Social Relationships and Negative Emotional Traits Are Associated With Central Adiposity and Arterial Stiffness in Healthy Adolescents

Aimee J. Midei and Karen A. Matthews
University of Pittsburgh

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 (Carver, 1997), Social Relationships Index (study entry only; Uchino, Holt-Lunstad, Uno, & Flinders, 2001), Spielberger Trait Anger and Anxiety (Spielberger et al., 1979), and the Cook–Medley Hostility Scale (Cook & Medley, 1954). 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 (β = -.121, p = .05) and higher Trait Anger (β = .117, p = .05) had increased WHR over time, adjusted for initial WHR. Those with higher Attachment Anxiety (β = .211, p = .01) and Total Hostility (β = .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 noninsulin-dependent diabetes (Kissebah & Krakower, 1994; Lapidus, Bengtsson, Hallstrom, & Bjorntorp, 1984). These associations are independent of body mass index (BMI). In addition, central adiposity is associated with other risk factors for heart disease, such as 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. Noninvasive 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 et al., 2001; Munakata, Ito, Nunokawa, & Yoshinaga, 2003; Ochnish 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. Positive 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 suggested that psychosocial variables were associated with central adiposity. Low social support may be one important factor. Wing, Matthews, Kuller, Meilahn, and Plantinga (1991) found that social support was negatively correlated with WHR in women, after adjusting for BMI. Another study showed that low levels of social support predicted WC over 5 years when controlling for baseline WC (Raikkonen, Matthews, & Kuller, 1999). A study that included adolescents (Ravaja, Keltikangas-Jarvinen, & Viikari, 1998) reported that adolescent and young adult men 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, Folsom, Jacobs, Hughes, and Flack (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 (Ahlborg et al., 2002; Kaye et al., 1993; Niaura et al., 2000, 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, Matthews, & Kuller, 1999; Raikkonen, Matthews, Kuller, Reiber, & Bunker, 1999). 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, Meiminger, Liehr, Chandler, and Chan (1998) found that among 15 to 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, Tancer, Seema, Josyula, and Desai (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 to 16 years old) from two high schools in the metropolitan Pittsburgh, Pennsylvania 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 hr prior to the session. Of the 213, 1 participant did not have WHR at Time 1, and 1 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 to 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; Uchino, Holt-Lunstad, Uno, & Flinders, 2001) measured Supportive Relationships in a participant’s life. The SRI was developed as a self-report version of the social support interview (Fiore, Becker, & Coppell, 1983; Kiecolt-Glaser, Dura, Speicher, Tras, & Glaser, 1991; Uchino, Kiecolt-Glaser, & Cacioppo, 1992) 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 they were when the participant needed informational and emotional support, using a scale ranging from 1 (not at all) to 6 (extremely). 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, et al. (2001) revealed that responses on the SRI were temporally stable with significant 2-week test–retest correlations of r = .69 (p < .001); the Cronbach’s alpha in the present sample was .63.

Participants completed the Measurement of Attachment Quality (MAQ; Carver, 1997), a 14-item, measure of attachment orientation (Carver, 1997). They characterized their agreement with each statement using a scale ranging from 1 (strongly disagree) to 4 (strongly agree). 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, & Perec, 2003). 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 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 scale ranging from 1 (almost never) to 4 (almost always). 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 4 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 WHR was ascertained by dividing the waist measurement by the hip measurement. To obtain 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.

**PWV.** PWV measurement required the participant to lie in a supine position for 5 min 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 nondirectional transcutaneous 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 s 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 min. 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, Staessen, Vlachopoulos, Duprez, and Plante (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 min baseline and averaged. Heart rate was measured continuously via electrocardiogram using a modified lead II configuration and averaged across the last 3 min of the 10 min 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- to 4-hr 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 2 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 noncompleters was conducted using one-way analysis of variance (ANOVA). 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. In addition, 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 nonparticipants at Time 1 showed no differences in age, race, sex, WHR, WC, and the social relationship measures. The nonparticipants 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 greater (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.

![Table 1](Characteristics of Participants at Time 1 and Time 2)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Time 1</th>
<th>Time 2</th>
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<tbody>
<tr>
<td>N</td>
<td>211</td>
<td>156</td>
</tr>
<tr>
<td>Age: M (SD)</td>
<td>14.6 (.62)</td>
<td>17.8 (.98)</td>
</tr>
<tr>
<td>% Black (n)</td>
<td>50.2 (106)</td>
<td>50.0 (78)</td>
</tr>
<tr>
<td>% female (n)</td>
<td>50.7 (107)</td>
<td>48.7 (76)</td>
</tr>
<tr>
<td>Parental education—% mothers with some college or greater (n)</td>
<td>45.9 (205)</td>
<td>46.4 (153)</td>
</tr>
<tr>
<td>% fathers with some college or greater (n)</td>
<td>46.6 (191)</td>
<td>51.4 (140)</td>
</tr>
<tr>
<td>WHR: M (SD)</td>
<td>0.79 (.05)</td>
<td>0.80 (.06)</td>
</tr>
<tr>
<td>WC: M (SD)</td>
<td>71.7 (9.3)</td>
<td>75.9 (9.8)</td>
</tr>
<tr>
<td>BMI: M (SD)</td>
<td>22.7 (4.0)</td>
<td>24.3 (4.1)</td>
</tr>
<tr>
<td>PWV: M (SD)</td>
<td>N/A</td>
<td>548.8 (121.3)</td>
</tr>
</tbody>
</table>

Note. WHR = waist-to-hip ratio; WC = waist circumference; BMI = body mass index; PWV = pulse wave velocity; M = mean; SD = standard deviation.

Table 2

<table>
<thead>
<tr>
<th>PSYCHOSOCIAL VARIABLES AND CENTRAL ADIPOSITY</th>
</tr>
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</table>

<table>
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<tr>
<th>Time 1 Mean (Standard Deviations) Psychosocial Scores of Participants in the Follow-Up Evaluation</th>
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<tr>
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<tr>
<td></td>
</tr>
<tr>
<td>Social relationships</td>
</tr>
<tr>
<td>Anxiety</td>
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<tr>
<td>Supportive Relationships</td>
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<tr>
<td>Negative emotional traits</td>
</tr>
<tr>
<td>Trait Anger</td>
</tr>
<tr>
<td>Trait Anxiety</td>
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<tr>
<td>Total Hostility</td>
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</table>

Note. N = 156. Standard deviations in parentheses.

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., Raikkonen, Matthews, & Kuller, 1999; Raikkonen, Matthews, & Kuller, Reiber, et al. 1999; Wing et al., 1991) and 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 findings suggest 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 (Dinizetham, Couper, Evans, Arnett, & Jones, 2004), which was also apparent in the present sample of adolescents.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Attachment Anxiety</th>
<th>Supportive Relationships</th>
<th>Trait Anger</th>
<th>Trait Anxiety</th>
<th>Total Hostility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment Anxiety</td>
<td>—</td>
<td>—</td>
<td>.18*</td>
<td>.56**</td>
<td>.24**</td>
</tr>
<tr>
<td>Supportive Relationships</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Trait Anger</td>
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<tr>
<td>Trait Anxiety</td>
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</table>

* \(p < .05\).  ** \(p < .01\).

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) 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 suggested that social relationships and negative emotional traits play a role in cortisol secretion. Seeman, Berkman, Blazer, and Rowe (1994) examined 12-hr 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 (Adams, 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 et al., 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.

### References


