social Relationships Index (study entry only), Spielberger Trait Anger and Anxiety, and the Cook-Medley Hostility Scale. Central adiposity was assessed by waist-to-hip ratio (WHR) at both assessments and arterial stiffness by pulse wave velocity (PWV) at the second assessment only.

Results—Linear regression models controlled for demographic variables and body mass index showed that adolescents with less Supportive Relationships ($\beta = -.121$, $p = .05$) and higher Trait Anger ($\beta = .117$, $p = .05$) had increased WHR over time, adjusted for initial WHR. Those with higher Attachment Anxiety ($\beta = .211$, $p = .01$) and Total Hostility ($\beta = .234$, $p < .01$) had greater PWV. Psychosocial associations for PWV were more apparent among blacks.

Conclusion—Psychosocial variables may be important in the development of central adiposity and arterial stiffness in adolescence.

Keywords

central adiposity; arterial stiffness; social relationships; negative emotional traits; adolescents

Central adiposity, or deposition of body fat around the abdomen, is a risk factor for several negative health outcomes, including coronary heart disease, stroke, hypertension and non-insulin-dependent diabetes (Kissebah f& Krakower, 1994; Lapidus, Bengtsson, Hallstrom, & Bjorntorp, 1984). These associations are independent of body mass index (BMI). Additionally, central adiposity is associated with other risk factors for heart disease, such as

Address correspondence and reprint requests to: Karen A. Matthews, Department of Psychiatry, University of Pittsburgh, 3811 O'Hara Street, Pittsburgh, PA 15213. Electronic mail may be sent to: matthewska@upmc.edu.

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hyperinsulinemia, insulin resistance, and increased plasma triglycerides (Despres et al., 1990; Onat, Sansoy, & Uysal, 1999). Central adiposity includes subcutaneous adipose tissue, found directly under the skin, and visceral adipose tissue, found between and around the internal organs. Non-invasive measurements of central adiposity include waist circumference (WC) and waist-to-hip-ratio (WHR), or waist circumference adjusted for hip size.

Arterial stiffness, or hardening of the arteries, is involved in the pathophysiology of cardiovascular disease (Boutouyrie et al., 2002). Arterial stiffness is associated with aging, hypertension, and renal failure (Guerin, Blacher, Pannier, Marchais SJ, & London, 2001; Munakata, Ito, Nunokawa, & Yoshinaga, 2003; Ohnishi et al., 2003). Hardening of the arteries results in a greater load on the heart and adversely affects heart function (Chang et al., 2006). One measure of arterial stiffness is pulse wave velocity (PWV), which is distance traveled divided by time between pulse waves. Assuming the same distance, higher velocity is associated with stiffer vessels. Associations between arterial stiffness and central adiposity are apparent in adults (Choi et al., 2004) and adolescents (Im, Lee, Shim, Lee, & Lee, 2007).

Central adiposity and perhaps arterial stiffness in adolescence may pose later health risks. Research shows that central adiposity in childhood is associated with other cardiovascular risk factors in childhood, such as plasma lipid levels, glucose, insulin and blood pressure (Freedman, Srinivansan, Harsha, Webber, & Berenson, 1989; Zonderland et al., 1990; Zwiauer, Pakosta, Mueller, & Widhalm, 1992). Central adiposity measured in adolescence tracks into adulthood (Eisenmann, Welk, Wickel, & Blair, 2004). Consequently, central adiposity in adolescence sets up a trajectory of health risk across the life span. Adolescents with greater central adiposity have higher adulthood blood pressure, carotid intima-media thickness, and arterial stiffness (Eisenmann, Wickel, Welk, & Blair, 2005; Ferreira et al., 2004).

Several studies suggest that psychosocial variables are associated with central adiposity. Low social support may be one important factor. Wing and colleagues (1991) found that social support was negatively correlated with WHR in women, after adjusting for body mass index (BMI). Another study showed that low levels of social support predicted WC over 5 years when controlling for baseline WC (Raikkonen, Matthews, & Kuller, 1999a). A study that included adolescents (Ravaja, Keltikangas-Jarvinen, & Viikari, 1998) reported that adolescent and young adult males who had declines in social support across 3 years had increases in WHR, adjusted for BMI. This relationship was independent of depression and hostility. However, results are not entirely consistent, as Kaye and colleagues (1993) found null results for a relationship between social support and WHR in young adults.

Negative emotional traits have been more consistently linked to increased central adiposity. Several cross-sectional studies reported a positive association in adults between negative emotional traits, such as anger, anxiety, and hostility, and WHR (Ahlberg et al., 2002; Kaye, Folsom, Jacobs, Hughes, & Flack, 1993; Niaura et al., 2000; Niaura et al., 2002). Moreover, in a longitudinal investigation of women, anger, hostility, and depressive symptoms (although not anxiety) predicted an increase in central adiposity over time (Raikkonen et al., 1999a; Raikkonen, Matthews, Kuller, Reiber, & Bunker, 1999b). Another longitudinal study showed that negative emotional traits, particularly anger, anxiety, and components of hostility, predicted increased WHR (Nelson, Palmer, Pedersen, & Miles, 1999). Specifically, cynicism and anxiety predicted higher WHR in both men and women, and anger predicted higher WHR in men, although lower WHR in women. However, this study did not control for baseline WHR, which minimizes the ability to confirm temporal sequence. Only one study has examined these relationships in adolescents. Mueller and colleagues (1998) found that among 15–16 year olds, higher expressive anger was cross-sectionally associated with greater central body fat in boys but not girls.

Several cross-sectional studies link arterial stiffness and negative emotional traits. In the Baltimore Longitudinal Study of Aging, participants with suppressed anger had elevated carotid arterial stiffness measured in middle-aged adults (Anderson, Metter, Hougaku, & Najjar, 2006). However, trait anger and anger expression were not correlated with arterial stiffness. In Atherosclerosis Risk in Community Study of black and white men and women, high trait anger was significantly associated with carotid arterial stiffness in men, but not in women (Williams, Din-Dzietham, & Szklo, 2006). Yeragani and colleagues (2006) showed that patients with anxiety disorders had higher PWV than did controls.

The purpose of our investigation was to examine the psychosocial correlates of central adiposity and arterial stiffness in black and white adolescents, both concurrently and longitudinally. We hypothesized that adolescents with less supportive social relationships and greater negative emotional traits would have greater central adiposity over time and greater arterial stiffness. We explored whether associations were stronger in blacks versus whites and males versus females, an important issue given the strong association of race and sex with cardiovascular risk. Should psychosocial factors be connected to central adiposity and arterial stiffness in adolescence, it would suggest the value of early prevention and intervention, identify susceptible subgroups, as well as inform understanding of the pathogenesis of cardiovascular disease.

Method

Participants

Participants were 213 adolescents (ages 14–16) from two high schools in the metropolitan Pittsburgh, PA, area. The study was described as a study of stress and cardiovascular risk factors in freshman orientation and/or sophomore health classes and those who wanted additional information about the study were recruited if they met eligibility criteria. Exclusion criteria included history of cardiovascular disease or any condition that would require medication that might effect the cardiovascular system (e.g., high blood pressure, asthma, oral contraception), drug or alcohol abuse, history of mental illness, parental report of child being more than 80% above ideal weight according to height and weight tables, and unwillingness to not smoke within 12 hours prior to the session. Of the 213, one participant did not have WHR at time 1, and one participant was an outlier on weight and was deleted from all analyses. Of the 213 participants, 160 returned for testing approximately 3.3 years later (SD = 0.83; range = 1.5 – 5.9). Fifty-three participants were not available for follow-up because they could not be located (n = 29), they refused (n = 4), they relocated (n = 6), or there were scheduling problems (n = 14).

Measures

Social Relationships—The Social Relationships Index (SRI) measured Supportive Relationships in a participant's life. The SRI was developed as a self-report version of the social support interview (Fiore, Becker, & Coppel, 1983; Kiecolt-Glaser, Dura, Speicher, Tras, & Glaser, 1991; Uchino, Holt-Lunstad, Uno, & Flinders, 2001) and adapted for the present study by focusing on a subset of relationships in the full SRI. That is, participants were asked to rate four individuals (mother/stepmother, father/stepfather, best friend, and teacher/coach/school personnel) on how helpful and how upsetting (1 = not at all, 6 = extremely) they were when the participant needed informational and emotional support. To obtain a measure of Supportive Relationships, the helpful scores for both informational and emotional support for all relationships were averaged to create a mean support score. Work by Uchino and colleagues (2001) revealed that responses on the SRI were temporally stable with significant two week test-retest correlations of $r = .69$ ($p < .001$); the Cronbach's α in the present sample was .63.

Participants completed the Measurement of Attachment Quality (MAQ), a 14-item, measure of attachment orientation (Carver, 1997). They characterized their agreement with each statement on a four-point Likert scale, from strongly agree to strongly disagree. Minor modifications were made to accommodate the age of the sample. Specifically, the phrase "my partner" was changed to "someone I care about" in two items. The item "My desire to merge sometimes scares people away" was changed to "I like to be so close with others that it sometimes scares people away." The scale yielded two scores based on the factor analysis in the present sample (Gallo & Matthews, 2006): Avoidant Attachment and Anxious Attachment. The latter is reported herein because of its association with Trait Anxiety. This scale consisted of seven items reflecting a desire for excessive intimacy and fear of rejection, for example, "I have trouble getting others to be as close as I want them to be"; "I often worry someone I care about will not want to stay with me." Individuals high in anxious attachment tend to be sensitive to rejection cues, demanding, clingy, jealous, vigilant, and emotionally reactive (Mikulincer, Shaver, & Pereg, 2003). These individuals may not only experience less actual social support but may also perceive less social support. Internal consistency for the Attachment Anxiety scale was acceptable, Cronbach's $\alpha = .70$.

Negative Emotional Traits—Adolescents completed the Trait Anger and Anxiety scales of the State-Trait Personality Inventory (Spielberger, Jacobs, Crane, Russell, Westbury, Barker, et al., 1979). The Spielberger Trait Anger and Anxiety scale contained 20 statements concerning the frequency with which the emotion of anger and anxiety was experienced. Each statement was rated on a 4-point scale ranging from almost never to almost always felt. Example items reflecting Trait Anger are, "I am quick-tempered" and "I feel infuriated when I do a job and get a poor evaluation." Example items from the Trait Anxiety scale are, "I feel nervous and restless" and "I feel inadequate." Cronbach's alphas in the present sample were .77 for Trait Anger and .80 for Trait Anxiety.

Participants completed the Cook and Medley Hostility Scale (Cook & Medley, 1954), a scale comprised of 50 items from the Minnesota Multiphasic Personality Inventory. Our study used a subset of 26 items that loaded on three factors related to CHD incidence: Cynicism, Hostile Affect, and Aggressive Responding (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989), as well as a summary score of the three scales for Total Hostility. Scores on the subset of items from the Total Hostility Scale (correlating .93 with the full scale) were relatively stable, $r(85) = .56$, across four years in adolescents (Woodall & Matthews, 1993).

Central Adiposity and Weight-Related Variables—Waist circumference (WC) was measured in centimeters at the level of the umbilicus. Hip circumference was measured in centimeters at the greatest extension of the buttocks. The waist-to-hip ratio (WHR) was ascertained by dividing the waist measurement by the hip measurement. To obtain body mass index (BMI), participants' heights were measured with a fixed steel tape while they were in a standing position, and their weights were measured with a beam scale. The ratio of weight to height-squared (kg/m2) was calculated for each participant as a measure of BMI. WHR data at time 1 and 2 were available for 155 participants.

Pulse Wave Velocity—PWV measurement required the participant to lie in a supine position for five minutes before testing, during which three EKG leads were attached. The participant was required to remain awake and to refrain from talking during the testing session. Two blood pressure readings were recorded using an automated device (Dinamap, Critikon Company, Tampa, FL). Two non-directional trans-cutaneous Doppler flow probes (model 810-a, 10 MHz, Parks Medical Electronics, Aloha, OR) were positioned at the right common carotid and right femoral arteries. A computer system displayed and recorded output from the EKG and the two Doppler probes. The arterial flow waves from the two arterial sites were simultaneously recorded and the output was captured and stored in the computer system for subsequent scoring.

Three data collection runs were performed, each obtaining 20 seconds of simultaneously recorded carotid and femoral flow waveforms. The difference in timing between the two waves was the time component of the velocity equation. Aortic pulse wave velocity was then calculated by dividing the distance traveled by the time differential between the two waveforms. Results were averaged from all usable data collection of three runs for each participant. Total time for recording waveform and blood pressure measures was 30 minutes. This measure was added to the Time 2 assessment only and was obtained in 143 participants. There are no established PWV normative data by age. O'Rourke and colleagues (2002) reported values that ranged from 620 to 950 in healthy adults. The range in our sample was 350 to 940.

Resting Blood Pressure and Heart Rate—Blood pressure was collected using an IBS SD-700 automated monitor (IBS Corporation, Waltham, MA) and a standard blood pressure cuff placed over the brachial artery. To ensure the validity of the measures, a trained assistant using traditional auscultatory manual blood pressure procedures validated the placement of the cuff and IBS readings. Measures were taken at minutes 5, 7, and 9 of the 10 minute baseline and averaged. Heart rate was measured continuously via electrocardiogram using a modified lead II configuration and averaged across the last 3 minutes of the 10 minute baseline.

Procedure

Prior to participation in the study, written informed consent was obtained from all participants and a parent or legal guardian. The University of Pittsburgh Institutional Review Board approved all study protocols. At the University, adolescents completed a 3–4 hour protocol, which included an ultrasound examination, anthropometric measures, questionnaires, and psychophysiological responses to challenging tasks (Goldbacher, Matthews, & Saloman, 2005). While in school, they had their ambulatory blood pressure recorded throughout two days and an intervening night (Matthews, Salomon, Kenyon, & Zhou, 2005).

The follow-up assessment was similar to the initial protocol, but excluded the ambulatory blood pressure monitoring and added the measure of PWV. Written consent was obtained again. Participants were paid for their time and provided money for transportation or parking as necessary.

Statistical Analysis

All variables were normally distributed. Comparison of baseline characteristics of the completers and non-completers was conducted using one-way analysis of variance. Race by sex ANOVAs on Time 1 psychosocial variables were calculated. Relations between Time 1 Attachment Anxiety, Supportive Relationships, Trait Anger, Trait Anxiety, Total Hostility and Time 1 WHR and WC (considered in separate models) were evaluated using linear regression, with age, race, sex, and Time 1 BMI as covariates. Linear regressions that were fitted with WC as the outcome variable showed no significant relationships ($p > .10$) at Time 1; therefore, only WHR was used in longitudinal analyses and these results are reported.

To evaluate changes in central adiposity over time, we conducted one-way repeated measures ANOVA on WHR at Time 1 and Time 2. Similar analyses were done with interaction terms combining time and race or sex to examine race or sex differences in changes of central adiposity over time. To evaluate whether Time 1 psychosocial variables predicted change in central adiposity, linear regressions were used to examine the separate relationship between each Time 1 psychosocial variable and Time 2 WHR, controlling for Time 1 WHR, age, race, sex, time between Time 1 and Time 2, and Time 2 BMI.

To examine the relationship of the psychosocial variables and arterial stiffness, linear regression models were fitted with Time 2 psychosocial variables (considered in separate models) predicting Time 2 PWV, adjusted for race, sex, and Time 2 BMI and age. Additionally, we tested if Time 1 psychosocial variables predicted Time 2 PWV using linear regression models, adjusted for Time 1 age, time between Time 1 and Time 2, race, sex, and Time 2 BMI. We also introduced resting HR or SBP into models to evaluate whether these factors influenced the obtained associations (Anderson et al., 2006; Sutton-Tyrrell et al., 2005).

To examine if associations differed by race or sex, we created interaction terms between Time 1 psychosocial variables and race or sex, if main effects were obtained for them. These were used as independent variables in linear regressions to predict central adiposity and arterial stiffness.

Results

Participant Characteristics

See Table 1 for sample characteristics at study entry and follow-up. Comparison of the Time 1 characteristics of the 160 participants and 53 non-participants at Time 1 showed no differences in age, race, sex, WHR, WC, and the social relationship measures. The non-participants had significantly higher baseline Trait Anger, $F(1, 210) = 8.49$, $p < .01$, Trait Anxiety, $F(1, 210) = 4.16$, $p < .05$, Total Hostility, $F(1, 210) = 5.61$, $p < .02$, and BMI, $F(1, 210) = 3.79$, $p = .05$, at Time 1 than participants assessed twice. Table 2 shows the means and standard deviations of the psychosocial variables at Time 1 separated by race and sex. Analyses indicated that blacks had more Supportive Relationships and males had higher Total Hostility scores.

WHR increased over the follow-up period, Ms = .79 to .80, Time main effect, $F(1, 151) = 8.12$, $p < .01$. There were no significant two-way or three-way interactions between Time, Sex, and Race, all *p*s > .30. The between-subjects analysis showed that males had significantly higher overall WHR than females, $F(1, 151) = 64.21$, $p < .0001$, with no significant race differences.

The correlation between PWV and WHR at Time 2 was positive and significant (r = .19, $p < .03$). Table 3 shows the correlations among the psychosocial variables. Noteworthy associations are between Trait Anxiety and Anxious Attachment and between Trait Anger and Hostility.

Psychosocial Variables and Central Adiposity

In models adjusted for age, race, sex, and Time 1 BMI, the only Time 1 psychosocial variable associated with Time 1 WHR was Trait Anxiety ($\beta = .139$, $p < .02$).

Table 4 shows the results from linear regressions examining Time 1 psychosocial variables in relation to Time 2 WHR and PWV. Less Supportive Relationships and higher Trait Anger predicted increased WHR over time. Although Total Hostility was not associated with increased WHR over time, the subscale of Hostile Affect was related to Time 2 WHR ($\beta = .147$, $p < .02$). There were no significant interaction terms with Sex.

Psychosocial Variables and Arterial Stiffness

Higher Trait Anxiety at Time 2 was positively associated with PWV, ($\beta = .166$, $p = .04$). Increased levels of Attachment Anxiety and Total Hostility predicted higher PWV at Time 2, as shown in Table 4. The subscales of Hostile Affect and Aggressive Responding predicted higher PWV at Time 2, ($\beta = .194$, $p = .02$) and ($\beta = .177$, $p = .03$), respectively. Inclusion of resting HR or SBP at Time 1 or 2 did not alter the above associations.

The interaction term for race by Trait Anxiety ($\beta = .269$, $p = .02$) was significant. Higher Trait Anxiety ($\beta = .230$, $p < .05$) was associated with higher PWV in blacks, but lower Trait Anxiety was associated with higher PWV in whites (β = −.241, $p = .05$). In addition, higher Hostile Affect (β = .326, $p < .01$), Total Hostility (β = .310, $p < .01$), Attachment Anxiety (β = .272, $p = .02$), and less Supportive Relationships (β = -.273, $p = .02$) were associated with higher PWV in blacks.

Discussion

The present study tested whether less supportive social relationships and negative emotional traits are linked to central adiposity and arterial stiffness in a sample of healthy adolescents. The results from this study provided partial support for the study hypotheses. Adolescents with less supportive relationships and greater anger had greater central adiposity approximately 3.3 years later, independent of the effects of BMI. These results are consistent with the adult literature on central adiposity reporting an influence of social relationships and negative emotional traits (i.e. Wing et al., 1991; Raikkonen et al., 1999 a, b) and with the few studies on adolescents (Mueller et al., 1998; Ravaja et al., 1998). This study also showed that adolescents with greater anxious attachment and overall hostility had greater subsequent PWV. Two subscales of the Cook-Medley Ho, Hostile Affect and Aggressive Responding, were positively associated with PWV. The present study adds to the literature with multiple measures of social relationships and negative emotional traits and with concurrent as well as longitudinal associations in adolescence.

The study also suggested that the associations for PWV were particularly striking in blacks. Higher Attachment Anxiety, less Supportive Relationships, higher Trait Anxiety, higher Total Hostility and Hostile Affect were associated with higher PWV in blacks. Their stronger associations may be due to their higher risk for arterial stiffness compared to whites in adult samples (Din-Dzietham et al., 2004), which was also apparent in the present sample of adolescents.

It is important to speculate on the mechanisms connecting psychosocial variables to negative health outcomes. Less supportive social relationships and negative emotional traits may affect central adiposity via effects on neuroendocrine function. Björntorp (1991) has suggested that psychosocial stress may lead to increased activity along the hypothalamic-pituitary-adrenal (HPA) axis, characterized by increased secretion of cortisol from the adrenal gland. Increased secretion of cortisol is known to cause abdominal fat accumulation and result in visceral obesity (Björntorp, 1992). Visceral fat has greater blood flow and up to four times the amount of glucocorticoid receptors compared to peripheral fat (Pedersen, Jonler, & Richelsen, 1994), making it particularly sensitive to circulating cortisol. Several studies suggest that social relationships and negative emotional traits play a role in cortisol secretion. Seeman and colleagues (1994) examined 12-hour urinary cortisol samples and found relationships between social support and cortisol levels in men. Negative emotional traits, including anger, anxiety, and hostility, have been shown to be associated with elevated cortisol (Adam, 2006; Pope & Smith, 1991; van Eck, Berkhof, Nicolson, & Sulon, 1996). We did not include neuroendocrine measures in the present study so we cannot evaluate these mechanisms.

A mechanism linking PWV to less supportive social relationships and negative emotional traits may be elevated systolic blood pressure and heart rate. High systolic blood pressure and heart rate are known risk factors for arterial stiffness (Lehmann, Hopkins, & Gosling, 1993; O'Rourke, Staessen, Vlachopoulos, Duprez, & Plante, 2002; Sutton-Tyrrell et al., 2005). Psychosocial stress in adolescence can cause sympathetic activity, which increases resting systolic blood pressure and heart rate, thereby possibly leading to arterial stiffness. In our sample, however, statistical controls for resting blood pressure or heart rate did not alter the results. It is important to replicate our findings and pursue identification of mechanisms that might account for the results.

A limitation of this study is the single assessment of PWV, which limits the inferences that can be made regarding the development of arterial stiffness over time. Another limitation is that participants in our study were probably better adjusted and not representative of the students at their high schools. Consistent with this possibility is that the adolescents who did not participate in the follow-up session had higher anger, anxiety, and hostility scores. Finally, we did not correct for the number of statistical tests because our primary analyses were based on the study hypotheses.

The strengths of the present study include its diverse, adolescent sample and the longitudinal design. The longitudinal design aids researchers in understanding the progression of health risks and factors that may precede their development. The present study also offers a validated measure of arterial stiffness, which has been infrequently assessed in adolescents and rarely linked with psychosocial variables.

The findings from the present study have important implications. The relevance of psychosocial factors for understanding cardiovascular morbidity and mortality has been supported in adults, but has not been as extensively studied or documented in children and adolescents. The results from the present study suggest that social relationships and negative emotional traits may have important health consequences that are detectable in adolescence. Focusing on social relationships and negative emotional traits may provide opportunities for identification of individuals at risk for cardiovascular disease and early intervention. Future studies would benefit from focusing on mechanisms that link psychosocial variables to central adiposity and arterial stiffness, as these will aid in developing appropriate interventions.

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Table 1

Characteristics of Participants at Time 1 and Time 2

Characteristic	Time 1	Time 2
N	211	156
Age – mean (SD)	14.6 (.62)	17.8 (.98)
% Black (n)	50.2 (106)	50.0 (78)
% Female (n)	50.7 (107)	48.7 (76)
Parental Education – % Mothers with Some College or Greater (n)	45.9 (205)	46.4 (153)
% Fathers with Some College or Greater (n)	46.6 (191)	51.4 (140)
WHR – mean (SD)	0.79 (.05)	0.80 (.06)
WC – mean (SD)	71.7 (9.3)	75.9 (9.8)
BMI – mean (SD)	22.7 (4.0)	24.3 (4.1)
PWV – mean (SD)	N/A	548.8 (121.3)

Note. WHR = Waist-to-hip ratio; WC = Waist circumference; BMI = Body mass index

Table 2

Time 1 Mean (SD) Psychosocial Scores of Participants in the Follow-up Evaluation (n = 156)

	Blacks		Whites	
	Males	**Females**	**Males**	**Females**
Social Relationships				
Attachment Anxiety	14.58 (3.63)	14.70 (3.10)	15.29 (3.23)	15.50 (3.19)
Supportive Relationships[a]	4.53 (.89)	4.47 (.89)	4.12 (.81)	4.27 (.71)
Negative Emotional Traits				
Trait Anger	20.39 (5.06)	20.30 (5.81)	21.05 (3.96)	20.14 (4.33)
Trait Anxiety	16.87 (4.58)	16.93 (4.36)	17.45 (4.48)	18.00 (4.18)
Total Hostility[b]	14.76 (2.82)	14.03 (3.08)	14.29 (3.42)	12.56 (3.54)

[a]Blacks had more Supportive Relationships ($F(1, 152) = 5.34$, $p < .03$).

[b]Males had higher Total Hostility scores ($F(1, 152) = 5.68$, $p < .02$).

Table 3

Correlation Matrix of Time 1 Psychosocial Variables

Variables	Attachment Anxiety	Supportive Relationships	Trait Anger	Trait Anxiety	Total Hostility
Attachment Anxiety	—	−.25**	.18*	.56**	.24**
Supportive Relationships		—	−.04	−.24**	−.07
Trait Anger			—	.47**	.44**
Trait Anxiety				—	.29**

* $p < .05$.

** $p < .01$

Table 4

Linear Regression between Time 1 Psychosocial Variables and Central Adiposity (n = 155) or Arterial Stiffness (n=143) at Time 2

	WHR		PWV	
	β	***p***	**β**	***p***
Base Model				
Time 1 WHR	.391	<.0001	N/A	N/A
Time 1 Age	−.118	.05	.068	.41
Time between Time 1 and Time 2	−.143	.02	.049	.55
Sex (Male=0, Females=1)	−.286	<.0001	−.072	.38
Race (White=0, Black=1)	.041	.69	.181	.03
Time 2 BMI	.204	.002	.241	.004
Social Relationships				
Attachment Anxiety	.115	.06	.211	.01
Supportive Relationships	−.121	.05	−.136	.12
Negative Emotional Traits				
Trait Anger	.117	.05	.133	.11
Trait Anxiety	.109	.08	.022	.79
Total Hostility	.072	.25	.234	.006

Note. Psychosocial variables were run in separate regression models. WHR = Waist−to−hip ratio; BMI = Body mass index; PWV = Pulse wave velocity.