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Article

Asian Ethnic Subgroup Disparities in Delays of Surgical Treatment for Breast Cancer

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Abstract

Background: As Asian American breast cancer incidence rises, it is necessary to investigate the origins of differential breast cancer outcomes among Asian ethnic subgroups. This study aimed to examine disparities in delays of breast cancer surgery among Asian ethnic subgroups. **Methods:** We obtained California Cancer Registry data on female breast cancer diagnoses and treatment from 2012 to 2017. Our main independent variable was patient race and ethnicity, including 6 Asian ethnic subgroups. Dependent variables included time to surgical treatment for breast cancer and receipt of surgical treatment within 30 and 90 days of diagnosis. We conducted multivariable logistic regression to determine the odds of receiving surgery within 30 and 90 days of diagnosis and multivariable Cox proportional hazards regression to determine the risk of prolonged time to surgery. **Results:** In our cohort of 93 168 breast cancer patients, Hispanic (odds ratio [OR] = 0.86, 95% confidence interval [CI] = 0.82 to 0.89) and non-Hispanic Black (OR = 0.83, 95% CI = 0.78 to 0.88) patients were statistically significantly less likely than non-Hispanic White patients to receive surgery within 30 days of breast cancer diagnosis, whereas Asian Indian or Pakistani (OR = 1.23, 95% CI = 1.09 to 1.40) and Chinese (OR = 1.30, 95% CI = 1.20 to 1.40) patients were statistically significantly more likely to receive surgery within 30 days of diagnosis. **Conclusions:** This large, population-based retrospective cohort study of female breast cancer patients is the first, to our knowledge, to demonstrate that time to surgical treatment is not equal for all Asians. Distinct differences among Asian ethnic subgroups suggest the necessity of further investigating breast cancer treatment patterns to fully understand and target disparities in breast cancer treatment.

Although incidence of breast cancer remained relatively stable among non-Hispanic White women from 2005 to 2014, breast cancer incidence increased approximately 0.3% per year for Hispanics, 0.4% per year for non-Hispanic Blacks, and 1.7% per year for Asian or Pacific Islanders (1). However, among Asian ethnic subgroups, the annual increase in breast cancer incidence ranged from no statistically significant change in Japanese women to 2.55% in Korean women (2).

In addition to genetic and environmental effects on breast cancer incidence and mortality, cancer screening and treatment are key factors predicting breast cancer diagnosis, severity, and mortality (3-5). However, access to appropriate cancer treatment is limited by socioeconomic factors creating unequal barriers to care for racial and ethnic minorities and lower-income patient groups (6). A meta-analysis of 6 studies demonstrated that delays in surgical treatment for breast cancer, specifically, are associated with an 8% increase in mortality risk for every 4 weeks that surgery is delayed (7). Known risk factors for breast cancer surgical delays include non-Hispanic Black and Hispanic race and ethnicities, lower socioeconomic status, limited access to care and health information, smaller tumor size, and use of mastectomy (8-10). More recent diagnosis years are also associated with increased likelihoods of surgical delays, and as the frequency and length of surgical delays for breast cancer increase, it is necessary to understand the causes of these delays for all patients (8,11).

Among Asian American ethnic subgroups, distinct differences in health risks and outcomes exist due to unequal factors among ethnic groups, such as level of education and socioeconomic status, access to health insurance and usual source of health care, health literacy and health communication behaviors, and differential effects of discrimination (12-18). However,

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despite large growth in breast cancer incidence among Asian Americans and clear differences in the distribution of this growth between Asian ethnic subgroups, no research has explored racial and ethnic disparities in time to breast cancer surgical treatment with detailed ethnic subgrouping of Asian patients. Therefore, our aim was to characterize trends in the time between breast cancer diagnosis and definitive surgery for patients of a variety of races and ethnicities, including detailed Asian ethnic subgroups.

Methods

Data Source and Study Cohort

We conducted a population-based retrospective cohort study using data obtained from the California Cancer Registry (CCR), a statewide cancer surveillance program that collects and maintains individual patient sociodemographic, tumor characteristic, and tumor treatment information for nearly all cancers diagnosed in California.

Our study cohort included women diagnosed between 2012 and 2017 with stage I-III invasive breast cancer in California. Women were excluded from this study if they did not have surgery at the primary site, if the type of surgery was unknown, if the complete date (including day, month, and year) of diagnosis or definitive surgery was missing, or if they did not have surgery as the first treatment for their cancer. Women who did not have complete information recorded for all covariates were also excluded from our analyses.

Patient Race and Ethnicity

To classify participants into racial and ethnic groups, participants were first stratified by Hispanic ethnicity. Non-Hispanic participants were further grouped into more detailed subgroups based on the primary race and ethnicity recorded for each patient, and mutually exclusive racial and ethnic groups were created for subgroups with at least 800 observations. These mutually exclusive racial and ethnic groups included Asian Indian or Pakistani, Chinese, Filipino, Hispanic, Japanese, non-Hispanic Black, non-Hispanic White, Other (non-Asian minority racial and ethnic groups), Other Asian (minority Asian racial and ethnic groups), and Vietnamese.

Covariates

The following factors were abstracted from the CCR database and included as potential confounders in the relationship between patient race and ethnicity and time to surgical treatment: age at diagnosis (40-49 years, 50-59 years, 60-69 years, 70-79 years, 80 years and older), marital status (not married, married, other or unknown), socioeconomic status (quintiles), metropolitan level (metropolitan area core, less than metropolitan area core), insurance type (private, Medicare, Medicaid, uninsured, other), Charlson comorbidity score (0, 1, 2 or more, unknown), year of diagnosis (2012, 2013, 2014, 2015, 2016, 2017), combined American Joint Committee on Cancer (AJCC) tumor stage at diagnosis (I, II, III), tumor grade (I, II, III or IV, unknown), number of positive lymph nodes (0, 1, 2 or more, unknown), and type of surgery received (lumpectomy, mastectomy). Socioeconomic status was derived from patients' neighborhood-level socioeconomic status measured by Juan Yang's index of socioeconomic status, with missing values imputed based on principal components analysis of block group variables from the American Community Survey (19). Metropolitan level was measured by rural-urban commuting area (RUCA): those in the highest category of metropolitan level resided in an area with a RUCA score of 1, corresponding to a metropolitan area core, and those in the lowest category of metropolitan level resided in an area with a RUCA score of greater than 1, corresponding to any area less metropolitan than a metropolitan area core (20).

Time to Surgical Treatment

Time to surgical treatment was computed as the number of days elapsed between breast cancer diagnosis and definitive surgical treatment. Definitive surgical treatment is defined by the CCR as "the most definitive surgical resection of the primary site performed as the first course of treatment" (21). To be consistent with previous research establishing breast cancer surgical delays as a mortality risk factor and proposing optimal time intervals for receipt of surgical treatment for breast cancer, surgical delays were explored using both 30-day and 90-day benchmarks for the interval between diagnosis and surgical treatment (8,22-25).

Statistical Analyses

The distributions of all covariates by patient race and ethnicity and by 30- and 90-day surgical benchmarks were examined using Pearson's χ^2 test or the Monte Carlo estimate for the exact test when individual counts were less than 5. Multivariable logistic regression, controlling for all covariates previously mentioned, was then used to examine the associations between patient race and ethnicity and receiving surgery within 30 and 90 days of diagnosis. Lastly, multivariable Cox proportional hazards regression, controlling for all covariates, was used to estimate the association between patient race and ethnicity and time to surgical treatment. To account for multiple comparisons between the 10 included racial and ethnic patient groups and to minimize the chance of type 1 error, a Bonferroni correction was applied when estimating statistical significance of associations of patient race and ethnicity with the likelihood of receiving surgery within 30 and 90 days of diagnosis as well as with time to surgical treatment. Therefore, associations of 2-sided statistical significance tests were considered statistically significant when the P value was less than .005, computed as .05 divided by the 10 included racial and ethnic groups. Analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC, USA) and R statistical software through RStudio version 1.2.1335.

Results

Sociodemographic and Tumor Characteristics by Patient Race and Ethnicity

We identified 93 168 female breast cancer patients who met the inclusion criteria for our research (Figure 1). The majority of this cohort was non-Hispanic White (58.9%), followed by Hispanic (19.6%), non-Hispanic Black (5.8%), Filipino (4.3%), Chinese (3.1%), Asian Indian or Pakistani (1.1%), Vietnamese (1.1%), and Japanese (1.0%). A total 3.5% of the study cohort consisted of minority Asian ethnic subgroups, which were grouped as Other Asian and 1.6% of the study cohort consisted of other minority

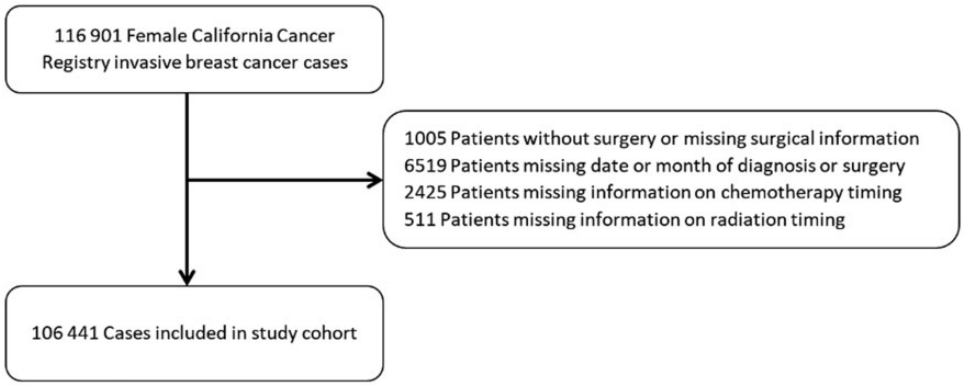

Figure 1. Flow chart displaying identification of study cohort from California Cancer Registry female invasive breast cancer case patients from 2012 to 2017.

racial and ethnic groups, which were grouped as Other race and ethnicity.

Table 1 shows the distribution of patient sociodemographic, health history, tumor, and cancer treatment characteristics by race and ethnicity. Whereas 61.9% of non-Hispanic White patients were 60 years or older at the time of diagnosis, 60.6% of Vietnamese, 58.6% of Other Asian, 56.9% of Asian Indian or Pakistani, 56.4% of Hispanic, and 55.9% of Chinese patients were younger than 60 years when diagnosed. The proportion of patients with a comorbidity score of 2 or greater ranged from 4.2% of Vietnamese patients to 15.9% of non-Hispanic Black patients. Those with stage I tumors ranged from 50.0% of Asian Indian or Pakistani patients to 63.0% of Japanese patients, and those with stage III tumors ranged from 5.4% of Japanese patients to 11.1% of Hispanic patients. The proportion of patients with grade I tumors ranged from 18.7% of Vietnamese patients to 30.5% of Japanese patients, and the proportion with grade III or IV tumors ranged from 22.8% of non-Hispanic White and Japanese patients to 37.1% of non-Hispanic Black patients. Across all racial and ethnic groups, most patients had zero positive lymph nodes. Rates of mastectomy ranged from 33.5% of non-Hispanic White patients to 50.6% of Vietnamese patients.

Sociodemographic and Tumor Characteristics by Time to Surgical Treatment for Breast Cancer

The proportion of patients receiving surgery within 30 days of breast cancer diagnosis ranged from 40.4% of Hispanics to 53.9% of Asian Indian or Pakistani patients, and the proportion of those receiving surgery within 90 days of diagnosis ranged from 91.5% of Other race and ethnicity patients to 96.1% of Chinese patients (Table 2). Slightly higher proportions of married patients received surgery within both 30 (47.5%) and 90 (95.3%) days of diagnosis compared with those who were not married. A total 38.8% and 90.0% of those in the lowest quintile of socioeconomic status met the 30- and 90-day surgical benchmarks, respectively, compared with 48.6% and 95.9% of those in the highest quintile of socioeconomic status. Among all insurance types, Medicaid-insured patients had the lowest proportions of patients meeting the 30-day (32.6%) and 90-day (85.9%) surgical benchmarks. For patients diagnosed in 2012, 50.9% had surgery within 30 days of diagnosis and 95.8% had surgery within 90 days of diagnosis. However, for patients diagnosed in 2017, 40.0% had surgery within 30 days of diagnosis and 92.6% had surgery within 90 days of diagnosis. Patients with stage I tumors had the lowest proportion receiving surgery within 30 days (44.3%) but the highest proportion receiving surgery within 90 days of diagnosis (94.8%). Although proportions of patients with different tumor grades who received surgery within 30 days of diagnosis were similar, those with grade III or IV tumors had the highest proportion of patients receiving surgery within 30 days of diagnosis (50.1%). Compared with those receiving lumpectomies, smaller proportions of patients receiving mastectomies received surgery within 30 (40.3%) and 90 (92.2%) days of diagnosis.

Associations Between Patient Race and Ethnicity and Surgical Delays

Compared with non-Hispanic White patients, Hispanic (odds ratio [OR] = 0.86, 95% confidence interval [CI] = 0.82 to 0.89) and non-Hispanic Black (OR = 0.83, 95% CI = 0.78 to 0.88) patients had statistically significantly lower odds of receiving surgery within 30 days of breast cancer diagnosis (Table 3). However, Asian Indian or Pakistani (OR = 1.23, 95% CI = 1.09 to 1.40) and Chinese (OR = 1.30, 95% CI = 1.20 to 1.40) patients had statistically significantly greater odds of receiving surgery within 30 days of diagnosis compared with non-Hispanic White patients. For the odds of receiving surgery within 90 days of breast cancer diagnosis, these trends were maintained for Chinese (OR = 1.42, 95% CI = 1.16 to 1.72), Hispanic (OR = 0.87, 95% CI = 0.81 to 0.94), and non-Hispanic Black (OR = 0.75, 95% CI = 0.67 to 0.84) patients. Additional factors associated with increased odds of surgery within both 30 and 90 days of diagnosis included being married, having higher socioeconomic status, living in a less metropolitan area, having private insurance, being diagnosed in an earlier year, being diagnosed with grade III or IV cancer, having 2 or more positive lymph nodes, and having a lumpectomy as opposed to a mastectomy. An increasing comorbidity burden was only associated with decreased odds of surgery within 90 days of diagnosis. Increasing tumor stage was associated with increased odds of surgery within 30 days of diagnosis but decreasing odds of surgery within 90 days of diagnosis.

Association Between Patient Race and Ethnicity and Time to Surgery

Compared with non-Hispanic White patients, Hispanics (HR = 0.93, 95% CI = 0.91 to 0.94), non-Hispanic Blacks (HR = 0.89, 95% CI = 0.87 to 0.92), Other Asians (HR = 0.95, 95% CI = 0.92 to

Table 1. Baseline characteristics of California Cancer Registry patients diagnosed with invasive breast cancer from 2012 to 2017 by race and ethnicity[a]

Patient characteristics	Asian Indian or Pakistani, No. (%) (n = 1056)	Chinese, No. (%) (n = 2853)	Filipino, No. (%) (n = 3977)	Hispanic, No. (%) (n = 18 302)	Japanese, No. (%) (n = 949)	Non-Hispanic Black, No. (%) (n = 5370)	Non-Hispanic White, No. (%) (n = 54 835)	Other, No. (%) (n = 1534)	Other Asian, No. (%) (n = 3297)	Vietnamese, No. (%) (n = 995)	P[b]
Age, y											
<40	102 (9.7)	147 (5.2)	165 (4.2)	1224 (6.7)	37 (3.9)	261 (4.9)	1581 (2.9)	75 (4.9)	243 (7.4)	59 (5.9)	<.001
40-49	238 (22.5)	651 (22.8)	684 (17.2)	4112 (22.5)	192 (20.2)	811 (15.1)	6788 (12.4)	266 (17.3)	798 (24.2)	269 (27.0)	
50-59	261 (24.7)	795 (27.9)	1062 (26.7)	4982 (27.2)	890 (27.0)	1483 (27.6)	12 488 (22.8)	409 (26.7)	890 (27.0)	276 (27.7)	
60-69	265 (25.1)	726 (25.5)	1242 (31.2)	4613 (25.2)	821 (24.9)	1436 (26.7)	16 787 (30.6)	433 (28.2)	821 (24.9)	274 (27.5)	
70-79	155 (14.7)	342 (12.0)	654 (16.4)	2406 (13.2)	403 (12.2)	992 (18.5)	11 630 (21.2)	250 (16.3)	403 (12.2)	89 (8.9)	
≥80	35 (3.3)	192 (6.7)	170 (4.3)	965 (5.3)	142 (4.3)	387 (7.2)	5561 (10.1)	101 (6.6)	142 (4.3)	28 (2.8)	
Marital status											
Not married	215 (20.4)	786 (27.6)	1223 (30.8)	7050 (38.5)	330 (34.8)	3253 (60.6)	21 063 (38.4)	529 (34.5)	980 (29.7)	291 (29.3)	<.001
Married	810 (76.7)	1939 (68.0)	2562 (64.4)	10 413 (56.9)	582 (61.3)	1818 (33.9)	31 301 (57.1)	761 (49.6)	2162 (65.6)	653 (65.6)	
Other/unknown	31 (2.9)	128 (4.5)	192 (4.8)	839 (4.58)	37 (3.9)	299 (5.6)	2471 (4.5)	244 (15.9)	155 (4.7)	51 (5.1)	
Socioeconomic status											
1 (Lowest)	57 (5.4)	167 (5.9)	308 (7.7)	4940 (27.0)	34 (3.6)	1240 (23.1)	3485 (6.4)	175 (11.4)	246 (7.5)	104 (10.5)	<.001
2	111 (10.5)	263 (9.2)	674 (17.0)	4444 (24.3)	87 (9.2)	1322 (24.6)	7855 (14.3)	280 (18.3)	484 (14.7)	239 (24.0)	
3	157 (14.9)	447 (15.7)	993 (25.0)	3822 (20.9)	158 (16.7)	1178 (21.9)	11 095 (20.2)	325 (21.2)	587 (17.8)	226 (22.7)	
4	233 (22.1)	755 (26.5)	1200 (30.2)	3097 (16.9)	282 (29.7)	1035 (19.3)	14 526 (26.5)	368 (24.0)	845 (25.6)	228 (22.9)	
5 (Highest)	498 (47.2)	1221 (42.8)	802 (20.2)	1999 (10.9)	388 (40.9)	595 (11.1)	17 874 (32.6)	386 (25.2)	1135 (34.4)	198 (19.9)	
Metropolitan level											
Highest	625 (59.2)	2212 (77.5)	2953 (74.3)	12 739 (69.6)	713 (75.1)	4052 (75.5)	34 072 (62.1)	976 (63.6)	2460 (74.6)	713 (71.7)	<.001
Lowest	431 (40.8)	641 (22.5)	1024 (25.8)	5563 (30.4)	236 (24.9)	1318 (24.5)	20 763 (37.9)	558 (36.4)	837 (25.4)	282 (28.3)	
Insurance type											
Private	696 (65.9)	1981 (69.4)	2621 (65.9)	9991 (54.6)	628 (66.2)	3205 (59.7)	32 165 (58.7)	850 (55.4)	2174 (65.9)	551 (55.4)	<.001
Medicare	184 (17.4)	525 (18.4)	805 (20.2)	3758 (20.5)	280 (29.5)	1390 (25.9)	18 586 (33.4)	346 (22.6)	657 (19.9)	157 (15.8)	
Medicaid	126 (11.9)	274 (9.6)	366 (9.2)	3832 (20.9)	17 (1.8)	571 (10.6)	2426 (4.4)	142 (9.3)	335 (10.2)	216 (21.7)	
Uninsured	<1%	12 (0.4)	18 (0.5)	154 (0.8)	<1 %	35 (0.7)	261 (0.5)	<1%	32 (1.0)	<1 %	
Other	<5%	61 (2.1)	167 (4.2)	567 (3.1)	<3%	169 (3.2)	1397 (2.6)	<13%	99 (3.0)	<7%	
Charlson comorbidity score											
0	525 (49.7)	1671 (58.6)	1781 (44.8)	9177 (50.1)	559 (58.9)	2463 (45.9)	32 002 (58.4)	701 (45.7)	1823 (55.3)	647 (65.0)	<.001
1	163 (15.4)	266 (9.3)	700 (17.6)	2995 (16.4)	129 (12.6)	1016 (18.9)	7864 (14.3)	213 (13.9)	424 (12.9)	106 (10.7)	
2 or more	81 (7.7)	122 (4.3)	389 (9.8)	1576 (8.6)	67 (7.1)	851 (15.9)	4393 (8.0)	128 (8.3)	166 (5.0)	42 (4.2)	
Unknown	287 (27.2)	794 (27.8)	1107 (27.8)	4554 (24.9)	194 (20.4)	1040 (19.4)	10 576 (19.3)	492 (32.1)	884 (26.8)	200 (20.1)	
Year of diagnosis											
2012	158 (15.0)	415 (14.6)	645 (16.2)	2765 (15.1)	155 (16.3)	902 (16.8)	9093 (15.6)	226 (14.7)	491 (14.9)	151 (15.2)	<.001
2013	171 (16.2)	439 (15.4)	645 (16.2)	2909 (15.9)	171 (18.0)	876 (16.3)	9218 (16.8)	224 (14.6)	462 (14.0)	161 (16.2)	
2014	163 (15.4)	446 (15.6)	635 (16.0)	2865 (15.7)	149 (15.7)	914 (17.0)	9072 (16.5)	207 (13.5)	509 (15.4)	175 (17.6)	
2015	195 (18.5)	521 (18.3)	700 (17.6)	3075 (16.8)	157 (16.5)	908 (16.9)	9325 (17.0)	271 (17.7)	572 (17.4)	146 (14.7)	
2016	178 (16.9)	514 (18.0)	643 (16.2)	3320 (18.1)	152 (16.0)	858 (16.0)	9079 (16.6)	273 (17.8)	612 (18.6)	180 (18.1)	
2017	191 (18.1)	518 (18.2)	709 (17.8)	3368 (18.4)	165 (17.4)	912 (17.0)	9048 (16.5)	333 (21.7)	651 (19.8)	182 (18.3)	
Tumor stage											
I	528 (50.0)	1623 (56.9)	2190 (55.1)	9464 (51.7)	598 (63.0)	2776 (51.7)	32 867 (59.9)	848 (55.3)	1881 (57.1)	555 (55.8)	<.001
II	356 (35.8)	1018 (35.7)	1421 (35.7)	6816 (37.2)	300 (31.6)	2030 (37.8)	17 674 (32.2)	542 (35.3)	1177 (35.7)	356 (35.8)	
III	84 (8.4)	212 (7.4)	366 (9.2)	2022 (11.1)	51 (5.4)	564 (10.5)	4294 (7.8)	144 (9.4)	239 (7.3)	84 (8.4)	

(continued)

Table 1. (continued)

Patient characteristics	Asian Indian or Pakistani, No. (%) (n = 1056)	Chinese, No. (%) (n = 2853)	Filipino, No. (%) (n = 3977)	Hispanic, No. (%) (n = 18 302)	Japanese, No. (%) (n = 949)	Non-Hispanic Black, No. (%) (n = 5370)	Non-Hispanic White, No. (%) (n = 54 835)	Other, No. (%) (n = 1534)	Other Asian, No. (%) (n = 3297)	Vietnamese, No. (%) (n = 995)	P[b]
Tumor grade											<.001
I	251 (23.8)	662 (23.2)	842 (21.2)	4104 (22.4)	289 (30.5)	1058 (19.7)	16 220 (29.6)	398 (26.0)	773 (23.5)	186 (18.7)	
II	462 (43.8)	1335 (46.8)	1853 (46.6)	8061 (44.0)	414 (43.6)	2180 (40.6)	25 038 (45.7)	684 (44.6)	1498 (45.4)	472 (47.4)	
III or IV	314 (29.7)	760 (26.6)	1166 (29.3)	5686 (31.1)	216 (22.8)	1993 (37.1)	12 514 (22.8)	386 (25.2)	919 (27.9)	301 (30.3)	
Unknown	29 (2.8)	96 (3.4)	116 (2.9)	451 (2.5)	30 (3.2)	139 (2.6)	1063 (1.9)	66 (4.3)	107 (3.3)	36 (3.6)	
No. of positive lymph nodes											<.001
0	700 (66.3)	2025 (71.0)	2805 (70.5)	12 084 (66.0)	699 (73.4)	3565 (66.4)	39 135 (71.4)	1008 (65.7)	2381 (72.2)	720 (72.4)	
1	151 (14.3)	331 (11.6)	495 (12.5)	2409 (13.2)	105 (11.1)	742 (13.8)	6535 (11.9)	219 (14.3)	403 (12.2)	118 (11.9)	
2 or more	166 (15.7)	338 (11.9)	517 (13.0)	3060 (16.7)	89 (9.4)	766 (14.3)	6349 (11.6)	189 (12.3)	372 (11.3)	121 (12.2)	
Unknown	39 (3.7)	159 (5.6)	160 (4.0)	749 (4.1)	56 (5.9)	297 (5.5)	2816 (5.1)	118 (7.7)	141 (4.3)	36 (3.6)	
Type of surgery											<.001
Lumpectomy	638 (60.4)	1556 (54.5)	1984 (49.9)	10 661 (58.3)	577 (60.8)	3505 (65.3)	36 453 (66.5)	947 (61.7)	1785 (54.1)	492 (49.5)	
Mastectomy	418 (39.6)	1297 (45.5)	1993 (50.1)	7641 (41.2)	372 (39.2)	1865 (34.7)	18 382 (33.5)	587 (38.3)	1512 (45.9)	503 (50.6)	

[a] Individual case counts of less than 11 have been suppressed for individual patient privacy; where case counts are less than 11, a percentage estimate is displayed.
[b] P values computed from 2-sided Pearson's χ^2 tests of statistical significance or, when individual counts were less than 5, the Monte Carlo estimate for the exact test of statistical significance.

0.98), and those of other races and ethnicities (HR = 0.87, 95% CI = 0.83 to 0.92) experienced a statistically significantly longer time to surgical treatment for breast cancer (Figure 2). However, Chinese patients experienced a statistically significantly shorter time to surgical treatment compared with non-Hispanic Whites (HR = 1.15, 95% CI = 1.11 to 1.20). Additional factors associated with a shorter time to surgical treatment included being married, having higher socioeconomic status, living in a less metropolitan area, having private insurance, being diagnosed in an earlier year, being diagnosed with stage III cancer, being diagnosed with grade III or IV cancer, having a larger number of positive lymph nodes, and having a lumpectomy as opposed to a mastectomy (Supplementary Table 1, available online).

Discussion

In our study of CCR female breast cancer patients who received surgical treatment for their cancer, we found that, compared with non-Hispanic White patients, Hispanic, non-Hispanic Black, minority Asian ethnic subgroup, and Other race and ethnicity patients were more likely to experience prolonged time to surgical treatment for breast cancer whereas Chinese patients were more likely to have a shorter time to surgical treatment. Our findings of increased odds of surgical delays in non-Hispanic Black and Hispanic patients, compared with non-Hispanic Whites, are consistent with ample work that previously investigated these trends (8-10). However, there has been limited research that investigated the association between Asian race and breast cancer surgical delays, and no work, to our knowledge, has investigated this association among Asian ethnic subgroups. Studies seeking to understand breast cancer surgical delays among Asian patients have consistently reported that, compared with White patients, Asian patients experience no statistically significant difference in the time from breast cancer diagnosis to surgical treatment (26-29). In addition, in sensitivity analyses we found there were no statistically significant differences in the odds of receiving surgery within 30 and 90 days of diagnosis or in the risk of prolonged time to surgery between non-Hispanic White patients and Asian patients when we treated Asian patients as 1 homogenous racial and ethnic group. Yet, by studying these associations for individual Asian ethnic subgroups, we found some subgroups face disparities in time to surgical treatment, compared with non-Hispanic White patients, and others that experience an advantage in time to surgical treatment over non-Hispanic White patients. Thus, studying breast cancer surgical treatment delays in aggregated Asian patients is most likely oversimplifying the true effects of belonging to various Asian ethnic subgroups. As identified in previous studies of disparate care and outcomes for Asian ethnic subgroups, contributors to these varying effects may be related to factors such as acculturation levels and length of residence in the United States, nativity, socioeconomic status, and access to care (30-34).

Previous work has also demonstrated that it is not sufficient to study Asian health outcomes by characterizing all Asian ethnic subgroups as 1 homogenous patient group. Adia et al. (35) found that although Asians, as a generalized group, did not have statistically significantly different odds of fair or poor health compared with non-Hispanic Whites, Vietnamese patients had statistically significantly greater odds of fair or poor health and Chinese, Japanese, and Korean patients had statistically significantly lower odds of disability compared with non-Hispanic Whites. Across a variety of health outcomes and

Table 2. Distribution of patient, tumor, and treatment characteristics for California Cancer Registry invasive breast cancer patients who received surgery within 30 and 90 days of diagnosis

	30-d benchmark			90-d benchmark		
Patient characteristics	Surgery within 30 d of diagnosis, No. (%) (n = 42 344)	Surgery greater than 30 d after diagnosis, No. (%) (n = 50 824)	P[a]	Surgery within 90 d of diagnosis, No. (%) (n = 87 659)	Surgery greater than 90 d after diagnosis, No. (%) (n = 5509)	P[a]
Race and ethnicity						
Asian Indian or Pakistani	569 (53.9)	487 (46.1)	<.001	1008 (95.5)	48 (4.6)	<.001
Chinese	1497 (52.5)	1356 (47.5)		2743 (96.1)	110 (3.9)	
Filipino	1801 (45.3)	2176 (54.7)		3729 (93.8)	248 (6.2)	
Hispanic	7396 (40.4)	10 906 (59.6)		16 820 (91.9)	1482 (8.1)	
Japanese	406 (42.8)	543 (57.2)		903 (95.2)	46 (4.9)	
Non-Hispanic Black	2205 (41.1)	3165 (58.9)		4925 (91.7)	445 (8.3)	
Non-Hispanic White	25 938 (47.3)	28 897 (52.7)		52 114 (95.0)	2721 (5.0)	
Other	691 (45.1)	843 (55.0)		1403 (91.5)	131 (8.5)	
Other Asian	1426 (43.3)	1871 (56.8)		3093 (93.8)	204 (6.2)	
Vietnamese	415 (41.7)	580 (58.3)		921 (92.6)	74 (7.4)	
Age, y						
<40	2041 (52.4)	1853 (47.6)	<.001	3734 (95.9)	160 (4.1)	<.001
40-49	6426 (43.4)	8383 (56.6)		13 875 (93.7)	934 (6.3)	
50-59	10 289 (45.0)	12 557 (55.0)		21 431 (93.8)	1415 (6.2)	
60-69	12 154 (45.3)	14 663 (54.7)		25 249 (94.2)	1568 (5.9)	
70-79	7873 (46.1)	9215 (54.0)		16 161 (94.6)	927 (5.4)	
≥80	3561 (46.2)	4153 (53.8)		7209 (93.5)	505 (6.6)	
Marital status						
Not married	14 889 (41.7)	20 831 (58.3)	<.001	33 000 (92.4)	2720 (7.6)	<.001
Married	25 166 (47.5)	27 835 (52.5)		50 512 (95.3)	2489 (4.7)	
Other/unknown	2289 (51.5)	2158 (48.5)		4147 (93.3)	300 (6.8)	
Socioeconomic status						
1 (Lowest)	4172 (38.8)	6584 (61.2)	<.001	9683 (90.0)	1073 (10.0)	<.001
2	6800 (43.2)	8959 (56.9)		14 582 (92.5)	1177 (7.5)	
3	8580 (45.2)	10 408 (54.8)		17 849 (94.0)	1139 (6.0)	
4	10 586 (46.9)	11 983 (53.1)		21 472 (95.1)	1097 (4.9)	
5 (Highest)	12 206 (48.6)	12 890 (51.4)		24 073 (95.9)	1023 (4.1)	
Metropolitan level						
Highest	26 599 (43.2)	34 916 (56.8)	<.001	57 718 (93.8)	3797 (6.2)	<.001
Lowest	15 745 (49.7)	15 908 (50.3)		29 941 (94.6)	1712 (5.4)	
Insurance type						
Private	26 741 (48.7)	28 121 (51.3)	<.001	52 430 (95.6)	2432 (4.4)	<.001
Medicare	11 540 (43.2)	15 148 (56.8)		25 023 (93.8)	1665 (6.2)	
Medicaid	2704 (32.6)	5601 (67.4)		7137 (85.9)	1168 (14.1)	
Uninsured	229 (43.1)	302 (56.9)		494 (93.0)	37 (7.0)	
Other	1130 (40.6)	1652 (59.4)		2575 (92.6)	207 (7.4)	
Charlson comorbidity score						
0	22 889 (44.6)	28 460 (55.4)	<.001	48 918 (95.3)	2431 (4.7)	<.001
1	6048 (43.6)	7828 (56.4)		13 032 (93.9)	844 (6.1)	
2 or more	3384 (43.3)	4431 (56.7)		7241 (92.7)	574 (7.3)	
Unknown	10 023 (49.8)	10 105 (50.2)		18 468 (91.8)	1660 (8.3)	
Year of diagnosis						
2012	7641 (50.9)	7360 (49.1)	<.001	14 375 (95.8)	626 (4.2)	<.001
2013	7577 (49.6)	7699 (50.4)		14 561 (95.3)	715 (4.7)	
2014	7078 (46.8)	8057 (53.2)		14 256 (94.2)	879 (5.8)	
2015	6971 (43.9)	8899 (56.1)		14 845 (93.5)	1025 (6.5)	
2016	6649 (42.1)	9160 (57.9)		14 731 (93.2)	1078 (6.8)	
2017	6428 (40.0)	9649 (60.0)		14 891 (92.6)	1186 (7.4)	
Tumor stage						
I	23 604 (44.3)	29 726 (55.7)	<.001	50 536 (94.8)	2794 (5.2)	<.001
II	14 555 (45.9)	17 189 (54.2)		29 674 (93.5)	2070 (6.5)	
III	4185 (51.7)	3909 (48.3)		7449 (92.0)	645 (8.0)	

(continued)

Table 2. (continued)

Patient characteristics	30-d benchmark			90-d benchmark		
	Surgery within 30 d of diagnosis, No. (%) (n = 42 344)	Surgery greater than 30 d after diagnosis, No. (%) (n = 50 824)	P[a]	Surgery within 90 d of diagnosis, No. (%) (n = 87 659)	Surgery greater than 90 d after diagnosis, No. (%) (n = 5509)	P[a]
Tumor grade						
I	10 819 (43.7)	13 964 (56.4)	<.001	23 332 (94.2)	1451 (5.9)	<.001
II	18 215 (43.4)	23 782 (56.6)		39 358 (93.7)	2639 (6.3)	
III or IV	12 156 (50.1)	12 099 (49.9)		22 977 (94.7)	1278 (5.3)	
Unknown	1154 (54.1)	979 (45.9)		1992 (93.4)	141 (6.6)	
No. of positive lymph nodes						
0	28 776 (44.2)	36 346 (55.8)	<.001	61 515 (94.5)	3607 (5.5)	<.001
1	5178 (45.0)	6330 (55.0)		10 824 (94.1)	684 (5.9)	
2 or more	5944 (49.7)	6023 (50.3)		11 152 (93.2)	815 (6.8)	
Unknown	2446 (53.5)	2125 (46.5)		4168 (91.2)	403 (8.8)	
Type of surgery						
Lumpectomy	28 399 (48.5)	30 199 (51.5)	<.001	55 773 (95.2)	2825 (4.8)	<.001
Mastectomy	13 945 (40.3)	20 625 (59.7)		31 886 (92.2)	2684 (7.8)	

[a]P values computed from 2-sided Pearson's χ^2 tests of statistical significance.

measures of care, Adia et al. (35) also found that Filipino patients experienced disparities more often than other Asian ethnic subgroups. A second study by Gordon et al. (36) found that Filipino patients had a consistently higher prevalence of chronic conditions compared with all Asians, whereas Chinese, Korean, and Southeast Asian patients had consistently lower rates of chronic conditions. This research supports our findings of unequal treatment outcomes for patients belonging to various Asian ethnic subgroups and suggests trends that have emerged in the study of outcomes of care for patients of differing Asian ethnic subgroups: Filipino patients tend to experience poorer outcomes, and Chinese and Korean patients tend to experience better outcomes compared with other Asian ethnic subgroups and with non-Hispanic Whites.

Consistent with these trends, our research found that, compared with non-Hispanic White patients, Chinese patients had greater odds of receiving surgical treatment for breast cancer within both 30 and 90 days of diagnosis and were more likely to receive surgical treatment sooner than non-Hispanic White patients. However, despite previous research demonstrating consistent disparities among Filipino patients, we found that there were no statistically significant differences in odds of treatment delay or time to surgical treatment for Filipinos. Nonetheless, the findings of our research demonstrate that Filipino patients received the greatest proportion of mastectomies, a known disparity among Filipino breast cancer patients. A systematic review by Simpson et al. (37) not only found that Filipino women were substantially less likely than non-Hispanic White women to receive breast conserving surgery but also that Asian women were less likely to receive breast reconstructive surgery. Thus, although time to surgical treatment may not be delayed for Filipino patients relative to non-Hispanic White patients, Filipino patients may still be more likely to experience an important disparity in terms of differential surgical treatment received.

Our study has strengths that warrant noting. Specifically, this was a population-based study of all women in California diagnosed with invasive breast cancer from 2012 to 2017 who received surgical treatment. This large population-based cohort not only allowed for generally robust analyses and inferences to be made based on our findings but also for substantial analyses of individual Asian ethnic subgroups composed of individually large sample sizes. We were also able to control for a large number of covariate factors as potential confounders in the relationship between race and ethnicity and breast cancer surgical treatment delays.

Our study also has limitations that warrant consideration. Specifically, there were some important variables that we were not able to control for, such as family history of breast cancer, breast cancer type, and patient nativity and immigration history. Omission of these factors in our multivariable analyses may have led to limited residual confounding in our findings. In addition, despite our overall large cohort size and individually large samples of racial and ethnic groups, there was still the need for an "Other Asian" category due to some Asian ethnic subgroups having small numbers of patients meeting our inclusion criteria, including Hmong, Kampuchean, Korean, Laotian, and Thai patients. Thus, there may be additional disparities in treatment outcomes for patients belonging to these Asian ethnic subgroups that were not able to be identified by this study.

In conclusion, our large population-based study of the CCR demonstrated distinct disparities in receiving timely surgical treatment for breast cancer among Hispanic, non-Hispanic Black, and minority Asian ethnic subgroup patients compared with non-Hispanic White patients. However, Chinese patients were more likely than non-Hispanic White patients to receive surgical treatment sooner. This study is the first, to our knowledge, to demonstrate that surgical treatment outcomes are not equal for all Asian breast cancer patients and that emphasis must be placed on understanding treatment disparities for patients belonging to specific Asian ethnic subgroups so that appropriate and necessary support can be provided to address these otherwise masked disparities.

Table 3. Multivariable logistic regression analyses analyzing the odds of receiving surgery within 30 and 90 days of invasive breast cancer diagnosis (n = 93 168)

Patient characteristics	30-d benchmark		90-d benchmark	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]
Race and ethnicity				
Non-Hispanic White	(Referent)		(Referent)	
Asian Indian or Pakistani	1.23 (1.09 to 1.40)	.001	1.10 (0.82 to 1.48)	.53
Chinese	1.30 (1.20 to 1.40)	<.001	1.42 (1.16 to 1.72)	<.001
Filipino	0.98 (0.92 to 1.05)	.60	0.93 (0.81 to 1.07)	.30
Hispanic	0.86 (0.82 to 0.89)	<.001	0.87 (0.81 to 0.94)	<.001
Japanese	0.85 (0.74 to 0.97)	.01	0.96 (0.71 to 1.30)	.81
Non-Hispanic Black	0.83 (0.78 to 0.88)	<.001	0.75 (0.67 to 0.84)	<.001
Other	0.94 (0.84 to 1.04)	.21	0.71 (0.59 to 0.86)	<.001
Other Asian	0.91 (0.84 to 0.98)	.008	0.89 (0.76 to 1.03)	.12
Vietnamese	0.95 (0.83 to 1.08)	.40	0.86 (0.67 to 1.10)	.23
Age, y				
50-59	(Referent)		(Referent)	
<40	1.42 (1.32 to 1.52)	<.01	1.90 (1.60 to 2.25)	<.001
40-49	0.96 (0.92 to 1.01)	.08	1.05 (0.96 to 1.14)	.32
60-69	1.06 (1.02 to 1.10)	.002	1.08 (1.00 to 1.17)	.06
70-79	1.17 (1.11 to 1.22)	<.001	1.27 (1.15 to 1.40)	<.001
≥80	1.11 (1.05 to 1.18)	<.001	1.20 (1.06 to 1.36)	.003
Marital status				
Not married	(Referent)		(Referent)	
Married	1.20 (1.16 to 1.23)	<.001	1.41 (1.33 to 1.50)	<.001
Other/unknown	1.36 (1.27 to 1.45)	<.001	1.11 (0.97 to 1.26)	.12
Socioeconomic status				
1 (Lowest)	(Referent)		(Referent)	
2	1.10 (1.05 to 1.16)	<.001	1.16 (1.06 to 1.27)	<.001
3	1.15 (1.09 to 1.21)	<.001	1.34 (1.22 to 1.46)	<.001
4	1.19 (1.13 to 1.25)	<.001	1.54 (1.40 to 1.69)	<.001
5 (Highest)	1.23 (1.17 to 1.30)	<.001	1.68 (1.52 to 1.85)	<.001
Metropolitan level				
Highest	(Referent)		(Referent)	
Lowest	1.30 (1.26 to 1.33)	<.001	1.12 (1.06 to 1.19)	<.001
Insurance type				
Private	(Referent)		(Referent)	
Medicare	0.77 (0.74 to 0.80)	<.001	0.69 (0.63 to 0.74)	<.001
Medicaid	0.54 (0.51 to 0.57)	<.001	0.38 (0.35 to 0.42)	<.001
Uninsured	0.77 (0.64 to 0.92)	.003	0.72 (0.51 to 1.01)	.05
Other	0.63 (0.58 to 0.68)	<.001	0.61 (0.53 to 0.71)	<.001
Charlson comorbidity score				
0	(Referent)		(Referent)	
1	1.02 (0.98 to 1.06)	.26	0.89 (0.82 to 0.96)	.004
2 or more	1.00 (0.95 to 1.05)	.97	0.76 (0.69 to 0.84)	<.001
Unknown	1.30 (1.26 to 1.35)	<.001	0.63 (0.59 to 0.67)	<.001
Year of diagnosis				
2012	(Referent)		(Referent)	
2013	0.95 (0.91 to 0.99)	.03	0.91 (0.81 to 1.01)	.09
2014	0.83 (0.79 to 0.87)	<.001	0.72 (0.65 to 0.80)	<.001
2015	0.73 (0.70 to 0.77)	<.001	0.65 (0.58 to 0.72)	<.001
2016	0.67 (0.64 to 0.71)	<.001	0.60 (0.55 to 0.67)	<.001
2017	0.60 (0.57 to 0.63)	<.001	0.58 (0.53 to 0.65)	<.001
Tumor stage				
I	(Referent)		(Referent)	
II	1.14 (1.10 to 1.17)	<.001	0.85 (0.79 to 0.91)	<.001
III	1.55 (1.44 to 1.65)	<.001	0.75 (0.65 to 0.85)	<.001
Tumor grade				
I	(Referent)		(Referent)	
II	1.01 (0.98 to 1.04)	.63	1.05 (0.98 to 1.12)	.18
III or IV	1.35 (1.30 to 1.40)	<.001	1.44 (1.32 to 1.56)	<.001

(continued)

Table 3. (continued)

Patient characteristics	30-d benchmark		90-d benchmark	
	OR (95% CI)	P[a]	OR (95% CI)	P[a]
Unknown	1.56 (1.43 to 1.71)	<.001	1.19 (0.99 to 1.43)	.07
No. of positive lymph nodes				
0	(Referent)		(Referent)	
1	0.99 (0.95 to 1.04)	.75	1.13 (1.03 to 1.24)	.01
2 or more	1.13 (1.07 to 1.19)	<.001	1.13 (1.03 to 1.24)	.002
Unknown	1.39 (1.30 to 1.48)	<.001	1.20 (1.07 to 1.24)	<.001
Type of surgery				
Lumpectomy	(Referent)		(Referent)	
Mastectomy	0.62 (0.61 to 0.64)	<.001	0.58 (0.55 to 0.62)	<.001

[a]Two-sided Wald χ^2 tests of statistical significance with Bonferroni adjusted alpha level used to control for multiple comparisons. CI = confidence interval; OR = odds ratio.

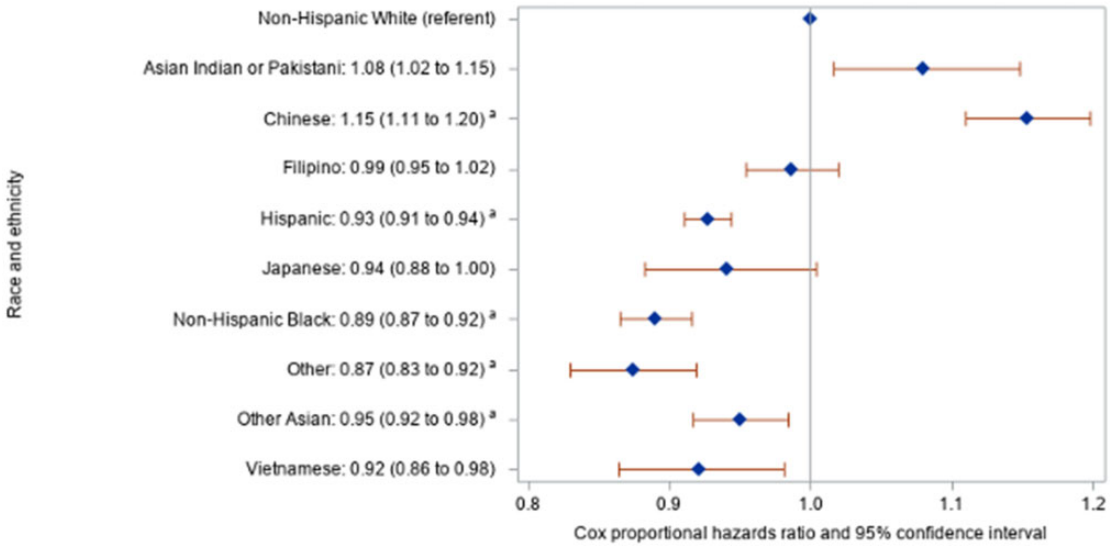

Figure 2. Forest plot displaying Cox proportional hazards ratios and 95% confidence intervals (numbers given within parentheses and displayed as error bars) for the likelihood of decreased time to surgery by patient race and ethnicity. Model fully adjusted for patient age, marital status, socioeconomic status, neighborhood metropolitan level, insurance type, Charlson comorbidity score, year of breast cancer diagnosis, tumor stage at diagnosis, tumor grade at diagnosis, the number of positive lymph nodes, and the type of surgery received. Model reports 2-sided χ^2 tests of statistical significance with Bonferroni adjustment used to control for multiple comparisons. [a] Indicates statistically significant associations at a Bonferroni adjusted alpha level to control for multiple comparisons.

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Data Availability

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