Few studies have examined longitudinal associations between close social relationships and weight change. Using data from 3,074 participants in the Coronary Artery Risk Development in Young Adults Study who were examined in 2000, 2005, and 2010 (at ages 33–45 years in 2000), we estimated separate logistic regression random-effects models to assess whether patterns of exposure to supportive and negative relationships were associated with 10% or greater increases in body mass index (BMI) (weight (kg)/height (m)²) and waist circumference. Linear regression random-effects modeling was used to examine associations of social relationships with mean changes in BMI and waist circumference. Participants with persistently high supportive relationships were significantly less likely to increase their BMI values and waist circumference by 10% or greater compared with those with persistently low supportive relationships after adjustment for sociodemographic characteristics, baseline BMI/waist circumference, depressive symptoms, and health behaviors. Persistently high negative relationships were associated with higher likelihood of 10% or greater increases in waist circumference (odds ratio = 1.62, 95% confidence interval: 1.15, 2.29) and marginally higher BMI increases (odds ratio = 1.50, 95% confidence interval: 1.00, 2.24) compared with participants with persistently low negative relationships. Increasingly negative relationships were associated with increases in waist circumference only. These findings suggest that supportive relationships may minimize weight gain, and that adverse relationships may contribute to weight gain, particularly via central fat accumulation.

body mass index; longitudinal study; social relationships; waist circumference

Abbreviations: BMI, body mass index; CARDIA, Coronary Artery Risk Development in Young Adults; CI, confidence interval; OR, odds ratio; SE, standard error.

A growing number of studies have examined associations between social relationships and weight change. Findings generally show that higher social support is associated with lower obesity (1–4). However, the majority of these studies have been cross-sectional, leaving open the possibility of reverse causality. The findings of longitudinal studies of supportive social relationships and adiposity are mixed (3, 5). A study of US women found that lower social support, measured as marital satisfaction, was associated with increased body mass index (BMI) (weight (kg)/height (m)²) (3). In contrast, a Dutch study found no association between positive experiences of social support and incident overweight/obesity (BMI ≥ 25) (5).

Most studies of social relationships and health have focused on supportive social relationships, but there is evidence suggesting that relationship strain or conflict may be associated with increased risk of weight gain (5–7). Negative aspects of close relationships were associated with 10% or greater increases in BMI and waist circumference in a British cohort (7) and with prevalent, but not incident, overweight/obesity in a Dutch cohort (5). In a US study, familial relationship strain was associated with weight gain among obese women, but not among men or leaner women (6).

Using data from participants in the Coronary Artery Risk Development in Young Adults (CARDIA) Study, we examined associations of both supportive and negative aspects of
social relationships with longitudinal weight change during a critical period in the life course in which large weight gain occurs (8). We hypothesized that supportive social relationships would be inversely associated with incident weight gain, whereas negative social relationships would be associated with increases in weight, particularly central weight gain.

METHODS

Study population

The CARDIA Study is a prospective, multicenter investigation of contributors to changes in cardiovascular disease risk factors and disease onset and progression during the transition from young adulthood to middle age. In 1985–1986, 5,115 black and white men and women aged 18–30 years were recruited and examined in Birmingham, Alabama; Chicago, Illinois; Minneapolis, Minnesota; and Oakland, California. Participants were sampled to achieve a cohort balanced by race (52% black, 48% white), sex (55% female), education (40% with ≤12 years of education, 60% >12 years of education), and age (45% aged 18–24 years, 55% aged 25–30 years). More details of the study design, recruitment, and procedures can be found elsewhere (9, 10). Participants were reexamined 2, 5, 7, 10, 15, 20, and 25 years later, with high retention rates (91%, 86%, 81%, 79%, 74%, 72%, and 72%, respectively). The current study uses data from the examinations in years 15, 20, and 25, which took place in 2000 (referred to herein as “baseline”), 2005, and 2010, respectively.

Supportive and negative aspects of social relationships

Supportive and negative aspects of social relationships were assessed at baseline and at the examination following baseline with an 8-item scale adapted from that of Schuster et al. (11), which includes questions on both supportive and unsupportive social interactions. Four items comprised the supportive social interactions subscale (Cronbach’s α = 0.83), and 4 items measured the negative social interactions subscale (α = 0.72) (12). To assess supportive social interactions, we asked participants how much they can open up to friends or family members if they have a serious problem. We also asked how much participants’ friends or family members really care about them, understand how they feel about things, and can be relied on to talk about their worries. Negative social interactions were measured by asking how often friends and family members make too many demands on them, criticize them, let them down, and get on their nerves. Responses to each item could range from 1 (not at all) to 4 (a lot). These items were summed to yield a supportive interactions score and a negative interactions score, each ranging from 4 to 16, with higher scores indicating greater supportive and greater negative interactions, respectively. The 2 subscales were moderately correlated (r = −0.37).

To obtain a measure that better reflects the patterns of these supportive and negative relationships over time, we combined the responses from the 2 examinations. Scores from the baseline examination and the examination following baseline were divided into tertiles on the basis of the observed distribution of responses to questions about supportive social relationships (lowest tertile, 4–13; middle tertile, 14–15; upper tertile, 16) and negative social relationships (lowest tertile, 4–6; middle tertile, 7–8; upper tertile, 9–16). Participants were separately categorized as being in persistently low (scores in the lowest tertile in both examinations), persistently intermediate (scores in the middle tertile in both examinations), persistently high (scores in the highest tertile in both examinations), increasingly (when the follow-up score was in a higher tertile compared with the baseline score), and decreasingly (when the follow-up score was in a lower tertile compared with the baseline score) supportive and negative social relationships.

Anthropometrics

BMI and waist circumference were measured at all examinations. Body weight in light clothing was measured to the nearest half-pound (1 lb = 0.45 kg) using a balance beam scale. Height without shoes was measured to the nearest 0.5 cm using a vertically mounted centimeter ruler and a metal carpenter’s square. Waist circumference was measured with a tape in duplicate to the nearest 0.5 cm around the iliac crest and the lowest portion of the rib cage and anteriorly midway between the xiphoid process and the umbilicus.

Covariates

Baseline measurements of several factors previously shown to be associated with obesity or weight gain were included in the analyses. Demographic covariates included age (in years), sex (male or female), self-identified race (black or white), and marital status (married/cohabiting or other). Socioeconomic indicators included education (high school degree or less, some college, or college or more completed), household income (≤$34,999, $35,000–$74,999, or ≥$75,000), and employment status (employed or not employed). Smoking status was dichotomized as current smoker or not current smoker. Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (13). The standard cutoff score of 16 or more was used to define the presence of depressive symptoms.

Leisure-time physical activity was assessed with the CARDIA physical activity questionnaire (14), which includes questions about the frequency of participation in 13 categories of sports and exercise during the previous 12 months. These included 8 vigorous-intensity activities and 5 moderate-intensity activities. On the basis of self-reported frequency of participation, we assigned an intensity score to each activity. This score was summed across all activities and expressed continuously in “exercise units.” The reliability and validity of the instrument are comparable to those of other activity questionnaires (15, 16).

Statistical analysis

Descriptive statistics were generated on the distribution of study covariates by examination year. Unadjusted mean BMI and waist circumference were also presented at each

examination year by supportive and negative social relationship categories. Supportive and negative social relationships were examined in separate multivariable random-effects regression models. We assessed both relative weight gain and absolute weight changes to more completely characterize how social relationships influence general and central weight over time. First, logistic regression random-effects modeling was used to examine whether categories of exposure to supportive or negative social relationships were associated with experiencing 10% or greater increases in BMI and waist circumference between baseline and the 2 follow-up examinations. The 10% cutpoint has been used in previous studies to assess meaningful weight gain over this length of time (7, 17). Second, linear regression was used to examine the association between each social relationship measure and absolute changes in BMI and waist circumference over the 10-year follow-up period using data from the 2005 and 2010 examinations. Initial models were adjusted for baseline age, sex, race, field center, marital status, and baseline BMI/waist circumference. Subsequent models were further adjusted for education, income, employment status, depressive symptoms, current smoking, and physical activity. Age, sex, race, baseline BMI/waist circumference, and field center were incorporated as time-invariant covariates. Marital status, education, income, employment status, depressive symptoms, current smoking, and physical activity were included as time-varying covariates using data from the 2000 and 2005 examinations. The interactions of sex and race with social relationships were tested in separate models using multiplicative interaction terms. Significance was determined if the $P$ value corresponding with the interaction term was less than 0.05.

The primary analyses for this study were based on the 3,074 nonpregnant participants who attended both the baseline and 10-year follow-up examinations and had at least 1 measurement of supportive and negative social relationships (assessed in either 2000 or 2005).

### Table 1. Selected Descriptive Characteristics of Participants ($n = 3,074$) by Examination Year, Coronary Artery Risk Development in Young Adults Study, 2000–2010

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Examination Year</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2005</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>%</td>
<td>Mean (SD)</td>
<td>%</td>
</tr>
<tr>
<td>BMI$^a$</td>
<td>28.7 (6.8)</td>
<td>29.5 (7.4)</td>
<td>30.1 (7.2)</td>
<td></td>
</tr>
<tr>
<td>≥10% BMI increase$^b$</td>
<td>16.2</td>
<td></td>
<td>28.1</td>
<td></td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>89.2 (15.0)</td>
<td>91.9 (15.5)</td>
<td>94.2 (16.0)</td>
<td></td>
</tr>
<tr>
<td>≥10% Waist circumference increase$^b$</td>
<td>13.3</td>
<td></td>
<td>27.9</td>
<td></td>
</tr>
<tr>
<td>Supportive social relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>34.2</td>
<td>32.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>35.0</td>
<td>34.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>30.8</td>
<td>33.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative social relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>42.3</td>
<td>39.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>31.5</td>
<td>32.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>26.2</td>
<td>27.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, years$^c$</td>
<td>40.3 (3.6)</td>
<td>43.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male$^c$</td>
<td>44.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black$^c$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤12 years of education</td>
<td>21.0</td>
<td>22.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual family income ≤$34,999$</td>
<td>38.6</td>
<td>47.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married or cohabiting</td>
<td>61.4</td>
<td>64.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>92.2</td>
<td>88.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CES-D score ≥16</td>
<td>16.5</td>
<td>17.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>20.6</td>
<td>18.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity, exercise units$^d$</td>
<td>350.7 (281.0)</td>
<td>341.3 (273.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; CES-D, Center for Epidemiologic Studies Depression Scale; SD, standard deviation.

$^a$ BMI is weight (kg)/height (m)$^2$.

$^b$ Indicates a 10% or greater increase relative to values in 2000.

$^c$ Only 1 value is included for age, race, and sex because they were modeled as time-invariant covariates.

$^d$ Exercise units represent the sum of intensity scores assigned based on self-reported frequency of participation in 13 categories of sports and exercise during the previous 12 months.
times) by chained equations was used to impute missing values (18). For those missing 1 measurement of social relationships, the missing measurement was imputed and then used to create the supportive/negative social relationship categories. We also conducted secondary sensitivity analyses using the 3,651 participants who attended the baseline examination and the 2,547 participants with complete data for all covariates. From the sample of 3,074 participants who were included in the primary analysis, 21 were missing data for BMI or waist circumference for at least 1 examination, 308 were missing 1 measurement of social relationships, and 198 were missing data on 1 or more of the other covariates for at least 1 examination. We used Stata, version 13, software (StataCorp LP, College Station, Texas) for all analyses.

RESULTS

Descriptive statistics

CARDIA Study participants were aged 33–45 years at baseline for this study (mean age 40.3 years; Table 1). Mean BMI started at 28.7 and ended at 30.1 by the end of the 10-year follow-up period. Only 16.2% of participants experienced a 10% or greater increase in BMI between 2000 and 2005; that number increased to 28.1% between 2000 and 2010. Mean waist circumference ranged from 89.2 cm in 2000 to 94.2 cm in 2010. Of all participants, 13.3% experienced a 10% or greater increase in waist circumference between 2000 and 2005, whereas 27.9% experienced a 10% or greater increase in waist circumference between 2000 and 2010. A smaller percentage of participants reported highly supportive social relationships in the follow-up examination compared with the baseline examination (32.3% vs. 34.2%); a smaller percentage reported highly negative relationships, as well (39.7% in 2005 vs. 42.3% in 2000). The study population was 43.4% male and 44.8% black. The majority of participants had completed more than 12 years of education and reported being employed, married, and with annual income levels of $35,000 or more in both 2000 and 2005.

Supportive social relationships and weight gain

In unadjusted models, mean BMI values were higher at each examination for those reporting persistently low supportive social relationships compared with those reporting persistently high supportive relationships (Figure 1A). Participants in the persistently intermediate social relationships category had lower mean BMI values than those in the increasingly supportive and decreasingly supportive categories. Those in the persistently low supportive social relationships category had higher mean waist circumference values at each examination compared with those in the persistently high supportive social relationships category (Figure 1B). Mean waist circumference was similar for those in the other 3 categories.

After adjustment for baseline age, sex, race, field center, marital status, and BMI, we found that participants persistently reporting highly supportive social relationships were less likely (odds ratio (OR) = 0.52, 95% confidence interval (CI): 0.35, 0.76) to experience a meaningful increase in their BMI values compared with those persistently reporting low supportive social relationships (Table 2). This association persisted after further adjustment for socioeconomic indicators, depressive symptoms, current smoking, and physical activity (OR = 0.58, 95% CI: 0.38, 0.86). Participants who persistently reported highly supportive social relationships were also significantly less likely to experience meaningful increases in their waist circumference than those who persistently reported low levels of supportive social relationships in both minimally adjusted models (OR = 0.58, 95% CI: 0.42, 0.82) and fully adjusted models (OR = 0.68, 95% CI: 0.48, 0.97). Other categories of supportive social relationships were not significantly associated with increases in BMI or waist circumference.

Linear regression analyses indicated that supportive relationships were not associated with absolute changes in BMI (fully adjusted $\beta$ ranging from −0.23 (standard error...
Results did not vary significantly by race (P for interaction ≥ 0.12) or sex (P for interaction ≥ 0.52). Patterns were similar when analyses were restricted to those with complete information on all covariates, and when all participants who completed the baseline examination were considered (results not shown).

### Negative social relationships and weight gain

Unadjusted mean BMI was higher at all examinations for those reporting persistently negative social relationships compared with those reporting persistently low and persistently intermediate negative relationships, with BMI for those with increasingly and decreasingly negative relationships falling in the middle (Figure 2A). Unadjusted mean waist circumference was highest for those in the persistently high negative relationships category and lowest for those in the persistently intermediate negative relationships category (Figure 2B). Unadjusted mean waist circumference was similar across examinations for those in the increasingly negative and persistently low negative social relationship categories.

Table 4 shows associations of negative social relationships with meaningful increases in BMI and waist circumference over the 10-year follow-up. Persistently high negative social relationships were marginally associated with meaningful
increases in BMI (OR = 1.50, 95% CI: 1.00, 2.24) and significantly associated with meaningful increases in waist circumference (OR = 1.62, 95% CI: 1.15, 2.29) in fully adjusted models. Increasingly negative social relationships were unassociated with meaningful increases in BMI, but they were significantly associated with meaningful increases in waist circumference (OR = 1.46, 95% CI: 1.02, 2.10) in minimally adjusted models; this was attenuated slightly in fully adjusted models (OR = 1.42, 95% CI: 0.99, 2.03).

Mean changes in BMI were not significantly different between those reporting persistently high negative relationships and those reporting persistently low negative relationships (Table 5; fully adjusted $\beta = 0.35$; SE, 0.19). In contrast, persistently high reports of negative social relationships were associated with significant increases in waist circumference compared with persistently low reports of negative social relationships in minimally adjusted ($\beta = 0.98$; SE, 0.42) and fully adjusted ($\beta = 1.03$; SE, 0.43) models. Other negative social relationship categories were unrelated to mean changes in BMI or waist circumference.

Results did not vary significantly by race ($P$ for interaction $\geq 0.12$) or sex ($P$ for interaction $\geq 0.52$). Patterns were similar when analyses were restricted to those with complete information on all covariates and when all baseline participants were examined (results not shown).

**DISCUSSION**

We investigated associations of supportive and negative aspects of social relationships with relative increases in BMI and waist circumference ($\geq 10\%$ increases from baseline measurements) and absolute changes in BMI and waist circumference over a 10-year period. After combining repeat assessments of reported social relationships, we found that participants persistently reporting highly supportive relationships were less likely to experience meaningful BMI or waist circumference increases, but they were not more likely to decrease their BMI or waist circumference values over the follow-up period. Those persistently reporting high levels of negative social relationships were more likely to experience relative and absolute increases in waist circumference, but only relative increases in BMI. Participants reporting increasingly negative social relationships were also significantly more likely to experience relative increases in waist circumference, but not in BMI.

Few studies have assessed longitudinal associations of social relationships and weight change (3, 5–7). It is difficult to compare our results directly with others in the literature because both social relationships and weight change (e.g., incident obesity vs. longitudinal change in BMI) have been defined differently across studies. Consistent with our findings, a recent study of negative aspects of social relationships and weight change in a British cohort of men and women found that those who reported greater exposure to negative aspects of close relationships were significantly more likely to increase their waist circumference and BMI values by 10% or more over the follow-up period (7).

Our findings that showed that persistently high and increasingly negative social relationships were associated with relative increases in waist circumference are consistent with those of previous studies showing that chronic exposure to psychosocial stressors is associated with central adiposity and visceral fat accumulation (19–22). Although waist circumference is not a direct measure of visceral fat, previous research on a subsample of CARDIA participants suggests that it may be a good predictor of visceral adipose tissue in this study population, particularly among white men, black women, and white women (23). Potential explanations for the link between chronic stressors and visceral fat accumulation include dysregulation of the physiological response to stress and the adoption of maladaptive health-related coping behaviors that may promote weight gain (24–26). The stronger associations of persistently negative and increasingly negative relationships with meaningful increases in waist circumference compared with BMI, as well as stronger...
associations of persistently negative relationships with absolute increases in waist circumference versus BMI, further support this hypothesized link between psychosocial stressors and visceral fat accumulation.

Our results for supportive social relationships suggest that, although highly supportive relationships were not associated with decreases in BMI or waist circumference over time, they did reduce the likelihood of substantial weight gain. This is consistent with the stress-buffering hypothesis, which posits that social support promotes physical health by buffering the adverse effects of chronic stress exposure (27). Thus, supportive social relationships may act to minimize weight gain by providing a healthy alternative to maladaptive stress coping behaviors. Adjustment for physical activity did not attenuate this association, but it is possible that other, unmeasured coping behaviors may account for the link between supportive social relationships and lower weight gain.

There are several strengths of this study. It is one of the first to examine the long-term associations of social relationships with incident weight gain, and it assesses these relationships during a point in the life course when adults are at high risk of gaining weight (8). In addition, we used repeated measurements of social relationships to better reflect chronic or persistent exposure to these potential health-promoting or health-harming exposures. Furthermore, we assessed both relative weight gain and absolute weight changes, which

Table 4. Odds Ratios for Associations of Negative Social Relationships With 10% or Greater Increases in BMIa and Waist Circumference, Coronary Artery Risk Development in Young Adults Study, 2000–2010

<table>
<thead>
<tr>
<th>Negative Social Relationships</th>
<th>≥10% Increase in BMI</th>
<th></th>
<th>≥10% Increase in Waist Circumference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Persistently high</td>
<td>1.60 (1.08, 2.37)</td>
<td>1.50 (1.00, 2.24)</td>
<td>1.77 (1.25, 2.49)</td>
<td>1.62 (1.15, 2.29)</td>
</tr>
<tr>
<td>Persistently intermediate</td>
<td>0.89 (0.56, 1.42)</td>
<td>0.90 (0.57, 1.43)</td>
<td>1.05 (0.70, 1.58)</td>
<td>1.05 (0.70, 1.58)</td>
</tr>
<tr>
<td>Increasingly negative</td>
<td>1.34 (0.90, 2.02)</td>
<td>1.29 (0.87, 1.95)</td>
<td>1.46 (1.02, 2.10)</td>
<td>1.42 (0.99, 2.03)</td>
</tr>
<tr>
<td>Decreasingly negative</td>
<td>1.12 (0.76, 1.66)</td>
<td>1.11 (0.75, 1.64)</td>
<td>1.23 (0.86, 1.75)</td>
<td>1.21 (0.85, 1.71)</td>
</tr>
<tr>
<td>Persistently low</td>
<td>1.00 (Referent)</td>
<td>1.00 (Referent)</td>
<td>1.00 (Referent)</td>
<td>1.00 (Referent)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

a BMI is weight (kg)/height (m)2.

b Adjusted for age, sex, race, field center, marital status, and baseline BMI.

c Adjusted for age, sex, race, field center, marital status, baseline BMI, education, income, employment, depressive symptoms, current smoking, and physical activity.

d Adjusted for age, sex, race, field center, marital status, and baseline waist circumference.

e Adjusted for age, sex, race, field center, marital status, baseline waist circumference, education, income, employment, depressive symptoms, current smoking, and physical activity.

f \( P < 0.05 \).

Table 5. Adjusted Associations of Negative Social Relationships With Mean Changes in BMIa and Waist Circumference, Coronary Artery Risk Development in Young Adults Study, 2000–2010

<table>
<thead>
<tr>
<th>Negative Social Relationships</th>
<th>Mean Change in BMI</th>
<th></th>
<th>Mean Change in Waist Circumference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \beta ) (SE)</td>
<td>( \beta ) (SE)</td>
<td>( \beta ) (SE)</td>
<td>( \beta ) (SE)</td>
</tr>
<tr>
<td>Persistently high</td>
<td>0.29 (0.18)</td>
<td>0.35 (0.19)</td>
<td>0.98 (0.42)( f )</td>
<td>1.03 (0.43)( f )</td>
</tr>
<tr>
<td>Persistently intermediate</td>
<td>−0.01 (0.21)</td>
<td>0.007 (0.21)</td>
<td>0.11 (0.48)</td>
<td>0.11 (0.48)</td>
</tr>
<tr>
<td>Increasingly negative</td>
<td>0.15 (0.19)</td>
<td>0.17 (0.19)</td>
<td>0.25 (0.43)</td>
<td>0.28 (0.43)</td>
</tr>
<tr>
<td>Decreasingly negative</td>
<td>0.05 (0.18)</td>
<td>0.07 (0.19)</td>
<td>0.40 (0.42)</td>
<td>0.41 (0.42)</td>
</tr>
<tr>
<td>Persistently low</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
<td>Referent</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; SE, standard error.

a BMI is weight (kg)/height (m)2.

b Adjusted for age, sex, race, field center, marital status, and baseline body mass index.

c Adjusted for age, sex, race, field center, marital status, baseline body mass index, education, income, employment, depressive symptoms, current smoking, and physical activity.

d Adjusted for age, sex, race, field center, marital status, and baseline waist circumference.

e Adjusted for age, sex, race, field center, marital status, baseline waist circumference, education, income, employment, depressive symptoms, current smoking, and physical activity.

f \( P < 0.05 \).
allowed for a more thorough characterization of how social relationships influence general and central weight change over time.

This study also has limitations. Our findings may be biased because of missing data, as well as loss to follow-up over the 10-year period. However, our sensitivity analyses suggest that these potential selection biases were minimal. Another limitation is that, despite adjustment for several potential confounding factors, including demographic characteristics, socioeconomic indicators, depressive symptoms, and marital status, the possibility of residual confounding remains because this is an observational study. In addition, although we did adjust for current smoking and physical activity, we were not able to assess whether dietary quality mediated associations of social relationships with weight gain.

Given that obesity is a risk factor for several adverse physical health outcomes, and that losing weight is challenging, identifying factors associated with primary prevention of weight gain is an important clinical and public health priority. This study adds to the growing body of literature highlighting the role of the social environment on the development of general and central obesity. Specifically, it points to the importance of measuring the quality of social relationships and differentiating the potential impact of supportive and negative aspects of these relationships on adiposity. A better understanding of the ways in which social relationships influence weight gain may help guide innovative interventions to reduce obesity risk.

ACKNOWLEDGMENTS

Author affiliations: Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, Illinois (Kiaari N. Kershaw, Arlene L. Hankinson, Kiang Liu, Mercedes R. Carnethon); Division of Cardiovascular Sciences, National Heart, Lung, and Blood Institute, Bethesda, Maryland (Jared P. Reis, Catherine M. Loria); and Division of Preventive Medicine, University of Alabama at Birmingham, Birmingham, Alabama (Cora E. Lewis). K.N.K. is funded by the National Institutes of Health (grant N01-HC-95164). The Coronary Artery Risk Development in Young Adults Study is supported by contracts HHSN268201300025C, HHSN268201300026C, HHSN 268201300027C, HHSN268201300028C, HHSN268201 300029C, and HHSN268200900041C from the National Heart, Lung, and Blood Institute, the Intramural Research Program of the National Institute on Aging, and an intragovernmental agreement between the National Institute on Aging and the National Heart, Lung, and Blood Institute (AG00005).

Conflict of interest: none declared.

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