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Race, Anthropometric Factors, and Stage at Diagnosis of Breast Cancer

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A recent study suggested that the greater prevalence of severe obesity among African-American women explained almost one third of the observed differences between African-American and White women in stage at diagnosis of breast cancer. The objective of this investigation was to attempt to replicate these findings in a second, larger population and to expand the analyses by including a measure of body fat distribution, the waist:hip ratio. The authors used data from a population-based study in North Carolina comprising 791 breast cancer cases (302 in African-American women and 489 in White women) diagnosed between 1993 and 1996. African-American women were more likely to have later-stage (TNM stage ≥II) breast cancer (odds ratio (OR) = 2.2; 95% confidence interval (CI): 1.6, 2.9). They also were much more likely to be severely obese (body mass index ≥32.3) (OR = 9.7; 95% CI: 6.5, 14.5) and to be in the highest tertile of waist:hip ratio (OR = 5.7; 95% CI: 3.8, 8.6). In multivariate logistic regression models, adjustment for waist:hip ratio reduced the odds ratio for later-stage disease in African-American women by 20%; adjustment for both waist:hip ratio and severe obesity reduced the odds ratio by 27%. These observations suggest that obesity and body fat distribution, in addition to socioeconomic and medical care factors, contribute to racial differences in stage at breast cancer diagnosis. *Am J Epidemiol* 2001;153:284–91.

anthropometry; blacks; breast neoplasms; mammography; neoplasm staging; obesity

Higher mortality from breast cancer among African-American women as compared with White women has been well documented (1–3). Although 5-year survival rates have improved over the past several decades for both African-American and White women, a substantial racial disparity still exists, and in fact it has increased in recent years (4). Poorer survival among African-American women is likely to be due to a number of factors, with later stage at diagnosis being a major reason for the difference in outcomes (2, 3, 5, 6). Recent statistics from the Surveillance, Epidemiology, and End Results program indicate that 55 percent of breast cancers among White women are in situ or stage I cancers at diagnosis as compared with only 41 percent among African-American women (1).

Racial differences in stage at diagnosis have often been attributed to differences in medical care or socioeconomic factors (5, 7–9). However, one recent study suggested that the higher prevalence of severe obesity among African-American women as compared with White women was an important explanatory variable (10). Specifically, in a study of breast cancer in Connecticut, Jones et al. (10) reported that adjustment for the greater prevalence of severe obesity among African-American women explained almost one third of the observed racial difference in stage at diagnosis. Severe obesity remained an important explanatory variable when data were adjusted for socioeconomic status, history of breast cancer screening, and other demographic and lifestyle factors. The objectives of this investigation were to attempt to replicate these findings in a second and larger population-based study in North Carolina, and to extend the inquiry to include a measure of body fat distribution, the ratio of waist circumference to hip circumference (waist:hip ratio).

MATERIALS AND METHODS

The Carolina Breast Cancer Study was a population-based case-control study carried out in 24 counties in central and eastern North Carolina (11). Breast cancer cases diagnosed between May 1993 and May 1996 were identified through a rapid case ascertainment system developed in conjunction with the North Carolina Central Cancer Registry. Pathology reports for all breast cancers diagnosed in the 26 hospitals in the study area were forwarded to the Central Cancer Registry and then to the Carolina Breast Cancer Study, most within 1 month of diagnosis. Virtually all (>97 percent) of the breast cancer cases occurring among residents of the study area were diagnosed at one of these hospitals. Eligible women were between the ages of 20 and

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Abbreviations: CI, confidence interval; OR, odds ratio; TNM, tumor-node-metastasis.

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74 years, resided in the 24-county study area, and had no prior history of breast cancer.

African-American women and women under age 50 years were oversampled using a modification of randomized recruitment (12). Women of all races were included in the study, but African-American women and White women comprised the vast majority of the subjects. Women of other races represented only 1.6 percent of the study population and were included with White women in the statistical analyses.

Permission to contact breast cancer patients was requested from the physician of record on the pathology report. Women for whom physician consent was obtained were contacted by a registered nurse, who scheduled an in-person interview. During the interview visit, the nurse administered a 1-hour questionnaire, took body measurements (height, weight, and waist and hip circumferences), and acquired the patient's signed consent for obtaining medical records related to the cancer. (Population-based controls were also selected and interviewed, but these analyses were restricted to cases only.) The study protocol was approved by the institutional review boards at the University of North Carolina School of Medicine and the participating hospitals. Medical records were requested from the hospitals, were abstracted by registered nurses, and were reviewed by one of the investigators (R. C. M.) to obtain relevant information, including tumor size, lymph node involvement, the presence of distant metastasis, and estrogen receptor status.

Of the 1,285 breast cancer patients sampled for the study, physician consent was not obtained for 5.7 percent; 6.1 percent were ineligible (usually because of a history of breast cancer), 0.9 percent died before being contacted, 3.3 percent could not be contacted, and 14.9 percent refused to participate. The overall response rate, calculated as the percentage of completed interviews among women who were located and eligible, was 77 percent for all cases. Response rates ranged from 83 percent among White case women younger than age 50 years to 68 percent among African-American case women aged 50 years or older (13). A total of 889 case women were interviewed. The analyses discussed in this paper were based on the 791 women (489 White and 302 African-American) for whom anthropometric data and medical record information on tumor stage were available.

Unconditional logistic regression analyses were used to obtain odds ratios and 95 percent confidence intervals. Modeling was performed using the GENMOD procedure of the SAS statistical software package (SAS Institute, Cary, North Carolina), which allows incorporation of an offset term to account for the sampling fractions used in the randomized recruitment study design. Variables related to tumor characteristics included stage (stage I vs. stage II or higher), determined using the tumor-node-metastasis (TNM) system (14); tumor size (<2 cm vs. ≥2 cm); lymph node status (positive vs. negative); and distant metastasis (present or absent). Severe obesity was defined as a body mass index (weight (kg)/height (m)^2) ≥ 32.3, which was the cutpoint established by the National Center for Health Statistics (15) and the one used in the earlier analyses by Jones et al. (10). Tertiles of waist:hip ratio were based on the distribution among all cases and controls in the Carolina Breast Cancer Study (16). Variables examined in the descriptive and multivariate analyses included age (as an 11-level ordinal variable reflecting 5-year age categories), education (less than high school graduation vs. high school graduation or higher), annual family income (<$30,000 vs. ≥$30,000), occupational category of the woman or her spouse (professional, administrator, or executive vs. nonprofessional), alcohol consumption (ever vs. never), smoking status (ever a regular smoker vs. never), parity (nulliparous vs. parous), and menopausal status (postmenopausal vs. pre- or perimenopausal). Women were categorized as postmenopausal if they reported having undergone natural menopause, bilateral oophorectomy, or hysterectomy and were over 55 years of age. All other women were included in the pre-/perimenopausal category.

Limited information on mammographic screening was available, and there were no data on time since last mammogram prior to the breast cancer diagnosis. A variable addressing screening adequacy (inadequate vs. adequate) was created using information on age at first mammogram and total number of mammograms, taking into account age-specific screening recommendations. All women who were under age 40 years at diagnosis were considered to have had adequate screening, since routine mammograms were not recommended for this age group (17). For women aged 40–49 years, the American Cancer Society recommended screening every 1–2 years and the National Cancer Institute had no specific recommendation during this time period (17). If a woman in this age range reported undergoing any mammograms prior to her breast cancer diagnosis, she was categorized as having had adequate screening. For women aged 50 years or more at diagnosis, the difference between age at diagnosis and age at first mammogram was divided by the total number of mammograms. Women for whom this number was 2 or greater (implying that, on average, mammograms had been 2 or more years apart) and women who reported having no mammograms prior to the breast cancer diagnosis were categorized as having had inadequate screening.

The extent to which a variable explained the racial difference in stage at diagnosis was determined by change-in-estimate (18): We observed the change in the odds ratio for the relation of race to stage at diagnosis after adding a specific variable (e.g., severe obesity or waist:hip ratio) to the logistic regression model. The percentage change in the odds ratio (OR) was calculated according to the formula [(adjusted OR – unadjusted OR)/(unadjusted OR – 1.00)] × 100.

RESULTS

The study population comprised 302 (38.2 percent) African-American women and 489 (61.8 percent) White women who had been diagnosed with a first invasive breast cancer. Characteristics of the study population are shown in table 1. African-American women were significantly more likely than White women to be in the lower category of each of three measures of socioeconomic status: education, family income, and occupational category. African-American

TABLE 1. Selected characteristics of African-American and White breast cancer patients from the Carolina Breast Cancer Study, North Carolina, 1993–1996

Characteristic	African-American women (*n* = 302)		White women (*n* = 489)		Odds ratio*	95% confidence interval
	No.	%	No.	%		
Age (years)						
≥50	140	46.4	183	37.4		
<50	162	53.6	306	62.6		
Education						
High school or more	211	69.9	437	89.4	1.00	
Less than high school	91	30.1	52	10.6	3.72	2.50, 5.54
Annual family income						
≥$30,000	84	29.9	307	67.0	1.00	
<$30,000	197	70.1	151	33.0	5.15	3.68, 7.22
Occupational category						
Professional	76	25.2	280	57.3	1.00	
Other	225	74.8	209	42.7	4.29	3.09, 5.93
Marital status						
Unmarried	167	55.3	141	28.8	1.00	
Married	135	44.7	348	71.2	0.31	0.23, 0.43
Alcohol consumption						
Never	99	32.8	127	26.0	1.00	
Ever	203	67.2	362	74.0	0.74	0.53, 1.02
Regular smoker						
Never	173	57.3	236	48.3	1.00	
Ever	129	42.7	253	51.7	0.71	0.53, 0.95
Menopausal status						
Pre-/perimenopausal	147	48.7	271	55.4	1.00	
Postmenopausal	155	51.3	218	44.6	1.15	0.73, 1.81
Family history of breast cancer						
No	266	88.1	409	83.6	1.00	
Yes	36	11.9	80	16.4	0.73	0.48, 1.13
Adequate mammography†						
No	93	30.8	92	18.8	1.00	
Yes	209	69.2	397	81.2	0.51	0.35, 0.73

Table continues

women were less likely to have been married or to have ever smoked cigarettes. There were no significant racial differences in menopausal status, family history of breast cancer, or alcohol consumption. African-American women were significantly less likely to have a history of screening mammography that was considered adequate with respect to age at the time of interview. Considering factors that are most relevant to this analysis, African-American women were much more likely than their White counterparts to be moderately obese (27.3 < body mass index < 32.3) or severely obese (body mass index ≥ 32.3). There were also significant racial differences in waist:hip ratios, with African-American women being more likely than White women to have values in the upper two tertiles. The relation with waist:hip ratio was attenuated after we adjusted for body mass index as a continuous variable, but African-American women were still more likely to have higher waist:hip ratios (OR = 1.46 (95 percent confidence interval (CI): 0.96, 2.22) for the middle tertile and OR = 2.89 (95 percent CI: 1.85, 4.51) for the highest tertile).

The relations between race and tumor characteristics are presented in table 1. In these age-adjusted analyses, African-American women were more likely than White women to be diagnosed with later-stage (TNM stage ≥II) breast cancer (OR = 2.16; 95 percent CI: 1.59, 2.92). The significant racial differences existed for all components of TNM stage: African-American women were more likely to have tumors ≥2 cm in diameter and were more likely to be diagnosed with positive lymph nodes or distant metastases.

The associations between severe obesity and waist:hip ratio and tumor characteristics are shown in table 2. There were statistically significant relations between severe obesity (body mass index ≥32.3) and later stage at diagnosis, larger tumor size, and distant metastasis. Women with positive lymph nodes also were more likely to be severely obese than those with negative lymph node status, although this differ-

TABLE 1. Continued

Characteristic	African-American women (*n* = 302)		White women (*n* = 489)		Odds ratio*	95% confidence interval
	No.	%	No.	%		
Body mass index‡						
<27.30	92	30.5	340	69.5	1.00	
27.30–32.29	95	31.5	94	19.2	4.37	3.00, 6.37
≥32.30	115	38.1	55	11.3	9.72	6.49, 14.54
Tertile of waist:hip ratio						
≤0.77	63	20.9	204	41.9	1.00	
0.78–0.85	99	32.8	181	37.2	2.14	1.44, 3.17
≥0.86	140	46.4	102	20.9	5.71	3.80, 8.59
TNM§ stage						
Stage I	106	36.1	220	46.4	1.00	
Stage II or higher	188	64.0	254	53.6	2.16	1.59, 2.92
Tumor size (cm)						
≤2	149	49.7	290	59.9	1.00	
>2	151	50.3	194	40.1	2.19	1.62, 2.95
Lymph node status						
Negative	168	56.6	319	66.2	1.00	
Positive	129	43.4	163	33.8	2.12	1.57, 2.88
Distant metastasis						
No	283	95.6	461	97.7	1.00	
Yes	13	4.4	11	2.3	2.66	1.14, 6.18

* Adjusted for age.
† See text for definition.
‡ Weight (kg)/height $(m)^2$.
§ TNM, tumor-node-metastasis.

ence was not quite statistically significant. We repeated these analyses using both more extreme (≥35) and less extreme (≥30 or ≥27) body mass index cutpoints for obesity. The body mass index cutpoint of ≥32.3 showed the strongest association between obesity and stage at diagnosis. Analyses of the relation of waist:hip ratio to tumor stage and the three components of TNM staging showed that the odds ratios for later-stage disease, larger tumors, positive lymph nodes, and distant metastasis increased with increasing waist:hip ratio. These analyses were also performed separately for African-American and White women. There were no significant interactions by race (data not shown). When examining the joint effects of severe obesity and waist:hip ratio, we found that increasing waist:hip ratio was associated with increased risk of later-stage breast cancer among both women who were severely obese and those who were not. The odds ratio for women who were both severely obese and in the highest tertile of waist:hip ratio was 3.61 (95 percent CI: 2.02, 6.43), as compared with the reference category of lowest tertile of waist:hip ratio and not severely obese.

Results from multivariate models that were used to evaluate the explanatory potential of severe obesity, waist:hip ratio, and other variables in the relation of race to stage at diagnosis are shown in table 3. The percentage change in the age-adjusted odds ratio for race was calculated after the inclusion of one or more additional variables. Adding a term for severe obesity (model 2) reduced the odds ratio for race by 12.8 percent, from 2.17 to 2.02. A larger reduction (20.5 percent) in the odds ratio for race was observed when waist:hip ratio was substituted for severe obesity in the model (model 3). When both factors were included (model 4), the odds ratio for race was reduced by 27.4 percent, which suggests that there was some overlap in the explanatory potential of these two anthropometric factors, but each still contributed to the reduction in the race-stage relation. Model 5 shows that mammographic screening accounted for approximately 11 percent of the racial difference in stage at diagnosis. The combination of the three factors of severe obesity, waist:hip ratio, and mammographic screening (model 6) reduced the race-associated odds ratio for later stage at diagnosis by 34.2 percent, from 2.17 to 1.77. After severe obesity, waist:hip ratio, and mammographic screening were taken into account, further adjustment for education, marital status, alcohol consumption, smoking history, parity, and menopausal status had a minimal effect on the race odds ratio (OR = 1.76 (95 percent CI: 1.24, 2.50); not shown in table). We constructed models 7–9 to explore the effects of the anthropometric factors when variables for screening history and education were already included in the model. The addition of the terms for the anthropometric variables in models 8 and 9 resulted in a greater reduction in the odds ratio for race than was seen in model 7. This suggests that the effect of the anthropometric factors is not due solely to their association with socioeconomic status.

We repeated the modeling using a three-level variable for obesity instead of dichotomizing women as severely obese

TABLE 2. Relations between severe obesity and waist:hip ratio and tumor characteristics in the Carolina Breast Cancer Study, North Carolina, 1993–1996

	No. of women (%)		Odds ratio*	95% confidence interval
	TNM† stage			
	Stage I	Stage ≥II		
Severe obesity				
No	269 (82.5)	337 (76.2)	1.00	
Yes	57 (17.5)	105 (23.8)	1.71	1.18, 2.46
	Tumor size (cm)			
	≤2	>2		
No	356 (81.1)	261 (75.7)	1.00	
Yes	83 (18.9)	84 (24.3)	1.63	1.15, 2.32
	Lymph nodes			
	Negative	Positive		
No	389 (79.9)	224 (76.7)	1.00	
Yes	98 (20.1)	68 (23.3)	1.40	0.98, 2.00
	Distant metastasis			
	No	Yes		
No	591 (79.4)	14 (58.3)	1.00	
Yes	153 (20.6)	10 (41.7)	3.07	1.31, 7.17
	TNM stage			
	Stage I	Stage ≥II		
Tertile of waist:hip ratio				
≤0.77	123 (37.7)	141 (32.0)	1.00	
0.78–0.85	116 (35.6)	156 (35.5)	1.58	1.10, 2.27
≥0.86	87 (26.7)	143 (32.5)	2.21	1.50, 3.26
	Tumor size (cm)			
	≤2	>2		
≤0.77	169 (38.5)	96 (28.0)	1.00	
0.78–0.85	143 (32.6)	135 (29.4)	2.41	1.67, 3.49
≥0.86	127 (28.9)	112 (32.7)	2.60	1.76, 3.86
	Lymph nodes			
	Negative	Positive		
≤0.77	173 (35.6)	93 (32.0)	1.00	
0.78–0.85	176 (36.2)	99 (34.0)	1.33	0.92, 1.92
≥0.86	137 (28.2)	99 (34.0)	1.87	1.27, 2.77
	Distant metastasis			
	No	Yes		
≤0.77	258 (34.8)	3 (12.5)	1.00	
0.78–0.85	266 (35.9)	8 (33.3)	4.05	1.00, 16.44
≥0.86	218 (29.4)	13 (54.2)	8.48	2.16, 33.38

* Adjusted for age.
† TNM, tumor-node-metastasis.

or not. Use of the three-level variable for obesity resulted in a reduction in the odds ratio for race similar to that shown in table 2 using the two-level variable. This suggests that it is only extreme overweight that influences stage at diagnosis.

We examined whether the relations between severe obesity or waist:hip ratio and later stage at diagnosis were modified by menopausal status, estrogen receptor status, or screening history. Because obesity is generally considered a

TABLE 3. Changes in odds ratio estimates* for the association between race and later-stage† breast cancer after adjustment for anthropometric measures and other covariates, Carolina Breast Cancer Study, North Carolina, 1993–1996

	Education		Inadequate mammographic screening		Tertile of waist:hip ratio‡		Severe obesity§		Race		% change¶ in the odds ratio for race
	OR#	95% CI#	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Model 1									2.17	1.60, 2.94	
Model 2							1.33	0.90, 1.95	2.02	1.47, 2.78	–12.8
Model 3					1.44 1.74	1.01, 2.07 1.16, 2.61			1.93	1.40, 2.65	–20.5
Model 4					1.41 1.68	0.98, 2.04 1.12, 2.53	1.21	0.81, 1.80	1.85	1.33, 2.57	–27.4
Model 5			2.02	1.38, 2.96					2.04	1.49, 2.77	–11.1
Model 6			1.95	1.33, 2.88	1.42 1.59	0.99, 2.06 1.05, 2.41	1.19	0.80, 1.76	1.77	1.27, 2.46	–34.2
Model 7	1.12	0.73, 1.71	1.98	1.34, 2.92					2.00	1.46, 2.74	–14.5
Model 8	1.07	0.70, 1.65	1.94	1.31, 2.87	1.45 1.63	1.01, 2.09 1.08, 2.46			1.82	1.31, 2.52	–29.9
Model 9	1.05	0.68, 1.63	1.94	1.31, 2.87	1.43 1.59	0.99, 2.06 1.05, 2.40	1.19	0.80, 1.77	1.76	1.25, 2.46	–35.0

* All odds ratios were adjusted for age.
† Tumor-node-metastasis stage ≥II.
‡ Odds ratios shown are for the middle and highest tertiles of waist:hip ratio.
§ Body mass index (weight (kg)/height (m)^2) ≥32.3.
¶ Refers to change in the odds ratio as compared with model 1. Calculated as [(adjusted OR – unadjusted OR)/(unadjusted OR – 1)] × 100.
# OR, odds ratio; CI, confidence interval.

risk factor for postmenopausal breast cancer but not premenopausal breast cancer (19), we hypothesized that the association between stage and severe obesity or waist:hip ratio would be stronger among postmenopausal women. We further hypothesized that the relation would be stronger among women with estrogen receptor-positive tumors, since heavier women have higher levels of bioavailable estrogen (19). Finally, we expected that the association might be stronger among women who did not have adequate mammographic screening, since obesity may delay the discovery of self-detected tumors. Our data (not shown) supported none of these hypotheses. There were no important differences in the relation between severe obesity or waist:hip ratio and stage at diagnosis when data were stratified by menopausal status, estrogen receptor status, or mammography history, and none of the interaction terms were statistically significant.

DISCUSSION

The goal of this investigation was to replicate findings reported by Jones et al. (10) which suggested that almost one third of the observed racial (African-American/White) difference in stage at breast cancer diagnosis could be explained by the greater prevalence of severe obesity among African-American women. Traditionally, the unfavorable stage distribution observed among African-American women with breast cancer has been attributed to racial differences in a number of factors, including socioeconomic status; delay in seeking treatment; attitudes toward, knowledge of, and beliefs about cancer; and access to health care, specifically mammography (8, 9, 20). Although these characteristics have been shown to differ among African-American and White women in a number of studies, systematic attempts to attribute the later stage at diagnosis to specific factors have been unable to fully account for the observed racial differences (5, 21, 22). Thus, the finding that a physiologic factor, severe obesity, might play an important role in the race-stage association warranted further examination.

As has been observed in other populations (10, 15, 23), there were racial differences in a number of anthropometric measures. African-American women with breast cancer in this North Carolina population were more likely than White women to be obese, to be severely obese, and to have greater waist:hip ratios. They also were more likely to be diagnosed with later-stage breast cancer, larger tumors, positive lymph nodes, and distant metastases. Among both African-American women and White women, severely obese women and those with a waist:hip ratio in the highest tertile were more likely to be diagnosed with later-stage breast cancer.

In an age-adjusted model, inclusion of waist:hip ratio explained 20 percent of the later stage at diagnosis observed in African-American women. Together, waist:hip ratio and severe obesity explained 27 percent of the observed racial difference in stage at diagnosis of breast cancer, which suggests that anthropometric characteristics contribute substantially to this relation. The mammographic screening variable exerted a small, independent effect, increasing the explanatory effect of this model to 34.2 percent. After these factors were taken into account, other variables, including lifestyle characteristics and socioeconomic measures, had a minimal effect on the relation between race and stage at diagnosis.

There are several potential explanations for the association between obesity, waist:hip ratio, and stage at diagnosis. It is plausible that detection of tumors in large breasts is more difficult, leading to a delay in diagnosis. One would expect that this would be an issue primarily for women who were not receiving regular mammograms and whose tumors would be self-detected as palpable breast lumps. Among women receiving mammograms, tumors should not be more difficult to detect in heavier women, because larger breasts tend to be less dense and more radiolucent (24). Although one study reported a positive relation between body mass index and nonlocalized breast cancer only among women whose tumors were self-detected, not among women whose tumors were found by mammography (25), other studies have found that the relations between obesity and stage at diagnosis were similar regardless of method of detection or screening history (10, 26). Our data are consistent with the latter studies, in that the relation between stage at diagnosis and obesity and waist:hip ratio was not stronger among women with an inadequate history of mammography. While delayed detection may contribute to the relation between obesity and stage at diagnosis, it is unlikely to fully explain the association.

Beyond detection issues, endocrinologic factors may be responsible for the association between obesity, high waist:hip ratio, and stage at diagnosis. A number of studies have found that breast cancer survival is poorer among heavier women, even when controlling for tumor size and stage of disease (27–30). This suggests that the growth and progression of breast tumors may be enhanced in obese women. Several mechanisms that could account for these observations have been proposed. Heavier women tend to have increased estrogen production due to conversion of androstenedione in adipose tissue (19). Obesity and a high waist:hip ratio also have been shown to be associated with lower levels of sex hormone-binding globulin, resulting in higher levels of unbound, biologically active estrogen (31, 32). In addition, abdominal obesity is often associated with hyperinsulinemia and increased levels of insulin-like growth factor type I (33, 34). Insulin and insulin-like growth factor type I show mitogenic activity in mammary cancer cells, and insulin-like growth factor type I may act synergistically with estrogen to stimulate breast cancer cell growth (35). Hyperinsulinemia has also been shown to be associated with lower levels of sex hormone-binding globulin (36). Thus, several related endocrinologic factors may account for the observed relation between waist:hip ratio, obesity, and breast cancer stage.

The limitations in the available data and their possible effects on the association between race and later stage at diagnosis must be acknowledged. Information on mammographic screening was not optimal, and education may not have been an ideal measure of socioeconomic status. In addition, no data were available for factors such as access to health care or cultural beliefs and attitudes. To the extent that these factors are associated with body size, we may have overestimated the effect of increased waist:hip ratio or obesity in explaining racial differences in stage at diagnosis. Furthermore, the lack of information on brassiere size or method of discovery of the breast cancer limited us in examining the hypothesis that the association of obesity with later stage at diagnosis is due to delayed detection.

This investigation provides additional evidence that racial differences in anthropometric factors contribute to the observed difference between African-American women and White women in stage at diagnosis of breast cancer. Additional research is needed to determine whether these associations are mediated by detection issues or physiologic factors. Future studies in which measures of biomarkers (e.g., hormones or growth factors) are available or more detailed information on mammographic screening is available may help to elucidate the mechanisms. Regardless of the pathways by which body size influences stage at diagnosis, public health initiatives designed to reduce obesity and modify body fat distribution through diet and exercise may have important implications for changing disease course in some individuals, particularly African-American women.

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