Socioeconomic Position, Stress, and Cortisol in Relation to Waist Circumference in African American and White Women

Peter T. Baltrus, PhD; Ruth S. Shim, MD; Jaile Ye, PhD; Leah Watson, BS; Sharon K. Davis, PhD

Objective: Abdominal fat deposition has been shown to be related to hypertension, dyslipidemia and diabetes. Studies have shown a correlation between cortisol (a stress hormone) and abdominal fat deposition. Low socioeconomic position (SEP) has also been shown to be related to abdominal fat deposition. It is hypothesized that chronic stress associated with low SEP leads to high cortisol levels which in turn lead to abdominal fat deposition. Previous research in this area has included mainly European subjects. The purpose of this study was to examine the evidence for the SEP-chronic stress-cortisol-abdominal fat hypothesis in a sample of African American and White American women.

Design: Data from the Regional Assessment Health Surveillance Study (RAHSS), a survey and physical examination of a representative sample of African American and White adults residing in six counties in Georgia, were utilized. The study population included 111 African American and 119 White women. Abdominal fat deposition was measured by waist circumference (inches). Education and income were the measures of SEP. Other exposures examined included serum cortisol, self-reported daily stress level, cigarette smoking, marital status, and number of children. Associations were examined using multiple linear regression models adjusted for age and body mass index (BMI).

Results: Among White women, less-educated women had a waist circumference 2.22 inches larger ($P<.05$) than more highly educated women. Among African American women, separated or divorced women (+2.29 in, $P<.05$) and widowed women (+3.13 in, $P<.01$) had larger waist circumferences than married women. No other factors were significantly associated with waist circumference.

Conclusions: The SEP-chronic stress abdominal fat accumulation hypothesis was only partially supported by the data. Different stressors and pathways may be important in producing abdominal fat accumulation in African American and White women. (*Ethn Dis.* 2010;20:376–382)

Key Words: SEP, SES, Socioeconomic, Obesity, Waist Circumference, Stress, Cortisol, HPA

From the National Center For Primary Care, Morehouse School of Medicine (PTB, RSS, JY); the Social Epidemiology Research Center, Morehouse School of Medicine (SKD); and the Department of Cell and Developmental Biology, University of North Carolina, Chapel Hill (LW).

Address correspondence to Peter Thomas Baltrus, PhD; National Center for Primary Care, Department of Community Health and Preventive Medicine; Morehouse School of Medicine; Atlanta, Georgia; 404-752-1180; pbaltrus@msm.edu

Introduction

Abdominal fat deposition and high waist circumference values are associated with increased risk of hypertension, diabetes, dyslipidemia, and metabolic syndrome when compared to normal waist circumference values.[1–3] In women, higher levels of androgens and cortisol seem to be associated with increased abdominal fat.[1] Furthermore, increased abdominal fat has been shown to be associated with poor coping with stress, including sick leave, psychological maladjustments, psychosomatic and psychiatric disease.[1] For women in particular, increasing waist-hip ratio, a measure of abdominal fat distribution, is associated with increasing risk of cardiovascular disease, regardless of body mass index.[4]

Cortisol levels have been shown to be associated with levels of perceived chronic stress and also with abdominal fat deposition.[5] The association between cortisol levels and abdominal obesity is often attributed to dysfunction of the hypothalamic-pituitary-adrenal (HPA) axis, which leads to the dysregulation of cortisol.[6] This may be a result of direct stimulation by the brain (the flight or flight response), or stress coping behaviors such as cigarette smoking; which has been shown to be related to both cortisol levels and abdominal obesity.[7,8] Low socioeconomic position (SEP) has been shown to be related to cortisol levels and abdominal fat deposition.[9,10] This may be due to chronic stress of daily living due to low SEP and/or the prevalence of cigarette smoking in low socioeconomic position groups. Sociodemographic factors (such as education) and health factors (eg, smoking, exercise) are associated with the distribution of abdominal obesity.[11]

Psychological factors such as social isolation and chronic stress have been associated with increased risk of cardiovascular disease.[12] It is believed that one mechanism by which social support may provide a health benefit is by buffering the effects of stress.[13] While previous research has examined the relationship between stress and increased waist circumference,[14] only one previous study has examined the relationship of measures of social support with waist circumference.[15] Having children in the household may either be a stressor or a source of social support. To our knowledge the role of children on waist circumference has not been examined in any other study.

Most previous studies examining factors associated with cortisol and

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abdominal obesity have been done in European, primarily Scandanavian, populations.[16] Our study is one of the few to examine the relationships between socioeconomic position, stress, cortisol, and abdominal fat deposition in a sample containing African Americans as well as Whites. We hypothesized that low socioeconomic position, high perceived stress, cigarette smoking and high cortisol levels would be associated with greater waist circumference in both White and African American women. We also examined the correlation with social support, marital status and number of children.

A causal model of how some of the examined factors interact is provided in Figure 1. Waist circumference may be influenced by differential distribution of fat in the abdominal area (pathway A and B) or by non-differential weight gain (pathway C). Pathway A could be termed an endogenous pathway as it involves a direct relationship between the mind and body, while pathway B and C are mediated by external factors and therefore could be termed exogenous pathways. This study sought to examine the differential distribution of body fat (pathway A and B), although some information on pathway C can be inferred by the results.

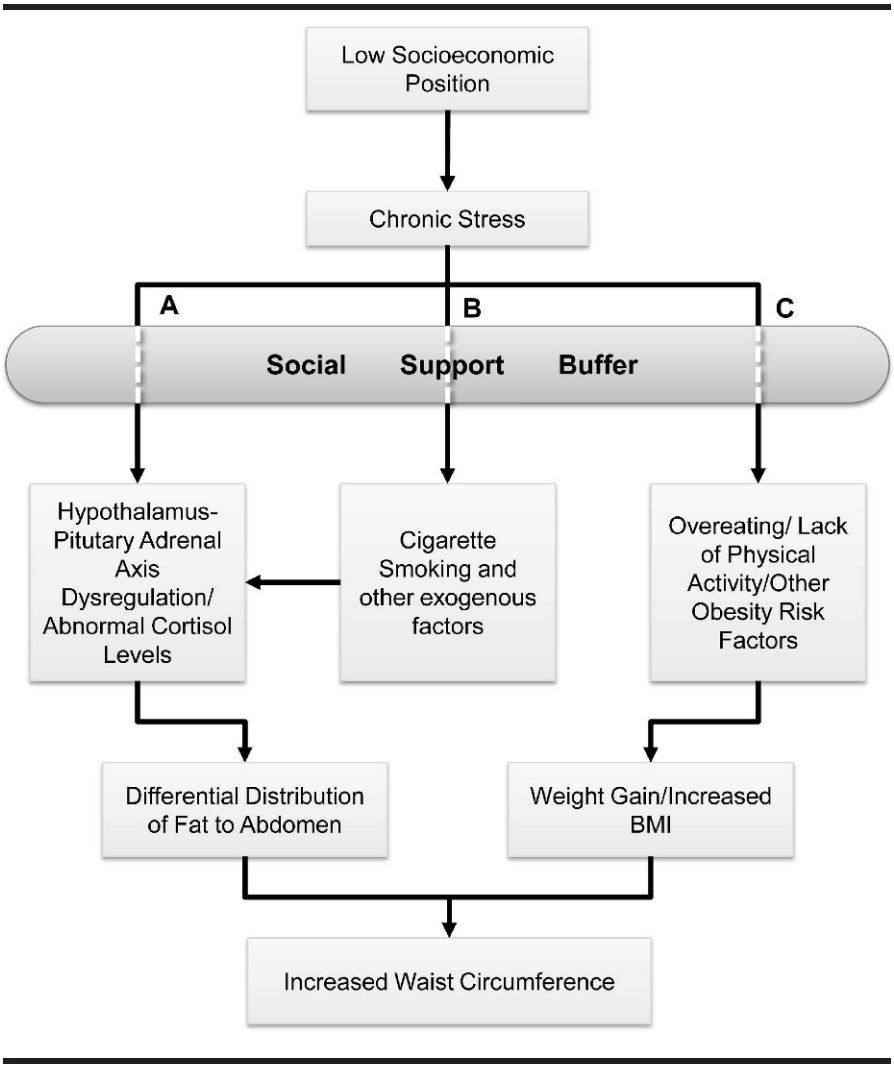

Fig 1. Causal model illustrating interaction of select factors

METHODS

Data Source

The Regional Assessment Health Surveillance Study (RAHSS) was conducted in an urban area (Fulton County) and a rural area (Bulloch, Candler, Evans and Jenkins Counties) in Georgia using 2-part stratified random sampling. Approximately 2,916 persons aged 18 years and older and currently living in the two areas were contacted. The project consisted of two components: 1) a Behavioral Risk Factor Surveillance Survey (BRFSS) (modified from the Centers for Disease Control BRFSS questionnaire), and 2) a physiologic/clinical examination. A final sample of 1,850 White and African American persons (921 in the urban area and 929 in the rural area) completed the telephone interview, which was conducted by the Southern Research Group using modified CDC/ BRFSS questionnaire from June 2003 to November 2003. Of this sample, 157 participants in the urban area and 181 participants in the rural area were examined by Examination Management Service, Inc. and Quest Diagnostics, Inc. from August 2003 to January 2004.

Study Population

Our study population consisted of women from the RAHSS who participated in the physical examination and thus had measured height, weight, and waist circumference. Women missing information on any variables (except income) were excluded from the analyses. Our final study population included 111 African American women and 119 White women.

Outcome Measure

Waist circumference was measured in inches at largest point around the waist. The measure used was the mean of three such measurements during the same examination.

Exposure Measures

All values were self-reported except for serum cortisol. Serum cortisol was

measured from a blood sample of at least 0.5 mg/dL taken in the morning after a 12-hour fast. The sample was centrifuged and the cortisol level was measured via chemoimmunoassay. Education was categorized as less than high school, high school graduate, or education beyond high school. Using 2003 federal poverty guidelines, household income was reported in intervals. Respondents were classified as being below or near the poverty threshold if the federal poverty cutoff corresponding to the respondent's reported family size was above or within the respondent's reported income interval. Perceived stress was measured by the question, ''How would you rank the level of day-to-day stress and worry in your life?'' Responses were classified as very high, high, some, or little/none. Cigarette smoking status was classified as never, former, or current smoker. Marital status was categorized as never married, married/living together, separated/divorced, and widowed. Respondents reported the number of children under age 18 living in the household. Responses were categorized as 0, 1–2, or 3+. Social support was measured by the question, ''How many close friends or relatives would help you with your emotional problems or feelings if you needed it?'' Responses were categorized as <3 or ≥ 3 . Body mass index (BMI) was calculated from the measured height and weight of each subject.

Table 1. Sample demographics

	African American *n*=111	White *n*=119
Mean age, y (SD)	51.2 (16.5)	51.1 (15.6)
Mean BMI, units (SD)	33.2 (8.3)	28.1 (6.7)
Mean waist circumference, inches (SD)	37.3 (7.4)	33.1 (5.9)
Mean Cortisol Level, mcg/dL (SD)	12.8 (6.9)	15.1 (8.2)
Education, *n* (%)		
< High school	32 (28.8)	17 (14.3)
=High school	44 (39.6)	30 (25.2)
>High school	35 (31.5)	72 (60.5)
Poverty, *n* (%)		
Below poverty level	30 (27.0)	13 (10.9)
Above poverty level	65 (58.6)	97 (81.5)
Missing	16 (14.4)	9 (7.6)
Life stress, *n* (%)		
Very high	15 (13.5)	16 (13.5)
High	13 (11.7)	22 (18.5)
Some	33 (29.7)	54 (45.4)
Very little/none	50 (35.0)	37 (22.7)
Smoking status, *n* (%)		
Current	25 (22.5)	20 (16.8)
Former	24 (21.6)	33 (27.7)
Never	62 (55.9)	66 (55.5)
Marital status, *n* (%)		
Married/living together	25 (22.5)	64 (53.8)
Divorced/separated	30 (27.0)	25 (21.0)
Widowed	21 (18.9)	17 (14.3)
Never married	35 (31.5)	13 (10.9)
Number of children under 18, *n* (%)		
0	67 (60.4)	79 (66.4)
1–2	35 (31.5)	34 (28.6)
3+	9 (8.1)	6 (5.0)
Social support, *n* (%)		
>3 friends or relatives	77 (69.4)	104 (87.4)
<3 friends or relatives	34 (30.6)	15 (12.6)

Statistical Methods

A series of multiple linear regression models were estimated using SAS v 8.0 separately for African American and White women. The base statistical model (model 1) used was: $WC_i = \beta_0 + \beta_{1,i}$ Age + $\beta_{2,i}$Exposure, where WC is the waist circumference, β_0 is the intercept term, $\beta_{1,i}$ is the value of waist circumference associated with a 1-year change in age. $\beta_{2,i}$ is the outcome of interest: the value of waist circumference associated with the exposure variable (education, poverty) compared to the reference value. Models were estimated for each exposure variable separately. Variables were entered into the model in conceptually relevant combinations to reflect the causal model proposed in Figure 1. Model 2 added perceived life stress, model 3 added social network variables (marital status, number of kids, social support), model 4 added BMI, and model 5 added cortisol.

RESULTS

The distribution of the variables for African American and White women is shown in Table 1. African American women tended to have a greater BMI and waist circumference and lower cortisol levels than White women. They also tended to have a lower educational level and be below or near the poverty level. White women were more likely to report high stress levels, but the percent reporting very high levels was the same for both groups. African American women were more likely to be current smokers, have multiple children under age 18 in the household, were less likely to be married, and less likely to have 3 or more friends or relatives to call on in a time of need.

The results of the regression analyses are shown in Table 2. The results differed by race. In the models where waist circumference was not adjusted for

BMI, low education was a significant predictor of greater waist circumference in African American women. No other measures were significant predictors of waist circumference in the models without BMI adjustment. The education association became non-significant when adjusted for BMI. However, marital status was a significant and substantial predictor of waist circumference in the BMI adjusted models. Divorced/separated and widowed women had larger waists than married women. Never married women also tended to have larger waists than married women, but the results were not statistically significant. The results remained significant and only changed slightly when the other exposures were adjusted for.

Among White women, education was the only significant predictor of waist circumference in the BMI adjusted models. Compared with women with more than a high school education, those with less than a high school education had larger waists. There was no significant difference in waist circumference between those with a high school education and those with more than a high school education. The education results remained significant after adjustment for the exposure variables.

Poverty was not found to be significantly associated with waist circumference in any of the models for African American or White women (Table 3).

DISCUSSION

Low education was associated with a larger waist circumference in African American women, but the association became non-significant when adjusted for BMI. This may suggest that education influences weight gain in these women, but does not impact where the fat is distributed. Low education, but not being below the poverty level, was associated with greater waist circumference in White women. African American women who had been separated/divorced or widowed had larger waist circumferences than women who were currently married. Other measures of stress including blood cortisol were not associated with waist circumference in either race group.

The results for education for White women were similar to results in European populations.[9,10] The results also suggest that the effect of education was not mediated by any of the other variables since the effects remain significant after other variables are adjusted for in the model. While chronic stress associated with low SEP may be responsible for the association, it should be noted that poverty level was not associated with waist circumference. The reason for this discrepancy cannot be elucidated by the current analyses, but at least one study has found that education, but not income, was associated with weight gain among women.[17] The persistence of an association for education after the adjustment for BMI suggests that educational level may indeed be related to a differential distribution of fat to abdomen in White women (pathway A or B). The lack of a change in the education term when smoking is adjusted for suggest that smoking is not in the causal pathway, but other unidentified exogenous factors (Pathway B) cannot be ruled out. Alcohol consumption was not measured in this study but has been shown to be linked to greater waist circumference independent of BMI.[18]

In African American women, education was associated with waist circumference until BMI was adjusted for in the models. This suggests that low SEP may be related to abdominal obesity through its association with overall weight gain (Pathway C), but that it is not operating through the differential distribution of body fat (Pathway A and B). Other studies have observed the association between SEP and weight gain and general obesity in African American women.[19–21] The lack of an association with either socioeconomic measure and waist circumference adjusted for BMI for African Americans may be due to a different pattern of socioeconomic position throughout the life-course than that experienced by White women. African Americans may have experienced lower socioeconomic position throughout life and learned to deal with the accompanying stress better than White women. Another explanation is that life stress may be more consistent across the socioeconomic distribution in African Americans than in White women.

The finding of an association between waist circumference and marital status in African American women is a novel one. Perhaps the stress of a marital dissolution led to HPA axis dysregulation and the resultant abdominal fat deposition in these women, but it is not readily apparent why African American women would experience a stronger effect than White women. The magnitude of the difference, more than a 3-inch difference between widowed and married women, should be taken seriously; as these women may be on a pathway toward metabolic syndrome, diabetes and heart disease. If the stress of marital dissolution is to blame for the greater abdominal fat deposition then psychological counseling for African American women experiencing separation, divorce or widowhood may help prevent these seriously negative consequences down the road.

The finding of an association between waist circumference and marital status in African American women is a novel one.

Table 2. Results of linear regression models of education on waist circumference. Difference (inches) in waist circumference by exposure.

	African American Women					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Education: (vs > high school)						
< High school	5.37*	5.28*	4.72*	1.57	1.48	1.43
= High School	3.74*	3.42*	3.55*	0.23	0.16	0.17
Perceived life stress (vs little/no stress)						
Very high		2.30	3.23	1.08	0.91	0.68
High		−0.74	−1.05	0.46	0.39	0.29
Some		1.16	1.38	0.94	0.78	0.67
Marital status (vs Married)						
Divorced/Separated			2.87	2.58*	2.63*	2.59*
Widowed			3.04	3.01*	3.03*	2.93*
Never Married			−0.62	1.74	1.75	1.68
# **of Kids** (vs no kids)						
1–2			0.95	0.46	0.49	0.51
3+			0.68	−0.19	−0.17	−0.19
Social support (vs >3 friends/relatives)						
< 3 friends/relatives			0.10	−1.52	−1.52	−1.49
BMI				0.76†	0.75†	0.76†
Cigarette smoking (vs never smoker)						
Current					0.46	0.46
Former					−0.40	−0.56
Cortisol (change per mcg/dL)						0.04
	White Women					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Education (vs >high school)						
< High school	3.07	2.91	2.75	1.67*	1.71*	1.77*
= High School	.097	0.82	0.91	0.52	0.60	0.64
Perceived life stress (vs little/no stress)						
Very high		3.34	2.94	1.31	1.49	1.52
High		2.56	2.62	0.82	0.84	0.79
Some		1.80	1.65	0.46	0.62	0.65
Marital status (vs married)						
Divorced/separated			1.06	0.92	0.89	0.92
Widowed			.058	1.39	1.44	1.30
Never married			1.62	0.43	0.43	0.51
# **of Kids** (vs no kids)						
1–2			1.16	−0.21	−0.14	−0.06
3+			−1.58	1.41	1.64	1.86
Social support (vs >3 friends/relatives)						
< 3 friends/relatives			0.99	0.11	−0.18	−0.24
BMI				0.77†	0.78†	0.79†
Cigarette smoking (vs never smoker)						
Current					0.06	−0.04
Former					1.00	0.99
Cortisol (change per mcg/dL)						0.02

Model 1: Adjusted for age; Model 2: Model 1+ perceived life stress; Model 3: Model 2+social network.
Model 4: Model 3+ BMI; Model 5: model 4 + cigarette smoking; Model 6: model 5+ cortisol.
P: *<.05 †<.0001.

Table 3. Results of linear regression models of poverty on waist circumference. Difference (inches) in waist circumference by exposure.

	African American Women					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Poverty (vs above poverty threshold)						
Below poverty threshold	0.52	0.78	−0.08	−0.29	−0.41	−.40
Perceived life stress (vs little/no stress)						
Very high		3.40	4.35	1.09	0.85	0.61
High		−0.82	−1.28	0.38	0.29	0.19
Some		0.57	0.86	0.85	0.68	0.56
Marital status (vs Married)						
Divorced/separated			2.83	2.61*	2.74*	2.69*
Widowed			5.06*	3.79†	3.84†	3.69†
Never married			−.20	1.83	1.85	1.77
# of kids (vs no kids)						
1–2			1.26	0.76	0.83	0.85
3+			2.08	0.62	0.65	0.60
Social support (vs > 3 friends/relatives)						
< 3 friends/relatives			0.10	−1.57	−1.55	−1.52
BMI				0.76‡	0.76‡	0.77‡
Cigarette smoking (vs never smoker)						
Current					0.40	0.41
Former					−0.70	−87
Cortisol (change per mcg/dL)						0.05
	White Women					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Poverty (vs above poverty threshold)						
Below poverty threshold	0.73	.054	−0.12	−0.38	−0.30	−0.29
Perceived life stress (vs little/no stress)						
Very high		3.59	3.23	1.49	1.65	1.67
High		2.50	2.59	0.79	0.83	0.81
Some		1.99	1.85	0.56	0.69	0.71
Marital status (vs Married)						
Divorced/separated			1.56	1.27	1.17	1.18
Widowed			0.74	1.47	1.50	1.43
Never married			1.68	0.51	0.50	0.54
# of kids (vs no kids)						
1–2			1.30	−0.13	−0.07	−0.02
3+			−1.21	1.65	1.90	2.02
Social support (vs > 3 friends/relatives)						
< 3 friends/relatives			0.78	−0.01	−0.29	−0.32
BMI				0.78‡	0.79‡	0.79‡
Cigarette smoking (vs never smoker)						
Current					0.29	0.24
Former					0.96	0.95
Cortisol (change per mcg/dL)						0.01

Model 1: Adjusted for age; Model 2: Model 1+ perceived life stress; Model 3: Model 2+social network.
Model 4: Model 3+ BMI; Model 5: model 4 + cigarette smoking; Model 6: model 5+ cortisol.
P: *<.05 †<.01 ‡<.0001.

There were several limitations to the study. The sample size was relatively small, which may have limited the ability to detect significant associations. Also, it is not possible to know if the results are generalizable to outside Georgia or the southeastern United States. The cross-sectional design does not allow for a determination of the direction of causation between the variables studied. There may not have been an association with serum cortisol, which is a measure at one particular point in time. Other studies often use salivary cortisol measured several times a day in order to map a pattern of cortisol secretion. A pattern of secretion may have been more likely to correlate with waist circumference than a single point measure.

Despite the limitations, our study is of value since it is one of the first to examine the socioeconomic position/stress-waist circumference relationship in a sample including African American women. The results suggest that different causal pathways may influence waist circumference in White and African American women. Further studies (especially prospective ones) are needed to elucidate the relative importance of the endogenous vs the exogenous pathway in abdominal fat accumulation. Studies in other groups to confirm and examine the reasons for the marital dissolution effect in African American women should also be undertaken. A measure of childhood socioeconomic position should be included in future studies since fat distribution patterns may begin early in life and behaviors developed in youth may continue into adulthood.[22]

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AUTHOR CONTRIBUTIONS

Design concept of study: Baltrus, Shim, Ye, Watson, Davis

Acquisition of data: Baltrus, Shim, Ye, Watson, Davis

Data analysis and interpretation: Baltrus, Shim, Ye, Watson, Davis

Manuscript draft: Baltrus, Shim, Ye, Watson, Davis

Statistical expertise: Baltrus, Shim, Ye, Watson, Davis

Acquisition of funding: Baltrus, Shim, Ye, Watson, Davis

Administrative, technical, or material assistance: Baltrus, Shim, Ye, Watson, Davis

Supervision: Baltrus, Shim, Ye, Watson, Davis