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Does Mammographic Density Reflect Ethnic Differences in Breast Cancer Incidence Rates?

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Breast cancer incidence rates in the United States are substantially lower among Asian-American women than among White or African-American women. The authors determined whether mammographic density reflects these ethnic differences by evaluating mammograms from 442 White, African-American, and Asian-American women without breast cancer who served as controls in one of two population-based, breast cancer case-control studies conducted in Los Angeles, California, in 1994–1998. Absolute and percent mammographic densities were determined with a previously developed and validated computer-assisted method. Data were analyzed using multiple regression methods. Mean age-adjusted percent mammographic density was significantly higher in Asian Americans (35.9%) than in African Americans (27.8%, $p < 0.05$) but was no longer significant after further adjustment for body mass index. After adjustment for age, body mass index, selected menstrual/reproductive factors, and family history, absolute mammographic density was statistically significantly lower in Asian Americans than in African Americans ($p < 0.05$) but not than in Whites. The ethnic difference in absolute mammographic density was particularly evident among women older than age 50 years. Additional adjustment for breast size reduced these ethnic differences. This study suggests that absolute but not percent mammographic density reflects the lower breast cancer incidence rates of Asian Americans in relation to those of African Americans and Whites.

breast neoplasms; case-control studies; ethnic groups; mammography; regression analysis

Abbreviations: BMI, body mass index; CARE, Contraceptive and Reproductive Experiences.

Breast cancer incidence rates vary between countries, with high rates in the westernized developed countries and low rates in the less-developed or Asian countries (1, 2). Even in the United States, Asian-American women have traditionally had substantially lower age-adjusted breast cancer incidence rates than Whites and African Americans (3, 4). Compared with African Americans, White women in the United States have higher overall age-adjusted breast cancer incidence rates and higher age-specific incidence rates from about age 40–45 years onward, but the reverse is true for younger women (5). During the period 1993–1997 in Los Angeles County, California, the average annual age-adjusted incidence rates for non-Hispanic White women were 20 percent higher than those for African-American women and roughly double those for Asian-American women when all Asian ethnicities were combined (6).

Increased mammographic density has consistently been shown to represent a strong independent risk factor for breast cancer (7–11). However, the extent to which the lower breast cancer incidence rates of Asians are reflected in mammographic density is unclear (12–19). Two studies found that Asian-American women had significantly more favorable Wolfe's parenchymal patterns than White women did (18, 19); other studies reported that ethnicity was unrelated to Wolfe's parenchymal patterns (16, 17) or that percent density was higher in Asian-American women than in Whites (12–15). To our knowledge, only one study has examined differences in mammographic density between African-American and White women; these investigators

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reported that African Americans were statistically significantly more likely to have dense mammograms than were Whites aged 20–79 years (15).

Part of the discrepancy in Asian-White differences in mammographic density may be due to different methods of assessing this density across studies. Quantitative measurement of mammographic density may be a more sensitive method for detecting differences in breast cancer risk (7), but this method was, to our knowledge, used in only three studies conducted in Hawaii (12–14).

To shed further light on the possible ethnic differences in mammographic density, we compared absolute and percent mammographic densities among Asian-American, African-American, and White women without breast cancer by using a quantitative measurement. We also determined whether any ethnic differences in density were explained by other breast cancer risk factors.

MATERIALS AND METHODS

Subject selection

The subjects in this mammographic density study were women aged 35–64 years who had never been diagnosed with in situ or invasive breast cancer and who participated in one of two studies at our institution. The African-American and White women participated as controls in the Los Angeles part of the Women's Contraceptive and Reproductive Experiences (CARE) Study of US-born women (20). Controls were selected by random digit dialing and were frequency matched to cases on age, ethnicity, and residence in Los Angeles County. Participation rates in Los Angeles were 71 percent for African-American controls and 76 percent for White controls (20). The Asian-American women were controls from a breast cancer case-control study of Asian Americans (21). About 30 percent of Asian-American women in this study were born in the United States (21). Cases in the Asian-American study were of Chinese, Filipino, or Japanese-American ethnicity and resided in Los Angeles County at the time of breast cancer diagnosis. Cases were diagnosed between 1995 and 1997. Controls were frequency matched to cases on neighborhood of residence, age (5-year groups), and Asian ethnicity. A first suitable control refused to participate and a second or later control was recruited 68 percent of the time.

Participants in the current study were eligible if they had had a mammogram during the 5 years preceding their reference date (the date of household census for controls in the Women's CARE Study and the date on which the control was identified for the Asian-American study). The rate of refusing review of their mammograms was about 7 percent in the Women's CARE Study and 5 percent in the breast cancer case-control study of Asian Americans. Each participant provided a signed consent allowing review of her previous mammograms in this study. We identified 770 women who were eligible to participate. We obtained and scanned one or more mammograms for 493 of these women (64.0 percent). The success rate for obtaining mammograms was 75 percent for Whites, 59 percent for African Americans, and 50 percent for Asian Americans. We were unable to retrieve the mammograms of 277 women because the facility had no record of the woman ($n = 59$), the mammograms were no longer available at the facility ($n = 93$), no mammograms had been obtained during the eligible time period ($n = 73$), the facility no longer existed ($n = 32$), or the facility did not respond to our request before the study ended ($n = 20$). The study was approved by the Institutional Review Board at the University of Southern California.

Data collection and mammographic density assessment

We requested the subjects' most recent mammograms that had been obtained no later than 12 months after the reference date. We scanned craniocaudal mammograms using an Omnimedia XRS 6cx scanner (Lumisys, Sunnyvale, California) or a Cobrascan CX312T scanner (Radiographic Digital Imaging, Torrance, California). The mammograms were scanned at a resolution of 150 pixels/inch (59 dots/cm). The eight-bit (256 shades of gray) images from the two scanners were indistinguishable with respect to density assessment. For controls in both parent studies, we randomly scanned the right or left breast. We used the computer-assisted method, "Madena," that we developed and validated previously (22) to assess absolute and percent mammographic densities quantitatively. With this method, the total area of the breast is outlined by using a computerized outlining tool, and the software estimates the number of pixels in the outlined area. The dense area is assessed by having a reader outline a region of interest that includes the entire breast but excludes artifacts such as the pectoralis muscle and prominent veins as well as fibrous strands. The reader then searches for the best threshold X where all pixels $\geq X$ within the region of interest are considered to represent mammographic density. The software estimates the area of the pixels above the threshold within the region of interest, which represents the dense area or the "absolute density." "Percent density," or the fraction (percentage) of the breast with densities, is the ratio of absolute density to the total breast area. The dense area was determined by one of the authors (G. U.), while the total area of the breast was determined by a research assistant trained by that author. We included 443 blind duplicates in batches. The coefficients of variation for breast size, absolute mammographic density, and percent mammographic density were 2.7 percent, 18.4 percent, and 19.1 percent, respectively.

The scanned mammogram files of five women could not be assessed for density because the digitized files were unusable and we were unable to obtain their films a second time. Therefore, we obtained mammographic density results for 488 women. Details regarding mammographic density as a measure of breast cancer risk in these ethnic groups can be found in Ursin et al. (11).

We obtained risk factor information from the parent case-control studies (20, 21). In both parent studies, a female interviewer used a structured questionnaire and a life events calendar to conduct in-person interviews with all subjects. The questionnaires for both studies were quite similar. Both studies obtained from each participant complete histories of menstrual and reproductive factors, use of oral contraceptives and hormone replacement therapy, weight 5 years prior to the date on which the subject was identified, medical history, and family history of breast cancer.

Statistical analysis

We treated percent and absolute mammographic densities as continuous and categorical variables. Age was defined as a subject's age at the time of her mammogram. Body mass index (BMI) was calculated as body weight (in kilograms) divided by height squared (in meters) and was obtained on average 3.7 years before the date of a subject's mammogram, with a range of from less than 6 years before to half a year after the date of the mammogram. The variables age, BMI, age at menarche, and duration of oral contraceptive use were treated as continuous. A full-term pregnancy was defined as any pregnancy that lasted more than 26 weeks. Number of full-term pregnancies and age at first full-term pregnancy were included as continuous variables in our analyses. Family history of breast cancer was categorized as follows: no first- or second-degree family history, breast cancer history for at least one first-degree relative (mother or sister), or breast cancer history for at least one second-degree relative but not a first-degree relative. We created a six-category variable combining menopausal status and hormone replacement therapy use at the time of the mammogram (premenopausal or, among postmenopausal women, never used hormone replacement therapy, currently using estrogen replacement therapy, currently using estrogen and progestin replacement therapy, previously used estrogen replacement therapy, or previously used estrogen and progestin replacement therapy). On the basis of additional information, we have classified seven controls differently regarding menopausal status/hormone replacement therapy use since our previous paper was published (11). We performed *t* tests, chi-square tests, and analyses of variance to determine whether there were any significant differences in the characteristics of subjects across the three ethnic groups.

To maintain a consistent sample size for all analyses, we excluded 46 women for the following reasons: menopausal status unknown ($n = 26$), missing BMI information ($n = 2$), age at first full-term pregnancy missing ($n = 3$), oral contraceptive use information missing ($n = 1$), age at menarche missing ($n = 3$), and adopted or did not know the family history of breast cancer for more than half of their first-degree family members ($n = 11$). After these exclusions, 442 women remained for analysis: 67 Asian Americans, 149 African Americans, and 226 Whites. For an additional 11 women, family history for one or two family members was unknown but a negative family history was known for the rest. We included these 11 women in the analyses, coding them as having no known family history of breast cancer. Excluding them yielded results similar to those presented in this paper. To assess whether included participants were similar to all nonincluded women, we conducted ethnic-specific analyses. The distributions of main risk factors of interest were similar in the two groups of African-American and Asian-American women. Several differences were noted for White women. Compared with Whites who were not included, Whites who were included were on average 3.6 years older (t-test $p = 0.0002$) and 1.3 kg/m^2 heavier (t-test $p = 0.04$), and 20.5 percent more of them used hormone replacement therapy (chi-square test $p = 0.0006$).

We used a multivariate linear regression model approach (23) to compare least-squares means of breast size, absolute mammographic density, and percent mammographic density across ethnic groups; analysis of covariance methods were used to adjust for covariates. We evaluated pairwise differences between ethnic groups by using Tukey's method, and we present the overall p value for all comparisons and p values of <0.05 for pairwise comparisons in the tables. The SAS statistical package (SAS Institute, Inc., Cary, North Carolina) was used for all data management and analysis. Since our sample size ($N = 442$) was relatively large, and since the residuals from the methods satisfied the normality and homoscedasticity assumptions, we treated percent and absolute mammographic densities as continuous variables without any transformation. In this paper, we describe the distribution of percent and absolute mammographic densities by ethnicity and age (>50 vs. ≤50 years). Chi-square tests were performed to determine whether the categorical distributions of percent or absolute mammographic density differed by ethnicity overall and within each age group. Since the results of nonparametric and parametric analyses were similar, only the parametric results are presented.

RESULTS

The characteristics of subjects included in our analyses are summarized in table 1. We observed statistically significant differences in BMI, age at menarche, parity, number of full-term pregnancies, age at first full-term pregnancy, duration of oral contraceptive use, menopausal status, and hormone replacement therapy use across ethnic groups. Of the three ethnicities, Asian Americans had the lowest mean BMI and the oldest mean age at first menstrual period, were the most likely to be parous, had the oldest mean age at first full-term pregnancy, and had used oral contraceptives for the shortest period of time. African Americans had the highest BMI of the three ethnic groups. Whites were the least likely to be parous and had the fewest full-term pregnancies. A greater percentage of Asian-American women than African-American or White women were premenopausal. Among postmenopausal women, Whites were the most likely and Asian Americans the least likely to have used hormone replacement therapy.

Breast size differed across the three ethnic groups. Asian Americans (361,300 pixels) were significantly smaller than African Americans (662,900 pixels) or Whites (495,400 pixels), whereas Whites were significantly smaller than African Americans. Similar patterns of results were observed for the two age categories, although, among women older than age 50 years, the breast size distribution of Asian-American and White women did not differ significantly. Among women of all ages, Asian Americans were less likely than Whites to be in the lowest percent mammographic density category ($p = 0.07$), but the distribution of percent mammographic density did not differ between African Americans and Whites ($p = 0.35$) (table 2). Among women aged 50 years or younger, both Asian Americans and

TABLE 1. Descriptive characteristics of three ethnic groups of women studied in relation to mammographic density and breast cancer incidence rates, Los Angeles, California, 1994–1998

Variable	Ethnicity			Two-sided *p* value
	Asian American	African American	White	
Mean age (years)	48.1	49.9	49.6	0.33*
Mean body mass index (weight (kg)/height (m)^2)	23.2	27.9	25.3	<0.0001*
Mean age at menarche (years)	12.9	12.5	12.3	0.04*
Parous (%)	91.0	87.2	78.8	0.02†
Mean no. of full-term pregnancies	2.3	2.5	2.0	0.008*
Mean age at first full-term pregnancy (years)	28.1	21.1	23.9	<0.0001*
Mean duration of oral contraceptive use (years)	2.5	4.8	4.0	0.01*
Breast cancer family history (%)				0.15†
None	83.6	81.9	74.3	
First-degree family history	10.5	8.7	9.7	
Second-degree family history only	6.0	9.4	15.9	
Menopausal status and HRT‡ use (%)				<0.0001†
Premenopausal	53.7	39.6	39.4	
Postmenopausal and never HRT use	22.4	19.5	7.1	
Postmenopausal and current ERT‡ use	4.5	18.8	18.1	
Postmenopausal and current EPRT‡ use	13.4	5.4	23.5	
Postmenopausal and prior ERT use	1.5	10.1	4.9	
Postmenopausal and prior EPRT use	4.5	6.7	7.1	
Mean breast size (1,000 pixels)				
All ages	361.3	662.9	495.4	<0.0001*
Age ≤50 years	317.6	599.6	472.5	<0.0001*
Age >50 years	415.2	714.6	516.8	<0.0001*

* Obtained from analysis of variance.

† Obtained from chi-square test.

‡ HRT, hormone replacement therapy; ERT, estrogen replacement therapy; EPRT, estrogen and progestin replacement therapy.

African Americans had distributions of percent mammographic density that differed from that of Whites ($p = 0.02$ for both comparisons). No Asian-American woman had a percent mammographic density less than 15 percent, whereas 27 percent of African-American and 22 percent of White women were in this category. Among women older than age 50 years, neither Asian-American nor African-American women differed from Whites regarding the distribution of percent mammographic density, although more African Americans were in the lowest density category and more Whites were in the highest density category.

Overall, Asian-American women were significantly more likely than White women to have an absolute mammographic density within the interquartile range ($p = 0.04$), but African-American and White women did not differ significantly regarding their distributions of absolute mammographic density ($p = 0.11$) (table 3). Among women aged 50 years or younger, Asian Americans were more likely than Whites to be in the midrange absolute mammographic density categories ($p = 0.02$), whereas the distributions of African Americans and Whites did not differ ($p = 0.32$). No statistically significant ethnic differences in the distribution of absolute mammographic density were observed for older women.

Overall, in the unadjusted analysis, the three ethnic groups differed regarding percent mammographic density ($p = 0.01$) (table 4). Asian Americans had a statistically significantly higher age-adjusted percent mammographic density (35.9 percent) than African Americans did (27.8 percent, $p < 0.05$), but they did not differ statistically from Whites (31.0 percent). These differences were observed for only younger women. The ethnic differences in percent mammographic density remained after adjustment for age only, but they disappeared after adjustment for both age and BMI.

Although we did not observe statistically significant differences in mean absolute mammographic density in an unadjusted or an age-adjusted model, after we adjusted for all covariates, African Americans (143,300 pixels) had a statistically significantly higher absolute mammographic density than Asian Americans (85,500 pixels, $p < 0.05$) or Whites (107,400 pixels, $p < 0.05$) did (table 5). We found no significant differences in absolute mammographic density between Asian Americans and Whites. These trends were

TABLE 2. Number (and %) of women in each category of percent mammographic density by ethnicity and age, Los Angeles, California, 1994–1998

Age group	Percent density										p value*
	<15		<30		<45		<60		≥60		
	No.	%	No.	%	No.	%	No.	%	No.	%	
All ages											
Asian American (n = 67)	9	13	16	24	19	28	15	22	8	12	0.07
African American (n = 149)	56	38	31	21	28	19	21	14	13	9	0.35
White (n = 226)	69	31	43	19	42	19	49	22	23	10	Reference
Age ≤50 years											
Asian American (n = 37)	0	0	8	22	11	30	10	27	8	22	0.02
African American (n = 67)	18	27	17	25	10	15	10	15	12	18	0.02
White (n = 109)	24	22	11	10	25	23	32	29	17	16	Reference
Age >50 years											
Asian American (n = 30)	9	30	8	27	8	27	5	17	0	0	0.39
African American (n = 82)	38	46	14	17	18	22	11	13	1	1	0.16
White (n = 117)	45	38	32	27	17	15	17	15	6	5	Reference

* Chi-square p value comparing Asian Americans or African Americans with Whites.

observed for women older than age 50 years but not for younger women.

Because of concern that the body weight information we had could be different from a woman's weight at the time of the mammogram, we also conducted an analysis restricted to women who had had a mammogram within 3 years of the age at which they reported their weight. We found that the patterns of ethnic differences in absolute and percent densities were the same as reported in the fully adjusted models shown in tables 4 and 5; however, possibly because of a smaller sample, all p values were >0.10.

Breast size was statistically significantly correlated with percent density (Pearson's correlation $r = -0.35$, $p < 0.0001$) and absolute density (Pearson's correlation $r = 0.25$, $p < 0.0001$) for all women combined. Additional adjustment for breast size had little effect on the percent density results presented in table 4. For Asian Americans, African Americans, and Whites, respectively, the values for percent density became 29.2 percent, 30.8 percent, and 28.0 percent for all women combined, and 32.5 percent, 30.2 percent, and 27.4 percent for women under 50 years of age and 27.7 percent, 32.0 percent, and 31.5 percent for women aged 50 years or

TABLE 3. Number (and %) of women in each category of absolute mammographic density by ethnicity and age, Los Angeles, California, 1994–1998

Age group	Quartile of absolute density*								p value†
	<25th		25–<50th		50–<75th		≥75th		
	No.	%	No.	%	No.	%	No.	%	
All ages									
Asian American (n = 67)	10	15	25	37	21	31	11	16	0.04
African American (n = 149)	39	26	34	23	28	19	48	32	0.11
White (n = 226)	61	27	52	23	62	27	51	23	Reference
Age ≤50 years									
Asian American (n = 37)	2	5	15	41	12	32	8	22	0.02
African American (n = 67)	12	18	17	25	12	18	26	39	0.32
White (n = 109)	23	21	21	19	31	28	34	31	Reference
Age >50 years									
Asian American (n = 30)	8	27	10	33	9	30	3	10	0.77
African American (n = 82)	27	33	17	21	16	20	22	27	0.15
White (n = 117)	38	32	31	27	31	27	17	15	Reference

* The quartile cutpoints were 47,226 pixels, 113,375 pixels, and 193,920 pixels.
† Chi-square p value comparing Asian Americans or African Americans with Whites.

TABLE 4. Unadjusted and adjusted mean percent mammographic density by ethnicity and age, Los Angeles, California, 1994–1998

Model and age group	Asian American (n = 67)		African American (n = 149)		White (n = 226)		Overall p value
	Mean	95% CI*	Mean	95% CI	Mean	95% CI	
Unadjusted							
All ages	37.0	31.8, 42.1	27.5	24.0, 31.0	30.9	28.1, 33.7	0.01†
Age ≤50 years	45.8	38.8, 52.9	34.4	29.2, 39.7	37.6	33.5, 41.7	0.04†
Age >50 years	26.0	19.3, 32.8	21.8	17.7, 26.0	24.5	21.1, 28.0	0.48
Age adjusted							
All ages	35.9	31.0, 40.8	27.8	24.6, 31.1	31.0	28.3, 33.6	0.03†
Age ≤50 years	45.8	38.7, 52.9	34.4	29.2, 39.7	37.7	33.5, 41.8	0.04†
Age >50 years	25.7	18.9, 32.4	21.8	17.7, 25.9	24.7	21.3, 28.1	0.48
Age and BMI* adjusted							
All ages	31.6	27.1, 36.2	31.2	28.1, 34.3	30.0	27.6, 32.4	0.75
Age ≤50 years	41.0	34.5, 47.5	38.8	33.9, 43.7	36.6	32.9, 40.3	0.46
Age >50 years	22.1	15.7, 28.4	24.3	20.5, 28.1	23.8	20.7, 27.0	0.84
Fully adjusted‡							
All ages	29.8	23.8, 35.8	30.7	25.4, 35.9	28.2	23.6, 32.9	0.50
Age ≤50 years	33.5	23.7, 43.2	30.2	21.1, 39.3	27.6	19.8, 35.4	0.31
Age >50 years	28.2	19.9, 36.5	31.8	25.1, 38.6	31.9	25.0, 38.7	0.59

* CI, confidence interval; BMI, body mass index.
† Tukey pairwise comparisons; Asian Americans and African Americans differ ($p < 0.05$).
‡ Adjusted for age, BMI, no. of full-term pregnancies, family history of breast cancer, age at menarche, age at first full-term pregnancy, parity, duration of oral contraceptive use, and menopausal status/hormone replacement therapy use.

more. The differences between the ethnic groups remained statistically nonsignificant after adjustment for breast size (all $p \geq 0.39$).

Additional adjustment for breast size diminished the statistically significant results across ethnicity and made the results for absolute density similar to those for percent density. Absolute density remained lowest in Asian Americans for all women combined (109,200 pixels vs. 137,100 pixels in African Americans and 117,700 pixels in Whites). In younger women, the density levels were 119,000 pixels in Asian Americans versus 136,300 pixels in African Americans and 110,100 pixels in Whites; in older women, there were 107,600 pixels in Asian Americans versus 140,000 pixels in African Americans and 134,000 pixels in Whites. None of these findings was statistically significant either (all $p \geq 0.22$).

DISCUSSION

Asian Americans had a statistically significantly higher percent mammographic density than African Americans did before we adjusted for other risk factors, but this ethnic difference was eliminated after adjustment for age and BMI. Asian Americans had a lower absolute mammographic density than African Americans did. This result was statistically significant after adjustment for age, BMI, menstrual and reproductive factors, and family history. The mean absolute mammographic density of Asian-American and White women did not differ statistically. African Americans had a similar percent density but a statistically significantly higher absolute mammographic density than Whites did after we adjusted for age and BMI.

Studies examining ethnic differences in the mammographic density of women without breast cancer provide conflicting evidence on whether Asian women differ from Whites in this regard (12–19). The largest known study so far used a binary assessment of mammograms, with mammograms assigned a BI-RADS (Breast Imaging Reporting and Data System; American College of Radiology, Reston, Virginia) score of I or II as "fatty" and III or IV as "dense" (15). This study found that, of women older than age 55 years, Asian Americans were statistically significantly more likely than Whites to have "dense" breasts (15). However, Turnbull et al. (19) reported that women from Bombay, India, were significantly more likely than White women in the United Kingdom to have favorable Wolfe's parenchymal patterns (N1, P1). Similarly, Gravelle et al. (18) found that healthy premenopausal Japanese women in suburban Tokyo were significantly more likely than premenopausal British women to have favorable N1 and P1 Wolfe's parenchymal patterns. The other reports by Grove et al. (16, 17) suggested no significant association between ethnicity and Wolfe's parenchymal patterns.

To our knowledge, only three other studies (12–14) have used a quantitative method to investigate ethnic differences in absolute and percent mammographic densities. Maskarinec et al. (12–14) used the same Madena method we used and found that Asian Americans had a statistically significantly

TABLE 5. Unadjusted and adjusted mean absolute mammographic density (per 1,000 pixels) by ethnicity and age, Los Angeles, California, 1994–1998

Model and age group	Asian American (*n* = 67)		African American (*n* = 149)		White (*n* = 226)		Overall *p* value
	Mean	95% CI*	Mean	95% CI	Mean	95% CI	
Unadjusted							
All ages	122.3	92.8, 151.8	157.1	137.3, 176.9	133.9	117.8, 149.9	0.09
Age ≤50 years	145.9	105.1, 186.7	181.4	151.1, 211.7	155.7	132.0, 179.5	0.30
Age >50 years	93.2	51.4, 135.0	137.2	111.9, 162.5	113.5	92.3, 134.7	0.16
Age adjusted							
All ages	119.3	90.0, 148.6	158.0	138.4, 177.6	134.1	118.2, 150.0	0.06
Age ≤50 years	146.2	105.4, 187.0	181.4	151.1, 211.7	155.6	131.9, 179.4	0.30
Age >50 years	92.5	50.5, 134.4	137.1	111.8, 162.4	113.8	92.6, 135.0	0.16
Age and BMI* adjusted							
All ages	112.9	82.2, 142.6	163.1	143.1, 183.1	132.7	116.8, 148.6	0.01†,‡
Age ≤50 years	139.0	97.5, 180.5	187.9	156.8, 219.1	154.0	130.3, 177.8	0.14
Age >50 years	86.7	44.2, 129.2	141.1	115.3, 166.9	112.4	91.2, 133.7	0.08
Fully adjusted§							
All ages	85.5	45.7, 125.4	143.3	108.5, 178.1	107.4	76.5, 138.3	0.005†,¶
Age ≤50 years	86.1	23.5, 148.7	134.6	76.0, 193.2	102.3	52.4, 152.1	0.18
Age >50 years	84.8	26.6, 143.0	146.9	99.5, 194.2	115.8	68.0, 163.6	0.06

* CI, confidence interval; BMI, body mass index.
† Tukey pairwise comparisons; Asian Americans and African Americans differ ($p < 0.05$).
‡ Tukey pairwise comparisons; African Americans and Whites differ ($0.05 \leq p < 0.10$).
§ Adjusted for age, BMI, no. of full-term pregnancies, family history of breast cancer, age at menarche, age at first full-term pregnancy, parity, duration of oral contraceptive use, and menopausal status/hormone replacement therapy use.
¶ Tukey pairwise comparisons, African Americans and Whites differ ($p < 0.05$).

higher percent mammographic density and a nonsignificantly lower absolute mammographic density than Caucasians and Native Hawaiians did. These ethnic differences in mammographic density diminished after adjustment for BMI, age at menarche, diet, estrogen use, and family history. Our results are consistent with these results. We found no significant differences in absolute mammographic density between Asian Americans and Whites and that the significant differences in percent mammographic density disappeared after adjustment for BMI and age. The only other published study known to compare mammographic density in African-American and White women found that, in women 65 years of age or younger, African Americans were more likely than Whites to have mammograms that were "dense" (BI-RADS scores of III and IV) versus "fatty" (BI-RADS scores of I and II) (14). In our study, African Americans had a similar percent mammographic density as Whites in both age groups. African Americans had a higher absolute mammographic density than Whites among all women aged 35–64 years after we adjusted for age and BMI. These trends were similar for both younger and older women and whether age 45 or 50 years was used as the cutoff point (data not shown). The crossover in breast cancer incidence rates between African Americans and Whites that occurs at about age 40–45 years (5) therefore does not appear to be reflected in mammographic density.

Our study suggests that absolute mammographic density reflects the lower breast cancer incidence rates in Asian Americans better than percent mammographic density does because, in our full model, Asian Americans had a lower absolute, but similar percent mammographic density as African Americans or Whites. This result is consistent with the report from Maskarinec et al. (14) in which the absolute mammographic density was lowest in Japanese in Japan, intermediate in Japanese in Hawaii, and highest in Whites in Hawaii, but percent mammographic density was higher in Japanese than in Caucasians. Percent mammographic density has been reported to be a stronger breast cancer risk factor than absolute mammographic density (7). However, in our study, the risk estimates were fairly similar for absolute and percent mammographic densities (11). Percent density may not be a good predictor of ethnic differences because it is greatly influenced by breast size and body fat, which show substantial ethnic differences.

One limitation of our study is that we included few Asian-American women. Although Asian-American controls and African-American and White controls were selected by using well-accepted approaches in population-based studies, the former group was identified from neighborhood walks while the latter groups were recruited through random digit dialing. However, the studies were conducted during approximately the same time period in the 1990s, and the risk factor information, including mammogram history, was obtained by asking similar questions. Thus, it is unlikely that differences in control selection methods would have biased our results. Another potential weakness of our study is that we were unable to obtain mammograms from all eligible women. As mentioned above, women whose mammograms were available were similar to women whose mammograms were not available regarding most breast cancer risk factors. The differences in age and BMI among Whites who were included and those who were not are unlikely to have caused any of our results.

Another limitation is that we did not have information on body weight or BMI at the date of the mammograms. However, when we restricted our analyses to women who had reported their weight at an age that corresponded to 0–3 years within the mammogram date, our results were similar, although, with the smaller sample size, the differences across ethnic groups were no longer statistically significant. This finding suggests that any residual confounding of our results by body weight due to the lack of information on body weight at the time of the mammogram is likely to be minimal.

We found no statistically significant differences in absolute density across ethnic groups after adjustment for breast size. However, for all women combined, Asian-American women still had the lowest absolute density, while African Americans had the highest.

In summary, our study suggests that absolute but not percent mammographic density reflects the substantially lower breast cancer incidence rates of Asian Americans relative to those of African Americans and Whites. Neither percent nor absolute mammographic density reflects the crossover in breast cancer incidence rates between African Americans and Whites that occurs around age 40–45 years. Both absolute and percent mammographic densities should be reported in future studies, especially when multiethnic populations are included.

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