ORIGINAL INVESTIGATION

Differences in Breast Cancer Stage, Treatment, and Survival by Race and Ethnicity

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Background: In the United States, black and Hispanic white women with breast cancer present with more advanced stages and have poorer survival rates than non-Hispanic whites, whereas Asians and Pacific Islanders do not. However, Asians and Pacific Islanders and Hispanic whites are heterogeneous populations, and few studies have evaluated breast cancer stage, treatments, and mortality rates for subgroups of these populations.

Methods: Using data from 11 population-based tumor registries that participate in the Surveillance, Epidemiology, and End Results Program, we conducted a retrospective cohort study to evaluate the relationship between race and ethnicity and breast cancer stage, treatments, and mortality rates. The cohort of 124 934 women diagnosed as having a first primary invasive breast carcinoma between January 1, 1992, and December 31, 1998, included 97 999 non-Hispanic whites, 10 560 blacks, 322 American Indians, 8834 Asians and Pacific Islanders, and 7219 Hispanic whites.

Results: Relative to non-Hispanic whites, blacks, American Indians, Hawaiians, Indians and Pakistanis, Mexicans, South and Central Americans, and Puerto Ricans had 1.4- to 3.6-fold greater risks of presenting with stage IV breast cancer. Blacks, Mexicans, and Puerto Ricans were 20% to 50% more likely to receive or elect a first course of surgical and radiation treatment not meeting the 2000 National Comprehensive Cancer Network standards. In addition, blacks, American Indians, Hawaiians, Vietnamese, Mexicans, South and Central Americans, and Puerto Ricans had 20% to 200% greater risks of mortality after a breast cancer diagnosis.

Conclusions: Differences in breast cancer stage, treatments, and mortality rates are present by race and ethnicity. Breast cancer survival may be improved by targeting factors, particularly socioeconomic factors, that underlie these differences.

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BLACK,[1-7] HISPANIC white,[1,2,7-10] and American Indian[8,11] women seem more likely to be diagnosed as having advanced stages of breast cancer and to have poorer survival rates after diagnosis compared with non-Hispanic whites. Alternatively, Asian and Pacific Islander women, in the aggregate, have been observed not to differ from non-Hispanic whites with respect to breast cancer stage and survival rate.[1,2] However, several studies suggest that there may be variations in these factors across different ethnicities included in the category of Asians and Pacific Islanders. One study[1] of women living in the San Francisco Bay Area of California and 2 studies[12,13] of women living in Hawaii reported that Hawaiian and Filipino women are more likely to be diagnosed as having advanced stages of breast cancer and to have poorer survival rates after diagnosis compared with non-Hispanic whites. Two of these studies[12,13] also found that Japanese and Chinese women present with less advanced stages of breast cancer and have better survival rates than non-Hispanic whites. However, previous studies[1,2,7-10,12] evaluating the relationship between race and ethnicity and breast cancer stage and survival rates have been limited in their sample sizes, in their ability to evaluate subgroups of Asians and Pacific Islanders and Hispanic whites, or in their generalizability, as most studied women from limited geographic regions.

In addition, few studies have assessed how the types of treatment that patients with breast cancer receive differ by race and ethnicity. The 2000 National Comprehensive Cancer Network practice guidelines[14] and the 1990 National Institutes of Health Consensus Development Conference[15] state that either breast-conserving surgery (BCS) combined with radiotherapy or a total mastectomy constitutes appropriate primary care for most women with stage I or II breast cancer.

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However, radiotherapy after BCS has been underused,[16,17] and a recent study[18] found that the proportion of women receiving inappropriate primary breast cancer treatments is increasing in the United States. There is also evidence suggesting that treatment choices may vary by race and ethnicity. One study[19] of women diagnosed as having breast cancer between 1990 and 1995 found that nonwhite women were less likely to receive BCS compared with white women.

Using data from 11 population-based tumor registries that participate in the Surveillance, Epidemiology, and End Results (SEER) Program, we assessed the relationship between race and ethnicity, using 17 separate categories, and breast cancer stage, primary treatments, and mortality rates.

METHODS

Women diagnosed as having a first primary invasive breast cancer between January 1, 1992, and December 31, 1998, were identified through 11 population-based cancer registries in the United States that participate in the National Cancer Institute's SEER Program. We chose 1992 as the starting point for this analysis because in this year 2 registries were added to the SEER Program—those serving the urban areas surrounding Los Angeles and San Jose, Calif, both of which contain racially and ethnically diverse populations. The other SEER registries that were used include those serving the states of Connecticut, Hawaii, Iowa, New Mexico, and Utah and the urban areas surrounding Atlanta, Ga; Detroit, Mich; San Francisco–Oakland, Calif; and Seattle, Wash. Patient medical records are the principal sources of data used by the SEER registries. It is estimated that more than 95% of all incident cancer cases in the populations under surveillance are ascertained. Further operational details and methods used by the SEER Program are provided elsewhere.[20]

A total of 128 195 women whose invasive breast cancer diagnosis was their first primary cancer diagnosis of any type were eligible for this study. Women were excluded if their cancer was diagnosed at autopsy (n=35), if their race was classified as other (n=230) or unknown (n=853), and if their Hispanic ethnicity was classified as either "Spanish surname only" (meaning that the only evidence of a woman's Hispanic origin is her surname or maiden name) or unknown (n=2074). In addition, to make the race and ethnicity categories mutually exclusive, 53 black women, 1 American Indian woman, and 15 Asians and Pacific Islanders who were also categorized as being Hispanic were excluded, leaving a total of 124 934 participants.

The primary exposure of interest was race and ethnicity. Beginning in 1988, in addition to categorizing race and ethnicity as white, black, American Indian or Alaskan, Chinese, Japanese, Filipino, and Hawaiian, the SEER registries added categories for Koreans, Vietnamese, and Asian Indians and Pakistanis, among others. Of the 8834 Asians and Pacific Islanders included in the study, 258 were of less common Asian and Pacific Islander races, including Thai, Laotian, and Tongan, and 396 were classified as being other or not otherwise specified (NOS) Asians and Pacific Islanders. These 654 women were grouped together. In 1988, the SEER registries also added information about "Spanish surname or origin," specifically coding whether individuals were Mexican, Puerto Rican, Cuban, South or Central American (except Brazil), other specified Spanish or Hispanic origin (includes European), or Spanish or Hispanic NOS. We used these expanded categorizations in our analyses; however, because of the small number of Cubans (n=142), we merged them with the 3845 women of other or NOS Spanish or Hispanic origin.

Along with age at diagnosis and year of diagnosis, the SEER registries also provide information about the following tumor characteristics: American Joint Committee on Cancer stage, size, grade, number of positive lymph nodes, number of lymph nodes examined, estrogen receptor (ER) status, progesterone receptor (PR) status, and histologic type. Information on surgical and radiation treatments is available, but data on adjuvant chemotherapy and adjuvant hormonal therapy are not. Although information on marital status is provided, data regarding other sociodemographic factors, such as income and health insurance status, are not.

In addition to evaluating stage, we were also interested in assessing whether the primary surgical and radiation treatments given to women of different races and ethnicities with stage I and II breast carcinomas met the standards of care outlined by the 2000 National Comprehensive Cancer Network practice guidelines and the 1990 National Institutes of Health Consensus Development Conference using methods consistent with previous studies.[18,21] First, women were classified as having received BCS if according to the SEER registry they received a partial (less than total) mastectomy (which includes segmental mastectomy, lumpectomy, quadrectomy, tylectomy, wedge resection, nipple resection, excisional biopsy, or partial mastectomy, NOS). They were then classified as having received standard primary treatment if they received (1) BCS with axillary lymph node dissection and radiotherapy or (2) a total mastectomy (including simple, modified radical, radical, and extended radical mastectomies) with axillary lymph node dissection. Women were classified as receiving inappropriate primary care not meeting the standard of care if they underwent (1) a subcutaneous mastectomy, (2) BCS without radiotherapy, (3) BCS without axillary lymph node dissection, or (4) a total mastectomy without axillary lymph node dissection.[18] Although the 2000 National Comprehensive Cancer Network guidelines apply only to women with stage I and II carcinomas whose tumors are smaller than 2.0 cm, the study that affected this guideline was not published until August 1998.[22] This study reported that neoadjuvant chemotherapy is beneficial to women with stage I and II carcinomas with tumors measuring 2.0 to 5.0 cm. Before its publication, when most of our study took place, neoadjuvant chemotherapy was not thought to benefit and was infrequently used to treat women with early-stage tumors measuring 2.0 to 5.0 cm. However, neoadjuvant chemotherapy was and still is considered to be a more appropriate first course of treatment for women with stage II cancer whose tumors are 5.0 cm or larger. This is important when assessing surgical treatment because the type of surgery recommended after chemotherapy depends on a patient's chemotherapeutic response. For these reasons, we chose to limit treatment analysis to women with tumors smaller than 5.0 cm.

Using statistical software (Stata 6.0 for Windows; Stata Corp, College Station, Tex), polytomous logistic regression was performed to compute odds ratios and 95% confidence intervals (CIs)[23] and to evaluate the effects of confounding and modifying factors on the association between race and ethnicity and American Joint Committee on Cancer stage. In this model, the baseline category used was stage I. The association between race and ethnicity and the appropriateness of the primary treatment given to women with stage I and II breast cancer was assessed using unconditional logistic regression. In addition to adjusting all analyses for age at diagnosis, year of diagnosis, and SEER registry, we adjusted the appropriateness of treatment analysis for American Joint Committee on Cancer stage. In both of these analyses, non-Hispanic whites served as the reference group, as this group represented more than 85% of the total study population.

Follow-up information (survival) is ascertained annually by each registry through a variety of data sources, including hospital cancer registries and discharge data sets, the Department of Motor Vehicles registration files, regional records of the Health Care Financing Administration, death records, vot-

Table 1. Comparison of Various Characteristics Among 124 934 Women With Breast Cancer of Different Races and Ethnicities

Characteristic	Race, No. (%)				
	Non-Hispanic White (n = 97 999)	Black (n = 10 560)	American Indian (n = 322)	Asian or Pacific Islander (n = 8834)	Hispanic White (n = 7219)
Demographics					
Age at diagnosis, y					
<30	420 (0.4)	142 (1.3)	4 (1.2)	74 (0.8)	129 (1.8)
30-39	4850 (5.0)	1046 (9.9)	33 (10.3)	763 (8.6)	823 (11.4)
40-49	16 751 (17.1)	2457 (23.3)	82 (25.5)	2247 (25.4)	1796 (24.9)
50-59	20 566 (21.0)	2391 (22.6)	102 (31.7)	2145 (24.3)	1628 (22.6)
60-69	21 874 (22.3)	2120 (20.1)	53 (16.5)	1891 (21.4)	1483 (20.5)
70-79	21 871 (22.3)	1664 (15.8)	37 (11.5)	1324 (15.0)	971 (13.5)
≥80	11 667 (11.9)	740 (7.0)	11 (3.4)	390 (4.4)	389 (5.4)
Mean ± SD	62 ± 14	57 ± 15	54 ± 13	57 ± 13	56 ± 14
Diagnosis year					
1992	13 487 (13.8)	1441 (13.7)	57 (17.7)	1051 (11.9)	1149 (15.9)
1993	13 479 (13.8)	1410 (13.4)	46 (14.3)	1063 (12.0)	1052 (14.6)
1994	13 615 (13.9)	1477 (14.0)	41 (12.7)	1073 (12.2)	927 (12.8)
1995	13 913 (14.2)	1509 (14.3)	34 (10.6)	1236 (14.0)	990 (13.7)
1996	14 060 (14.4)	1542 (14.6)	59 (18.3)	1333 (15.1)	992 (13.7)
1997	14 831 (15.1)	1601 (15.2)	45 (14.0)	1535 (17.4)	1001 (13.9)
1998	14 614 (14.9)	1580 (15.0)	40 (12.4)	1543 (17.5)	1108 (15.4)
Follow-up, mo					
<6	11 492 (11.7)	1422 (13.5)	30 (9.3)	1104 (12.5)	873 (12.1)
7-12	8830 (9.0)	1131 (10.7)	30 (9.3)	867 (9.8)	693 (9.6)
13-36	32 752 (33.4)	3769 (35.7)	129 (40.1)	3138 (35.5)	2339 (32.4)
37-83	44 925 (45.8)	4238 (40.1)	133 (41.3)	3725 (42.2)	3314 (45.9)
Mean ± SD	36 ± 24	33 ± 23	36 ± 24	34 ± 23	36 ± 24
Registry					
Atlanta, Ga	5314 (5.4)	1890 (17.9)	12 (3.7)	66 (0.8)	48 (0.7)
Connecticut	12 569 (12.8)	717 (6.8)	3 (0.9)	58 (0.7)	262 (3.6)
Detroit, Mich	12 047 (12.3)	3040 (28.8)	7 (2.2)	113 (1.3)	52 (0.7)
Hawaii	1218 (1.2)	29 (0.3)	11 (3.4)	2871 (32.5)	9 (0.1)
Iowa	11 548 (11.8)	135 (1.3)	5 (1.6)	32 (0.4)	30 (0.4)
Los Angeles, Calif	17 164 (17.5)	2960 (28.0)	13 (4.0)	2562 (29.0)	3787 (52.5)
New Mexico	3610 (3.7)	64 (0.6)	166 (51.6)	35 (0.4)	1276 (17.7)
San Francisco–Oakland, Calif	11 066 (11.3)	1246 (11.8)	13 (4.0)	1746 (19.8)	838 (11.6)
San Jose, Calif	5531 (5.6)	142 (1.3)	5 (1.6)	777 (8.8)	667 (9.2)
Seattle, Wash	13 280 (13.6)	327 (3.1)	80 (24.8)	517 (5.9)	104 (1.4)
Utah	4652 (4.8)	10 (0.1)	7 (2.2)	57 (0.7)	146 (2.0)

(continued)

ers' registration records, and the Social Security Death Index. In addition to vital status, the SEER registries also provide survival time for each patient, calculated in months using the date of diagnosis and whichever of the following occurred first: (1) date of death, (2) date last known to be alive, or (3) December 31, 1998 (the follow-up cutoff date used in our analysis).

Associations between race and ethnicity and mortality rates were estimated using the Cox proportional hazards regression model.[24] Using Stata 6.0 for Windows, Cox regression analysis was performed to compute hazard ratios and 95% CIs and to evaluate the effects of confounding and modifying factors. We used 2 models to assess survival, one adjusting for age and SEER registry and the second accounting for other potential confounders, specifically American Joint Committee on Cancer stage, ER status, PR status, and whether surgical and/or radiation breast cancer therapy was used.

RESULTS

A comparison of various characteristics by race and ethnicity is given in **Table 1**. Non-Hispanic white women tended to have later diagnosis ages compared with women of other races and ethnicities, and they had the oldest mean age at diagnosis. With respect to geographic location, black women most frequently came from the Atlanta, Detroit, and Los Angeles registries; American Indians from New Mexico and Seattle; Asian Americans and Pacific Islanders from Hawaii, Los Angeles, and San Francisco–Oakland; and Hispanic whites from Los Angeles and New Mexico. Blacks, Hispanic whites, and American Indians were somewhat more likely to present with tumors that were larger, and they had higher grades, had more positive lymph nodes, were ER negative, and were PR negative compared with non-Hispanic whites and Asians and Pacific Islanders. Compared with the other racial and ethnic groups, non-Hispanic whites were more likely to have breast tumors with lobular histologic features. With respect to breast cancer treatments, blacks, American Indians, and Hispanic whites were somewhat more likely to have surgery not recommended or to refuse surgery and less likely to be treated with radiation than were non-Hispanic whites.

Compared with non-Hispanic whites, blacks, American Indians, and Hispanic whites had 1.7- to 2.5-fold el-

Table 1. Comparison of Various Characteristics Among 124 934 Women With Breast Cancer of Different Races and Ethnicities* (cont)

Characteristic	Race, No. (%)				
	Non-Hispanic White (n = 97 999)	Black (n = 10 560)	American Indian (n = 322)	Asian or Pacific Islander (n = 8834)	Hispanic White (n = 7219)
Tumor Characteristics					
Size, cm					
<2.0	54 187 (55.3)	4200 (39.8)	149 (46.3)	4519 (51.2)	2847 (39.4)
2.0-4.9	32 797 (33.5)	4297 (40.7)	125 (38.8)	3212 (36.4)	3087 (42.8)
≥5.0	7804 (8.0)	1583 (15.0)	37 (11.5)	886 (10.0)	1003 (13.9)
Unknown	3211 (3.3)	480 (4.6)	11 (3.4)	217 (2.5)	282 (3.9)
Grade					
1	13 856 (14.1)	864 (8.2)	26 (8.1)	1051 (11.9)	691 (9.6)
2	34 076 (34.8)	2686 (25.4)	111 (34.5)	3106 (35.2)	2199 (30.5)
3	28 812 (29.4)	4303 (40.8)	106 (32.9)	2949 (33.4)	2725 (37.8)
4	2669 (2.7)	255 (2.4)	15 (4.7)	229 (2.6)	206 (2.9)
Unknown	18 586 (19.0)	2452 (23.2)	64 (19.9)	1499 (17.0)	1398 (19.4)
Positive lymph nodes, No.					
0	52 795 (53.9)	4497 (42.6)	137 (42.6)	4982 (56.4)	3373 (46.7)
1	9163 (9.4)	1091 (10.3)	36 (11.2)	794 (9.0)	702 (9.7)
2-4	9613 (9.8)	1230 (11.7)	43 (13.4)	937 (10.6)	880 (12.2)
≥5	8557 (8.7)	1221 (11.6)	42 (13.0)	863 (9.8)	912 (12.6)
None examined	17 331 (17.7)	2394 (22.7)	61 (18.9)	1191 (13.5)	1274 (17.7)
Unknown	540 (0.5)	127 (1.2)	3 (0.9)	67 (0.8)	78 (1.1)
ER status*					
Positive	62 038 (78.0)	4620 (60.8)	186 (67.6)	5434 (74.5)	3562 (68.7)
Negative	17 491 (22.0)	2980 (39.2)	89 (32.4)	1859 (25.5)	1621 (31.3)
PR status†					
Positive	52 472 (68.3)	3917 (53.4)	160 (59.5)	4825 (67.8)	3067 (60.8)
Negative	24 365 (31.7)	3415 (46.6)	109 (40.5)	2294 (32.2)	1979 (39.2)
Histologic type					
Ductal	69 945 (71.4)	7577 (71.8)	240 (74.5)	6737 (76.3)	5057 (70.1)
Lobular	8534 (8.7)	556 (5.3)	14 (4.4)	363 (4.1)	435 (6.0)
Other or unknown	19 520 (19.9)	2427 (22.9)	68 (21.1)	1734 (19.6)	1727 (23.9)
Treatments					
Surgical treatment‡					
Surgery performed	94 870 (97.6)	9839 (94.3)	304 (96.5)	8561 (97.6)	6876 (96.9)
Not recommended	2010 (2.1)	499 (4.8)	9 (2.9)	174 (2.0)	191 (2.7)
Refused surgery	352 (0.4)	97 (0.9)	2 (0.6)	35 (0.4)	32 (0.5)
Radiation therapy§					
None	52 884 (54.9)	5996 (58.7)	180 (57.5)	4929 (57.0)	4151 (59.0)
Treated with radiation	42 737 (44.4)	4120 (40.3)	130 (41.5)	3676 (42.5)	2835 (40.3)
Refused radiation	730 (0.8)	104 (1.0)	3 (1.0)	41 (0.5)	53 (0.8)

Abbreviations: ER, estrogen receptor; PR, progesterone receptor.

*ER status was unknown or missing for 18 470 non-Hispanic whites (18.9%), 2960 blacks (28.1%), 47 American Indians (14.6%), 1541 Asians and Pacific Islanders (17.4%), and 2036 Hispanic whites (28.2%).

†PR status was unknown or missing for 21 162 non-Hispanic whites (21.6%), 3228 blacks (30.5%), 53 American Indians (16.4%), 1715 Asians and Pacific Islanders (19.4%), and 2173 Hispanic whites (30.1%).

‡Data on surgical treatment were unknown or missing for 767 non-Hispanic whites (0.8%), 125 blacks (1.2%), 7 American Indians (2.2%), 64 Asians and Pacific Islanders (0.7%), and 120 Hispanic whites (1.7%).

§Data on radiation therapy were unknown or missing for 1648 non-Hispanic whites (1.7%), 340 blacks (3.2%), 9 American Indians (2.8%), 188 Asians and Pacific Islanders (2.1%), and 180 Hispanic whites (2.5%).

evations in risk of stage III and stage IV tumors, adjusted for age at diagnosis, year of diagnosis, and SEER registry (**Table 2**). Although, overall, Asian Americans and Pacific Islanders seemed no different than non-Hispanic whites, subgroup differences were observed. Specifically, 40% and 30% reductions in the risks of stage III and stage IV tumors, respectively, were observed among Japanese women. Alternatively, elevations in risk of stage III or stage IV tumors were seen among Filipinos, Hawaiians, Indians and Pakistanis, and other and NOS Asians and Pacific Islanders. The overall elevations in risk of advanced tumor stage observed among Hispanic whites overall were also observed in varying magnitudes among Mexicans, South and Central Americans, Puerto Ricans, and other and NOS Hispanic whites.

Among women with stage I or II breast cancer with tumors smaller than 5.0 cm, blacks, other Asians and Pacific Islanders, Mexicans, and Puerto Ricans were 20% to 50% more likely than non-Hispanic whites to receive inappropriate primary surgical and radiation breast cancer treatment (**Table 3**). Overall, Asians and Pacific Islanders were 20% less likely to receive inappropriate therapy, although this reduction seemed to be confined to Japanese, Filipino, Korean, and Vietnamese women.

Compared with non-Hispanic whites, blacks, American Indians, and Hispanic whites had 1.3- to 2.0-fold

Table 2. Risk of Breast Cancer by AJCC Stage Among 124 934 Women With Breast Cancer of Different Races and Ethnicities

	AJCC Stage						
	I	II		III		IV	
Race and Ethnicity	No. (%)	No. (%)	OR* (95% CI)	No. (%)	OR* (95% CI)	No. (%)	OR* (95% CI)
Non-Hispanic white	49 424 (50.4)	37 521 (38.3)	1.0 (Referent)	6653 (6.8)	1.0 (Referent)	4401 (4.5)	1.0 (Referent)
Black	3736 (35.4)	4822 (45.7)	1.5† (1.5-1.6)	1164 (11.0)	2.3† (2.1-2.4)	838 (7.9)	2.5† (2.3-2.7)
American Indian	132 (41.0)	133 (41.3)	1.3 (1.0-1.6)	35 (10.9)	1.7† (1.2-2.5)	22 (6.8)	2.0† (1.3-3.2)
Asian and Pacific Islander	**4176** (47.3)	**3714** (42.0)	1.2† (1.1-1.2)	**591** (6.7)	1.1 (1.0-1.2)	**353** (4.0)	1.1 (0.9-1.2)
Japanese	1404 (58.0)	832 (34.4)	0.8† (0.8-0.9)	105 (4.3)	0.6† (0.5-0.7)	79 (3.3)	0.7† (0.5-0.9)
Filipino	893 (42.0)	969 (45.6)	1.3† (1.2-1.4)	179 (8.4)	1.5† (1.2-1.7)	84 (4.0)	1.2 (0.9-1.5)
Chinese	872 (47.1)	802 (43.3)	1.1† (1.0-1.2)	104 (5.6)	0.9 (0.8-1.2)	74 (4.0)	1.1 (0.8-1.4)
Hawaiian	319 (46.3)	282 (40.9)	1.3† (1.1-1.5)	53 (7.7)	1.3 (1.0-1.9)	35 (5.1)	1.4† (1.0-2.1)
Korean	181 (43.0)	196 (46.6)	1.2† (1.0-1.5)	30 (7.1)	1.1 (0.7-1.6)	14 (3.3)	0.9 (0.5-1.6)
Vietnamese	149 (38.5)	194 (50.1)	1.4† (1.1-1.7)	32 (8.3)	1.5 (1.0-2.1)	12 (3.1)	1.0 (0.6-1.8)
Indian and Pakistani	107 (34.3)	158 (50.6)	1.6† (1.3-2.1)	27 (8.7)	1.9† (1.2-2.8)	20 (6.4)	2.3† (1.4-3.7)
Other and NOS Asian and Pacific Islander	251 (40.0)	281 (44.8)	1.3† (1.1-1.6)	61 (9.7)	1.6† (1.2-2.2)	35 (5.6)	1.7† (1.2-2.5)
Hispanic white	**2601** (36.0)	**3511** (48.6)	1.5† (1.5-1.7)	**692** (9.6)	1.9† (1.7-2.1)	**415** (5.8)	1.8† (1.6-2.0)
Mexican	638 (29.5)	1131 (52.2)	1.9† (1.7-2.1)	246 (11.4)	2.7† (2.3-3.1)	150 (6.9)	2.7† (2.3-3.3)
South and Central American	319 (36.4)	426 (48.6)	1.5† (1.3-1.7)	85 (9.7)	1.8† (1.4-2.2)	46 (5.3)	1.6† (1.2-2.3)
Puerto Rican	59 (30.9)	102 (53.4)	2.0† (1.4-2.8)	10 (5.2)	1.3 (0.7-2.6)	20 (10.5)	3.6† (2.1-6.0)
Other and NOS Hispanic white	1585 (39.8)	1852 (46.5)	1.4† (1.3-1.5)	351 (8.8)	1.6† (1.5-1.9)	199 (5.0)	1.4† (1.2-1.6)

Abbreviations: AJCC, American Joint Committee on Cancer; CI, confidence interval; NOS, not otherwise specified; OR, odds ratio; and SEER, Surveillance, Epidemiology, and End Results.

*All ORs are adjusted for age at diagnosis, year of diagnosis, and SEER registry using polytomous logistic regression. Non-Hispanic whites served as the reference race and ethnicity, and stage I served as the baseline AJCC stage.

†$P<.05$.

Table 3. Appropriateness of Treatment for Stage I and II Breast Cancer Cases With Tumors Smaller Than 5.0 cm by Race and Ethnicity

	Patients, No. (%)		
Race and Ethnicity	Standard Treatment	Inappropriate Treatment	OR* (95% CI)
Non-Hispanic white	54 981 (79.3)	14 319 (20.7)	1.0 (Referent)
Black	4975 (77.1)	1477 (22.9)	1.4† (1.3-1.4)
American Indian	189 (86.3)	30 (13.7)	1.0 (0.7-1.5)
Asian and Pacific Islander	**5083** (84.6)	**929** (15.5)	0.8† (0.8-0.9)
Japanese	1450 (83.4)	288 (16.6)	0.7† (0.6-0.8)
Filipino	1231 (87.2)	180 (12.8)	0.7† (0.6-0.9)
Chinese	1055 (82.6)	222 (17.4)	1.0 (0.9-1.2)
Hawaiian	383 (84.2)	72 (15.8)	0.9 (0.6-1.1)
Korean	252 (88.7)	32 (11.3)	0.7† (0.5-1.0)
Vietnamese	235 (90.4)	25 (9.6)	0.6† (0.4-1.0)
Indian and Pakistani	160 (82.9)	33 (17.1)	1.2 (0.8-1.8)
Other and NOS Asian and Pacific Islander	317 (80.5)	77 (19.5)	1.3† (1.0-1.7)
Hispanic white	**3830 (82.3)**	**826** (17.7)	1.0 (1.0-1.1)
Mexican	1037 (81.0)	243 (19.0)	1.2† (1.1-1.4)
South and Central American	457 (81.9)	101 (18.1)	1.0 (0.8-1.3)
Puerto Rican	90 (69.8)	39 (30.2)	1.5† (1.0-2.3)
Other and NOS Hispanic white	2246 (83.5)	443 (16.5)	0.9 (0.8-1.0)

Abbreviations: CI, confidence interval; NOS, not otherwise specified; and OR, odds ratio.

*All ORs are adjusted for age at diagnosis, year of diagnosis, American Joint Committee on Cancer stage, and Surveillance, Epidemiology, and End Results registry using unconditional logistic regression. Non-Hispanic whites served as the reference race and ethnicity, and appropriate treatment served as the baseline treatment group.

†$P<.05$.

greater risks of mortality, whereas Asians and Pacific Islanders had the same risk of mortality, adjusting for age and SEER registry (**Table 4**). However, mortality rates differed among Asian and Pacific Islander subgroups, with Japanese women having better survival rates and Hawaiians, Vietnamese, and other and NOS Asians and Pacific Islanders having poorer survival rates than non-Hispanic whites. Among Hispanic whites, 1.2- to 1.7-fold increases in risk of mortality were observed among Mexicans, South and Central Americans, and Puerto Ricans. Although somewhat attenuated, elevations in risk of mortality were observed among black, American In-

Table 4. Risk of Mortality After Breast Cancer by Race and Ethnicity

Race and Ethnicity	Patients at Risk, No.	Events, No.	HR* (95% CI)	
			Adjusted for Age and SEER Registry Only	Adjusted for Age, SEER Registry, Stage, ER Status, PR Status, Surgical Treatment, and Radiation Therapy
Non-Hispanic white	95 619	14 089	1.0 (Referent)	1.0 (Referent)
Black	10 102	2393	2.0† (1.9-2.1)	1.5† (1.4-1.6)
American Indian	306	69	2.0† (1.6-2.6)	1.7† (1.3-2.3)
Asian and Pacific Islander	**8586**	**865**	0.9 (0.9-1.0)	0.9† (0.8-1.0)
Japanese	2363	187	0.6† (0.5-0.7)	0.6† (0.5-0.8)
Filipino	2067	227	1.0 (0.9-1.2)	0.9 (0.8-1.1)
Chinese	1801	177	0.9 (0.8-1.0)	0.8† (0.7-1.0)
Hawaiian	667	88	1.3† (1.0-1.7)	1.3† (1.0-1.7)
Korean	408	34	1.0 (0.7-1.4)	1.1 (0.8-1.5)
Vietnamese	372	45	1.3† (1.0-1.8)	1.1 (0.7-1.5)
Indian and Pakistani	301	34	1.2 (0.8-1.6)	0.8 (0.6-1.5)
Other and NOS Asian and Pacific Islander	607	73	1.4† (1.1-1.7)	1.2 (0.9-1.5)
Hispanic white	**6922**	**1117**	1.3† (1.2-1.4)	1.1† (1.0-1.1)
Mexican	2058	359	1.7† (1.5-1.9)	1.3† (1.2-1.6)
South and Central American	842	112	1.2† (1.0-1.5)	1.1 (0.8-1.3)
Puerto Rican	186	41	1.6† (1.2-2.2)	1.2 (0.8-1.8)
Other and NOS Hispanic white	3836	605	1.2 (1.1-1.3)	1.0 (0.9-1.1)

Abbreviations: CI, confidence interval; ER, estrogen receptor; HR, hazard ratio; NOS, not otherwise specified; PR, progesterone receptor; and SEER, Surveillance, Epidemiology, and End Results.

*All HRs were estimated using Cox regression. Non-Hispanic whites served as the reference race and ethnicity.

†$P<.05$.

dian, Hawaiian, and Mexican women, and decreases in risk were observed among Japanese and Chinese women even after adjusting for stage, ER status, PR status, surgical treatment, and radiation therapy in addition to diagnosis age and SEER registry.

COMMENT

Previous studies have shown that blacks,[1-7] American Indians,[8,11] and Hispanic whites[1,2,7-10] present with more advanced stages of breast cancer and have poorer survival rates after diagnosis than non-Hispanic whites. With respect to Asians and Pacific Islanders, it has also been shown that Japanese and Chinese women have better survival and that Hawaiians have worse survival relative to non-Hispanic whites.[12,13] Our findings expand on these studies because we evaluated risk among women of different racial and ethnic subgroups and assessed all races and ethnicities in a large multisite population-based setting. We confirmed the findings described previously and demonstrated that these differences in stage and survival rates have persisted through 1998 in the United States.

Our study also builds on previous work that used SEER Program data, including a study[6] evaluating breast cancer stage and survival rates by race between 1973 and 1991. This study also found that black women had poorer breast cancer outcomes, but it was unable to evaluate other races and ethnicities specifically. Herein, we provide some of the first evidence that Indians and Pakistanis, Mexicans, South and Central Americans, and Puerto Ricans are more likely to present with advanced stages of breast cancer. In addition, with regard to survival, we documented that blacks, American Indians, Hawaiians, Mexicans, South and Central Americans, and Puerto Ricans have greater risks of mortality compared with non-Hispanic whites and that for blacks, American Indians, Hawaiians, and Mexicans, these mortality differences persist even after adjusting for stage, ER status, PR status, and primary breast cancer treatments received.

Another strength of this study is that we evaluated how primary treatments administered to patients with breast cancer differ by race and ethnicity. Current National Comprehensive Cancer Network practice guidelines for breast cancer state that either breast-conserving therapy (or partial mastectomy) or total mastectomy is recommended for most women with stage I or II breast carcinoma. Although most women receive care meeting this standard and the proportion of women with breast cancer undergoing breast conservation is increasing, the proportion of women receiving inappropriate care is rising in the United States.[18] Although few studies have reported on differences in treatment by race and ethnicity, differences seem to exist, as nonwhites are less likely than whites to receive breast-conserving therapy.[19] Our results regarding breast cancer treatments are noteworthy because they demonstrate that although certain racial and ethnic groups were less likely to receive the standard of care, including blacks, Mexicans, and Puerto Ricans, certain Asian and Pacific Islander subgroups were more likely to receive such care. These treatment differences may be due to a combination of factors. Treatment decisions may relate to socioeconomic factors, patient-physician interactions, or knowledge. It is the responsibility of physicians to counsel patients with breast cancer on their treatment options, but racial and ethnic barriers may inhibit these conversations from being thoroughly completed.

A potential limitation of this study is that our exposure of interest, race and ethnicity, was determined via medical record reviews. However, information on race

was classified as other or unknown, and ethnicity was classified as "Spanish surname only" or unknown whether Spanish or Hispanic or not, for only 3157 women, representing 2.5% of the eligible study population. With respect to Asians and Pacific Islanders, only 396 women, representing 4.5% of this population, were classified as being of an NOS Asian or Pacific Islander race. However, an inability to categorize Hispanic whites into subgroups was more of an important problem, as 3845 women, representing 53.3% of this population, were classified as being of an other or NOS Spanish or Hispanic origin. This inability to categorize most Hispanic whites into particular subgroups could bias our results with respect to these subgroups either toward or away from the null. However, in general, our findings with respect to other and NOS Hispanic whites were similar in magnitude and direction to those of Hispanic whites overall and to the specified Hispanic subgroups, suggesting that the importance of this bias may be limited.

Another limitation of this study is that the SEER Program only collects information on treatments started or planned to start within 4 months of initial treatment. Because some women receive chemotherapy before irradiation, it is possible that information about irradiation may be missed for these women. However, during the study, the recommendation of neoadjuvant chemotherapy was typically reserved for women with tumors that were 5.0 cm or larger or who presented at an advanced stage,[14] and these women were excluded from our treatment analysis. Also, the radiation therapy information provided by the SEER registries has been shown to be greater than 90% accurate.[25,26]

With respect to our evaluation of mortality rates, a potentially more important problem is that data on adjuvant therapies, specifically chemotherapy and hormonal therapy, were not available. Both treatments should be recommended to most women with breast cancer per the 2000 National Institutes of Health Consensus Development Panel, as both have been shown to improve survival rates.[27] Thus, it is possible that differences in the administration of these treatments by race and ethnicity could explain the differences in survival rates that we observed. Further studies are required to investigate this issue, but our data highlight that survival differences are present even after adjusting for numerous potential confounders. If the differences that persist after this adjustment are in fact due to differences in patterns of chemotherapy and hormonal therapy use, then improving the regimens given to women of certain racial and ethnic groups may prove to be an important means of improving survival rates in these populations.

In interpreting the results of this study it is also important to acknowledge that an additional limitation was our lack of information regarding other factors that may be associated with breast cancer stage, treatments, and mortality rates. Specifically, data on socioeconomic status, access to health care, family history of breast cancer, use of mammography, and hormonal and reproductive factors were unavailable. With respect to mortality rates, the end point we evaluated was death from any cause, so different distributions of other comorbidities by race and ethnicity could have contributed to the mortality rate differences we observed. However, although differences in these factors have been suggested as possible explanations for differences in breast cancer stage and survival rates by race and ethnicity, the results of studies addressing these issues are mixed. With respect to blacks, some studies[28,29] have shown that differences in insurance coverage and socioeconomic status do not explain the observed differences in stage, and others[30-33] have found that after adjusting for factors such as socioeconomic status, income, stage, and breast cancer treatments, differences in survival rates are no longer observed. Despite these conflicting results, the differences we observed in stage, treatments, and survival rates by race and ethnicity are likely due to a combination of socioeconomic and lifestyle, rather than to biologic, factors. A recent study[33] offers compelling evidence that being black is not associated with unfavorable breast cancer outcomes when socioeconomic status is adjusted for and that a low socioeconomic status, not race, is associated with last-stage breast cancer, types of treatment received, and mortality rates. Studies similar to this one, which strongly suggests that socioeconomic, not biologic, differences explain disparities in breast cancer outcomes by race and ethnicity, need to be conducted that include women of other racial and ethnic groups so that the types of socioeconomic differences that explain these disparities can be identified. It is hoped that such studies will point to the types of interventions that are needed to improve breast cancer outcomes among poor women of different racial and ethnic backgrounds.

Other explanations for the poorer survival rates and the more advanced stages of breast cancer that women of particular racial and ethnic groups experience compared with non-Hispanic whites have been proposed, including differences in mammography use, obesity, and tumor marker expression. A recent study[34] found that the black-white difference in cancer stage is present among nonusers of mammography (odds ratio, 2.54; 95% CI, 1.37-4.71) but not among regular mammography users (odds ratio, 1.34; 95% CI, 0.40-4.51). The authors estimated that 12% of the excess late-stage disease among black women is owing to the underuse of mammography, adjusting for socioeconomic status and other comorbidities. In addition, differences in patterns of mammography use by race and ethnicity could partly explain our results with respect to treatments received, as the availability of mammographic data before surgery can affect the choice and adequacy of surgery. With respect to obesity, one study[35] found that adjusting for obesity attenuated the risk of more advanced breast cancer stage in blacks relative to whites by 32% from an odds ratio of 1.98 (95% CI, 1.22-3.19) to 1.66 (95% CI, 1.01-2.73). Differences in tumor marker expression could also explain these findings, as black and Hispanic white women are more likely to have tumors that are hormone receptor negative and to have higher S-phase fractions, both of which are relatively poor prognostic markers.[7] Black women are also more likely to have tumors that are grade III and to have high-grade nuclear atypia, high mitotic activity, and more necrosis.[36] One study[37] that considered several of the potentially modifying factors of the relationship between race and stage discussed previ-

ously, including access to health care, use of mammography, body mass index, and tumor marker expression, found that no single factor or group of factors explained the race-stage difference noted between blacks and whites by more than 50%. However, others[38] have shown that this difference no longer persists when breast cancer stage is adjusted for income, age, and marital status. Thus, the differences in stage and survival rates by race and ethnicity observed in this study are likely to be the result of numerous factors.

In summary, a combination of socioeconomic and lifestyle factors, and possibly tumor characteristics, are likely to contribute to the differences in stage at breast cancer presentation and survival rates by race and ethnicity. However, the differences in treatments received that we observed by race and ethnicity are likely to be solely the result of socioeconomic and cultural factors. Understanding these differences is of public health importance as increasing the availability of screening programs targeting women of certain racial or ethnic groups, particularly those with a low socioeconomic status, and improving the treatment regimens that those who develop cancer receive, may be valuable means of improving early breast cancer detection rates and improving survival rates in these populations.

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REFERENCES

1. Hsu JL, Glaser SL, West DW. Racial/ethnic differences in breast cancer survival among San Francisco Bay Area women. *J Natl Cancer Inst.* 1997;89:1311-1312.
2. Boyer-Chammard A, Taylor TH, Anton-Culver H. Survival differences in breast cancer among racial/ethnic groups: a population-based study. *Cancer Detect Prev.* 1999;23:463-473.
3. Chevarley F, White E. Recent trends in breast cancer mortality among white and black US women. *Am J Public Health.* 1997;87:775-781.
4. Joslyn SA, West MM. Racial differences in breast carcinoma survival. *Cancer.* 2000;88:114-123.
5. Elmore JG, Moceri VM, Carter D, Larson EB. Breast carcinoma tumor characteristics in black and white women. *Cancer.* 1998;83:2509-2515.
6. Edwards MJ, Gamel JW, Vaughan WP, Wrightson WR. Infiltrating ductal carcinoma of the breast: the survival impact of race. *J Clin Oncol.* 1998;16:2693-2699.
7. Elledge RM, Clark GM, Chamness GC, Osborne CK. Tumor biologic factors and breast cancer prognosis among white, Hispanic, and black women in the United States. *J Natl Cancer Inst.* 1994;86:705-712.
8. Frost F, Tollestrup K, Hunt WC, Gilliland F, Key CR, Urbina CE. Breast cancer survival among New Mexico Hispanic, American Indian, and non-Hispanic white women (1973-1992). *Cancer Epidemiol Biomarkers Prev.* 1996;4:861-866.
9. Zaloznik AJ. Breast cancer stage at diagnosis: caucasians versus Hispanics. *Breast Cancer Res Treat.* 1997;42:121-124.
10. Bentley JR, Delfino RJ, Taylor TH, Howe S, Anton-Culver H. Differences in breast cancer stage at diagnosis between non-Hispanic white and Hispanic populations, San Diego County 1988-1993. *Breast Cancer Res Treat.* 1998;50:1-9.
11. Sugarman JR, Dennis LK, White E. Cancer survival among American Indians in western Washington state (United States). *Cancer Causes Control.* 1994;5:440-448.
12. Meng L, Maskarinec G, Wilkens L. Ethnic differences and factors related to breast cancer survival in Hawaii. *Int J Epidemiol.* 1997;26:1151-1158.
13. Meng L, Maskarinec G, Lee J. Ethnicity and conditional breast cancer survival in Hawaii. *J Clin Epidemiol.* 1997;50:1289-1296.
14. Carlson RW, Anderson BO, Bensinger W, et al. NCCN practice guidelines for breast cancer. *Oncology.* 2000;14:33-49.
15. Treatment of early-stage breast cancer. *NIH Consens Statement.* 1990;8:1-19.
16. Farrow DC, Hunt WC, Samet JM. Geographic variation in the treatment of localized breast cancer. *N Engl J Med.* 1992;326:1097-1101.
17. Lazovich DA, White E, Thomas DB, Moe RE. Underutilization of breast-conserving surgery and radiation therapy among women with stage I or II breast cancer. *JAMA.* 1991;266:3433-3438.
18. Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Relation between appropriateness of primary therapy for early-stage breast carcinoma and increased use of breast-conserving surgery. *Lancet.* 2000;356:1148-1153.
19. Lazovich D, Solomon CC, Thomas DB, Moe RE, White E. Breast conservation therapy in the United States following the 1990 National Institutes of Health Consensus Development Conference on the treatment of patients with early stage invasive breast carcinoma. *Cancer.* 1999;86:628-637.
20. Young JL Jr, Percy C, Asire AJ, et al. Surveillance, Epidemiology, and End Results: incidence and mortality, 1973-77. *Natl Cancer Inst Monogr.* 1981;57:1-1082.
21. Ballard-Barbash R, Potosky AL, Harlan LC, Nayfield SG, Kessler LG. Factors associated with surgical radiation therapy for early stage breast cancer in older women. *J Natl Cancer Inst.* 1996;88:716-726.
22. Fisher B, Bryant J, Wolmark N, et al. Effect of preoperative chemotherapy on the outcome of women with operable breast cancer. *J Clin Oncol.* 1998;16:2672-2685.
23. Breslow NE, Day NE. *The Analysis of Case-Control Studies.* Lyon, France: International Agency for Research on Cancer; 1980.
24. Cox DR. Regression models and life tables (with discussion). *J R Stat Soc B.* 1972;34:187-220.
25. Mann BA, Samet JM, Hunt WC, Key CR, Goodwin JM, Goodwin JS. Changing treatment of breast cancer in New Mexico from 1969 to 1985. *JAMA.* 1988;259:3413-3417.
26. Du X, Freeman JL, Goodwin JS. Information on radiation treatment in patients with breast cancer: the advantages of the linked Medicare and SEER data. *J Clin Epidemiol.* 1999;52:463-470.
27. Eifel P, Axelson JA, Costa J. National Institutes of Health Consensus Development Conference Statement: adjuvant therapy for breast cancer, November 1-3, 2000. *J Natl Cancer Inst.* 2001;93:979-989.
28. Roetzheim RG, Pal N, Tennant C, et al. Effects of health insurance and race on early detection of cancer. *J Natl Cancer Inst.* 1999;91:1409-1415.
29. Lannin DR, Matthews HF, Mitchell J, Swanson MS, Swanson FH, Edwards MS. Influence of socioeconomic and cultural factors on racial differences in late-stage presentation of breast cancer. *JAMA.* 1998;279:1801-1807.
30. Yood MU, Johnson CC, Blount A, et al. Race and differences in breast cancer survival in a managed care population. *J Natl Cancer Inst.* 1999;91:1487-1491.
31. Perkins P, Cooksley CD, Cox JD. Breast cancer: is ethnicity an independent prognostic factor for survival? *Cancer.* 1996;78:1241-1247.
32. Ansell D, Whitman S, Lipton R, Cooper R. Race, income, and survival from breast cancer at two public hospitals. *Cancer.* 1993;72:2974-2978.
33. Bradley CJ, Given CW, Roberts C. Race, socioeconomic status, and breast cancer treatment and survival. *J Natl Cancer Inst.* 2002;94:490-496.
34. McCarthy EP, Burns RB, Coughlin SS, et al. Mammography use helps to explain differences in breast cancer stage at diagnosis between older black and white women. *Ann Intern Med.* 1998;128:729-736.
35. Jones BA, Kasl SV, Curnen MGM, Owens PH, Dubrow R. Severe obesity as an explanatory factor for the black/white difference in stage at diagnosis of breast cancer. *Am J Epidemiol.* 1997;146:394-404.
36. Chen VW, Correa P, Kurman RJ, et al. Histological characteristics of breast carcinoma in blacks and whites. *Cancer Epidemiol Biomarkers Prev.* 1994;3:127-135.
37. Hunter CP, Redmond CK, Chen VW, et al. Breast cancer: factors associated with stage at diagnosis in black and white women. *J Natl Cancer Inst.* 1993;85:1129-1137.
38. Yood MU, Johnson CC, Blount A, et al. Race and differences in breast cancer survival in a managed care population. *J Natl Cancer Inst.* 1999;91:1487-1491.