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Disease Characteristics & Mortality among Asian Women with Breast Cancer

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Abstract

Background—Asian women with breast cancer are often studied in aggregate, belying significant intra-group diversity. We sought to examine differences in breast cancer characteristics and outcomes among Asian women.

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Author Contribution and Disclaimer:

Study conception: Yu, Fayanju. Statistical analysis: Thomas. Data interpretation: Yu, Thomas, Fayanju. Critical revision: all authors. Manuscript review: all authors.

Conflict of Interest:

The authors have no conflicts of interest.

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Social Media and Promotion

Twitter

Though commonly studied in aggregate, Asian women w/ breast cancer vary in mortality + distribution of tumor subtypes when stratified by country/region of origin.

Twitter Handles: @DrLolaFayanju, @JenniferPlichta, @DrShelleyHwang, @GreenupRachel, @DukeBladegirl, @mom2phd, @DukeCancer, @DukeSurgery, @DukeForge, @Duke_pophealth, @alicelingyu1, @PennCancer, @PennSurgery, @PC3Innovation

Methods—Asian, non-Hispanic Black, Hispanic, and non-Hispanic White women≥18y diagnosed with breast cancer 1990-2016 were identified in the SEER18 database. Asian patients were sub-classified as Chinese, Japanese, Korean, Filipino, Vietnamese, South Asian (Asian Indian or Pakistani), Southeast Asian (SEA; Cambodian, Laotian, Hmong, or Thai) or Other Asian. Unadjusted overall (OS) and cancer-specific survival (CSS) were estimated using the Kaplan-Meier method. Cox proportional hazards models were used to estimate adjusted OS and CSS.

Results—910,415 women were included: Asian=63,405, Black=92,226, Hispanic=84,451, White=670,333. Asian women had higher rates of HER2+ disease than White women (18.7% vs 13.8%) and the highest 10y unadjusted OS and CSS among all racial/ethnic groups (all p<0.001). SEA women had the highest rates of stage IV disease at presentation, while Japanese women had the lowest (5.9% vs 2.7%, p<0.001). Japanese women had the highest 10y unadjusted CSS (89.4%, 95% CI 88.7-90.1%) of any distinct Asian group, while SEA women had the worst (78%, 95% CI 74.1-81.3%, p<0.001). After adjustment, SEA women had the worst OS of any Asian group and were the only Asian group without improved OS compared to White women (reference, p=0.08).

Conclusion—Breast cancer characteristics and outcomes vary significantly among Asian women. Future research should consider disaggregation by country or region of origin to identify subgroups at risk for worse outcomes than aggregated data may suggest.

Precis:

Studying breast cancer among Asian women grouped as a single entity can lead to inaccurate generalizations regarding cancer-specific mortality and distribution of tumor subtypes. Future research should disaggregate these populations to better understand, treat, and counsel Asian patients with breast cancer.

Lay summary:

Asian women with breast cancer are frequently studied as a single entity. However, Asian ethnic groups differ greatly by country of origin, genetic ancestry, disease frequency, socioeconomic status, patterns of immigration, as well as dietary and cultural practices. We found that women of different Asian ethnicities vary significantly with regard to cancer characteristics, such as mortality and tumor subtype. Future research should disaggregate these populations to better understand, treat, and counsel Asian patients with breast cancer.

Keywords

Asian; Breast Neoplasms; Health Care Disparities; Racial Disparities; Ethnic Disparities; Health Outcomes

Introduction

An estimated 23 million people in the United States (US) identify as Asian.[1] Within the Asian population, cancer is the leading cause of death[2], and breast cancer is the most commonly diagnosed cancer among Asian women.[3]

Racial differences in breast cancer diagnosis, prognosis, and survival are well-documented.[4–10] However, these studies typically aggregate women from geographically diverse countries in East Asia, Southeast Asia, and the Indian subcontinent into a single "Asian" racial group. However, Asians in America vary greatly with regards to country of origin, genetic ancestry, disease frequency, socioeconomic status, patterns of immigration, as well as dietary and cultural practices. Thus, this generalization likely masks important epidemiological and sociocultural differences between groups that may also contribute to disparate outcomes among Asian patients. For example, Korean women in the US demonstrate lower rates of mammography participation when compared to Vietnamese and Chinese women.[3]

While many studies focus on breast cancer within select Asian populations, such as Chinese or South Asian, there is a paucity of research for many other Asian ethnicities, such as Hmong, Cambodian, or Laotian.[11–15] Even fewer studies compare disease characteristics and outcomes between Asian ethnic subgroups. Furthermore, some of these published findings are somewhat contradictory. For example, it remains unclear whether or not menopause occurs at an earlier age in people living in or originating from some parts of Asia as compared to what is observed in Western countries. Understanding if menopause occurs earlier in certain Asian populations is relevant for breast cancer research given the complex association between menopausal status at diagnosis and long-term outcome.[16, 17]

In light of the ancestral, cultural, and socioeconomic heterogeneity of this population, we sought to examine characteristics and outcomes after breast cancer diagnosis among distinct Asian subgroups living in the US and classified according to self-reported country or region of origin. We further explored differences among the Asian subgroups and also between Asians and members of other racial/ethnic groups in the US and compared findings between aggregated and disaggregated populations. We hypothesized that analysis of Asian subgroups would reveal differences otherwise lost in racial aggregation and that such knowledge can better personalize care for patients and inform efforts to improve equity in breast cancer care.

Methods

Adult female breast cancer patients were selected from the 1975-2016 Surveillance, Epidemiology, and End Results (SEER) 18 database (released November 2018; Figure 1).[18] Patients with missing or unknown survival data, estrogen receptor (ER) status, or progesterone receptor (PR) status; and those diagnosed before 1990 were excluded. Those with International Classification of Disease (ICD)-O-3 histologies not included in the World Health Organization (WHO) classification and those with self-reported race/ethnicity other than Asian, Hispanic, Non-Hispanic Black (NHB), or Non-Hispanic White (NHW) were also excluded. Patients reporting Asian descent were classified as Chinese, Japanese, Korean, Filipino, Vietnamese, South Asian (Asian Indian or Pakistani), Southeast (SE) Asian (Cambodian/Kampuchean, Laotian, Hmong, or Thai), or Other Asian. Although patients may have selected more than one race, SEER only reports one racial categorization per patient, with non-White race prioritized for individuals listing White race and another race. HER2 status was only available for patients diagnosed in or after 2010, while insurance

status was only available for patients diagnosed in or after 2007, thus analyses using these variables only include patients diagnosed in or after 2010 and 2007, respectively. Tumor subtypes were categorized as: (1) HER2+ (HER2+, ER+/ER−/ER borderline, and PR+/PR−/PR borderline), (2) hormone-receptor positive [HR+]/HER2− (estrogen-receptor positive [ER+] and/or progesterone-receptor positive [PR+] and HER2−/HER2 borderline), and (3) triple-negative breast cancer (TNBC; estrogen-receptor negative [ER−]/estrogen receptor [ER] borderline, progesterone-receptor negative [PR−]/progesterone [PR] borderline, and HER2−/HER2 borderline). Only patients diagnosed 2010 and after were included in analyses for which tumor subtype was relevant. SEER does not differentiate between clinical and pathological American Joint Commission on Cancer (AJCC) stage, thus we categorized extent of disease into 3 groups: (1) non-metastatic with no nodal involvement (M0/X and N0), (2) non-metastatic with nodal involvement (M0/X and N1-3), and (3) metastatic disease (stage IV, M1 disease and any N stage). M0/X patients with NX or missing N-stage were assigned a missing value for stage.

Patient characteristics were summarized with N (%) for categorical variables and median (interquartile range [IQR]) for continuous variables. Chi-square tests and analysis of variance (ANOVA) were used to test for differences in categorical and continuous variables, respectively, for two comparisons: (1) Asian vs. Hispanic vs. NHB vs. NHW patients and (2) Chinese vs. Japanese vs. Korean vs. Filipino vs. Vietnamese vs. South Asian vs. SE Asian vs. Other Asian vs. Hispanic vs. NHB vs. NHW patients.

Overall survival (OS) was defined as the time from diagnosis to death from any cause, and patients who did not die were censored at the time of last follow-up. Cancer-specific survival (CSS) was defined as the time from diagnosis to death due to breast cancer, and patients who did not die or who died from other causes were censored at time of last follow up. Patients who had other primary cancers before their breast cancer diagnosis or had unknown cause of death were excluded from all CSS analyses. Unadjusted OS and CSS were estimated using the Kaplan-Meier (KM) method, and log-rank tests were used to compare unadjusted OS and CSS between groups. Follow-up was estimated using the reverse KM method. Cox Proportional Hazards models were used to estimate the association of Asian vs. Hispanic vs. NHB vs. NHW race/ethnicity and Chinese vs. Japanese vs. Korean vs. Filipino vs. Vietnamese vs. South Asian vs. SE Asian vs. Other Asian vs. Hispanic vs. NHB vs. NHW race/ethnicity with OS and CSS after adjustment for available covariates including age, year of diagnosis, marital status, residential location, stage, grade, ER status, PR status, treatment with chemotherapy, treatment with radiation therapy, and surgery type. Additional models were conducted including one limited to patients diagnosed in or after 2010 and that included tumor subtype as a covariate in place of ER/PR. Subgroup analyses including those with tumor subtype were further stratified by pre- and post-menopausal status, defined by proxy as age <50 vs ≥50 years, respectively.[19]

Only patients with complete data were included in each analysis, and effective sample sizes are included for all tables and figures. No adjustments were made for multiple comparisons. All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary NC). Our study was deemed exempt by our institutional review board given our use of de-identified data.

Results

Demographics

The final cohort consisted of 910,415 women diagnosed with breast cancer from 1990 to 2016 (Figure 1, Table 1; for complete list of variables, see Supplemental Table 1): 73.6% NHW (n=670,333), 10.1% NHB (n=92,226), 9.3% Hispanic (n=84,451), 7.0% Asian (n=63,405). Among Asian women, the largest ethnic subgroup was Filipino, which comprised 27.1% (n=17,190) of Asian women, followed by Chinese (20.1%; n=12,736), Japanese (17.8%; n=11,303), Other Asian (12.0%; n=7,622), South Asian (8.8%; n=5,555), Korean (6.6%; n=4,163), Vietnamese (5.8%; n=3,689) and SE Asian (1.8%; n=1,147).

Overall median age at diagnosis was 61 years, and Asian women were younger than NHW women (median 57 vs 63 years; $p<0.001$, Table 1). Japanese women were the oldest among Asians (median 64 years) and Vietnamese, Southeast Asian, and Korean women were the youngest (median 53 years for all, Table 1). More NHW women were insured compared to Asian women (89.7% vs 82%; $p<0.001$), though Japanese women had the highest proportion of insured patients (94.5%) of any racial/ethnic group ($p<0.001$, Table 1). SE Asian women had the highest proportion of patients insured with Medicaid (33.3%) while Korean women had the highest proportion of uninsured individuals overall (4.2%) (Table 1).

Disease and treatment characteristics

NHW women were slightly more likely to be diagnosed with no nodal involvement at diagnosis when compared to Asians overall (66.6% vs 66.2%, $p<0.001$), but Japanese women actually had the highest rates of non-metastatic, node-negative disease of all races and countries of origin (73%, $p<0.001$, Table 1). NHB women had the highest rates of advanced disease of all comparison groups (6.8%), and SE Asian women had the highest rates among Asian groups (5.9%, $p<0.001$, Table 1). Asian women were more likely to have HER2+ disease than NHW women (18.7% vs 13.8%, $p<0.001$, Table 1). Among women <50 years old, Filipino women had the highest rates of HER2+ disease (27.1%), and among women ≥50 years old, Vietnamese women had the highest rates (21.5%; both $p<0.001$, Figures 2A and 2B). Notably, regardless of age, Japanese women had the lowest rates of HER2+ disease of all Asian groups and also had a lower rate than NHW women (both $p<0.001$, Figures 2A and 2B).

Asian women underwent mastectomy more frequently than NHW women (42.2% vs 34.4%; $p<0.001$, Table 1). Among Asian ethnicities, however, there was significant variation in surgical treatment: Japanese women had the lowest rates of mastectomy (31.6%) while Vietnamese women had the highest (49.2%; $p<0.001$, Table 1). NHW women had higher rates of lumpectomy and radiation receipt than Asian women but lower rates of chemotherapy (all $p<0.001$, Table 1).

Overall and Cancer-specific Survival

Asian women as a combined group had the best 10-year unadjusted OS and CSS of all racial/ethnic groups (both log-rank $p<0.001$, Figure 3A and 3B). Among Asian women, SE Asian women had the worst 10-year unadjusted OS (70%, 95% CI 66.1–73.5%), and

Japanese women had the second-worst (75.4%, 95% CI 74.5-76.3%), but the latter were also the oldest, with the highest proportion of patients ≥50 (Supplemental Figures). In contrast, Japanese women had the highest 10-year unadjusted CSS (89.4%, 95% CI 88.7-90.1%) of any Asian subgroup, while SE Asian women had the worst (78%, 95% CI 74.1-81.3%, log-rank p<0.001, Figure 3).

After adjustment, SE Asian women had the worst OS (largest hazard ratio) of any Asian group, although they were not statistically worse than Japanese women based on overlapping confidence intervals; they were also the only Asian group without significantly improved OS compared to NHW women (reference, HR 0.88, 95% CI 0.76-1.02, p=0.08, Table 2). Similarly, all Asian groups, except for SE Asians, had better adjusted CSS than NHW women (all p≤0.001, Table 2). (For OS and CSS comparisons with all Asians in one category, see Supplemental Table 2).

Discussion

Asian women in the US constitute a diverse and growing population. In our retrospective study of 910,415 women, we demonstrate differences among women with breast cancer from different regions of Asia with regards to sociodemographic factors, tumor characteristics (and concomitant therapeutic eligibility), as well as survival.

In the literature, Asian women consistently demonstrate lower mortality rates than NHW women,[20–23] but when analyzed by region of origin, some subgroups had mortality rates that were higher than other Asian groups and comparable to NHW women.[21, 23–25] In our study, being Asian was associated with better adjusted OS and CSS both in aggregate, as well as when disaggregated into specific Asian ethnicities compared to other racial/ethnic groups in the US with one notable exception: SE Asian women fared worse than women from other Asian subgroups and fared similarly to NHW women. This finding contrasts with a study by Parise et al.,[21] in which SE Asian women were actually found to have better CSS, and South Asian, Chinese, and Korean women had no significant difference in CSS compared to NHW women. However, their study combined Vietnamese women into the SE Asian group, which may account for this difference in observed outcomes. In contrast, our findings are similar to Yi et al., who found Asian groups were similar in CSS with the exception of Japanese women who fared better than other Asian groups and NHW women.[26] The observation that SE Asian women have worse survival outcomes might be explained in part by higher rates of TNBC disease among SE Asian women compared to most other Asian ethnicities. While the adjusted survival estimates do account for marital status, stage at diagnosis, grade, breast surgery, and ER/PR status, we were unable to adjust for HER2 status due to limited reporting of this variable prior to 2010. (Supplemental Table 1). Additionally, SE Asian women had the highest rate of Medicaid insurance compared to other Asian groups. Again, insurance status was only available for a limited set of diagnosis years, so could not be included in the adjusted modeling; however, this finding may suggest that social factors play a role in the survival disparity seen among SE Asian women.

Notably, there are also significant differences among Asian women with regards to screening participation. A review of 2009 data from the California Health Interview

Survey demonstrated that of the 5 ethnic groups (Chinese, Filipino, Japanese, Korean, and Vietnamese) included in the study, Filipino women had the highest rates of screening both in their lifetime and more recently while Korean women had the lowest rates of screening and were also the least likely to be insured,[27] a finding that was also corroborated in the work we report here. Nevertheless, despite these disparities, even among Korean women, over three-quarters of respondents had had a mammogram in her lifetime, a rate that is much higher than those observed in most non-Asian ethnic groups. In addition, Filipino and Korean women in our study did not have appreciably different rates of advanced disease at diagnosis (Table 1). Accordingly, it is not clear to what extent differences in rates of screening mammography among different Asian groups might contribute to differential rates of late-stage diagnosis, recurrence, and cancer-related death.

Racial differences in breast cancer molecular subtypes are well-documented in the literature.[5, 28–30] Black women are more likely to be diagnosed with TNBC[29] and Asian women have higher rates of HER2+ tumors when compared to other races.[11, 12, 21, 31] Our study is consistent with these findings when evaluating Asians as a single entity and when menopausal status is not stratified. However, these trends in subtype become more complex when analyzed by country/region of origin and when menopausal status is taken into account. Among pre-menopausal women, several distinct groups had higher rates of HER2+ disease compared to NHW women (19.3%), including Chinese, Filipino, South Asian, SE Asian, and Vietnamese women, with the greatest rates being among Filipino (27.1%), SE Asian (24.7%), and Vietnamese (25.2%) women. Among post-menopausal women, all but Japanese women had higher rates than NHW women (12.7%), with the greatest rates being among Korean (20.6%), SE Asian (20.8%), and Vietnamese (21.5%) women. These rates are nearly double those of Japanese women, who had the lowest rates of HER2+ disease in either age category. A study of the California Cancer Registry from 2011 yielded slightly different results, showing Korean, Filipino, Vietnamese, and Chinese women with higher HER2+ rates than NHW women, but this study did not account for menopausal status.[31] Thus, the oft cited observation that HER2 overexpression is more common among Asian women belies the differences amongst different Asian subgroups when sufficiently granular categories are used. This distinction between Asian subgroups extends to rates of TNBC as well. Among pre-menopausal women, rates ranged from 15.2% among South Asians to 8.3% in Japanese and Filipino women. Likewise, there was variation in TNBC rates among post-menopausal women, from the highest among Koreans (12.5%) to the lowest among Filipino (8.0%), Vietnamese (8.1%), and Other Asians (7.1%).

The granular categories in our study enabled comparisons between specific Asian subgroups and other non-Asian racial/ethnic groups. For example, of all the Asian groups, SE Asians were most similar to NHB in terms of later stage at diagnosis and higher-grade disease. Though this observation does not seem to be accounted for by oncologic characteristics in our study, such as prevalence of TNBC disease, these disease characteristics could, in part, be explained by the lower SES more commonly observed in these two groups relative to their comparison groups.[32, 33] Low SES has been found in the literature to contribute to worse health outcomes via factors including residential segregation, decreased access to healthcare, increased financial pressure, and epigenetic modifications as a result of adversity.[34–37] The socioeconomic commonalities between these two groups are often

overlooked, but it may be worthwhile to observe them in parallel and see how lessons learned in improving treatment receipt and outcomes in one group might potentially be applied in the other.

Japanese women were more similar to NHW women than other Asian groups along multiple dimensions associated with better survival: older median age at diagnosis, higher rates of health insurance, less urban geographic location, earlier disease stage at presentation, more frequent HR+ tumor subtype, lower rates of mastectomy, higher rates of adjuvant radiation therapy, and lower rates of chemotherapy. These trends may reflect the potential impact of immigration patterns on screening practices, health outcomes, and differing values placed on breast conservation between Asian cultures, with less acculturated Asian groups more often opting for mastectomy. Of all Asian-American groups, Japanese-Americans have one of the longest histories in the US, which is reflected in Japanese-Americans having the lowest rate of foreign-born residents compared to other Asian groups (27%, compared to the average 59% for All Asians).[38] The difference in breast cancer risk among immigrant Asian-Americans compared to U.S.-born Asian-Americans suggests an association between immigration pattern and Japanese-Americans' trends differing from those of Asians overall, meriting further study in datasets that collect immigration data.[39, 40] This phenomenon among Japanese-Americans contrasts with trends observed among Latinx individuals in the US, among whom subsequent generations often have worse health outcomes than first-generation, foreign-born individuals.[41] The differences between these two groups and amongst Asian-Americans illustrate the disparate effects of immigration, acculturation, and systemic bias on health outcomes of different groups and the importance of recognizing these differential effects in both research and clinical care.

Limitations

Racial data is mainly self-reported but as SEER only reports one racial/ethnic group per patient, the SEER-assigned racial designations in our cohort may not accurately reflect the identities of multiracial people in our cohort. Likewise, use of a composite "Hispanic" racial/ethnic category belies the diversity of this group, as we have previously described.[42] Although we included seven regionally distinct Asian groups in our study, some ethnicities were still aggregated for the purposes of statistical analysis and due to small sample size. Data for certain social determinants of health (e.g., immigration status) and clinical characteristics (e.g., body mass index) were not available to incorporate into our analysis. Additionally, SEER does not distinguish between receiving no treatment and receiving unknown systemic or radiation therapy, thus, we were unable to determine if a patient truly did not undergo treatment or if treatment status was unknown. Menopausal status, though commonly operationalized in research as <50 and ≥50 years old, does not capture potentially different average onset of menopause across regions and ethnicities. One study from 2005 found that northern Indian women had an onset of menopause that was 3 years earlier than women in the West, but other studies have not found significant differences in menopause onset between Eastern and Western populations.[23,24 43,44] Based on the relatively low level of missingness of covariates and the uninformative nature of that missingness, we assumed the unavailable data were missing at random, and complete case analysis was used for all adjusted modeling. Although this approach is appropriate when data are missing completely

at random, it may have introduced some bias into the hazard ratio and confidence interval estimates. Finally, HER2 status and insurance information only became readily available in 2010 and 2007, respectively, so only a subset of the cohort is analyzable along those dimensions.

Conclusion

In summary, our findings demonstrate that studying breast cancer among Asian women grouped as a single entity can lead to inaccurate generalizations regarding tumor-subtype distribution and long-term outcomes. Future research should be devoted to disaggregating these populations to better understand, treat, and counsel Asian patients with breast cancer, as well as to better understand the mechanisms by which acculturation in the US as well as systemic racism may impact breast cancer incidence and outcome.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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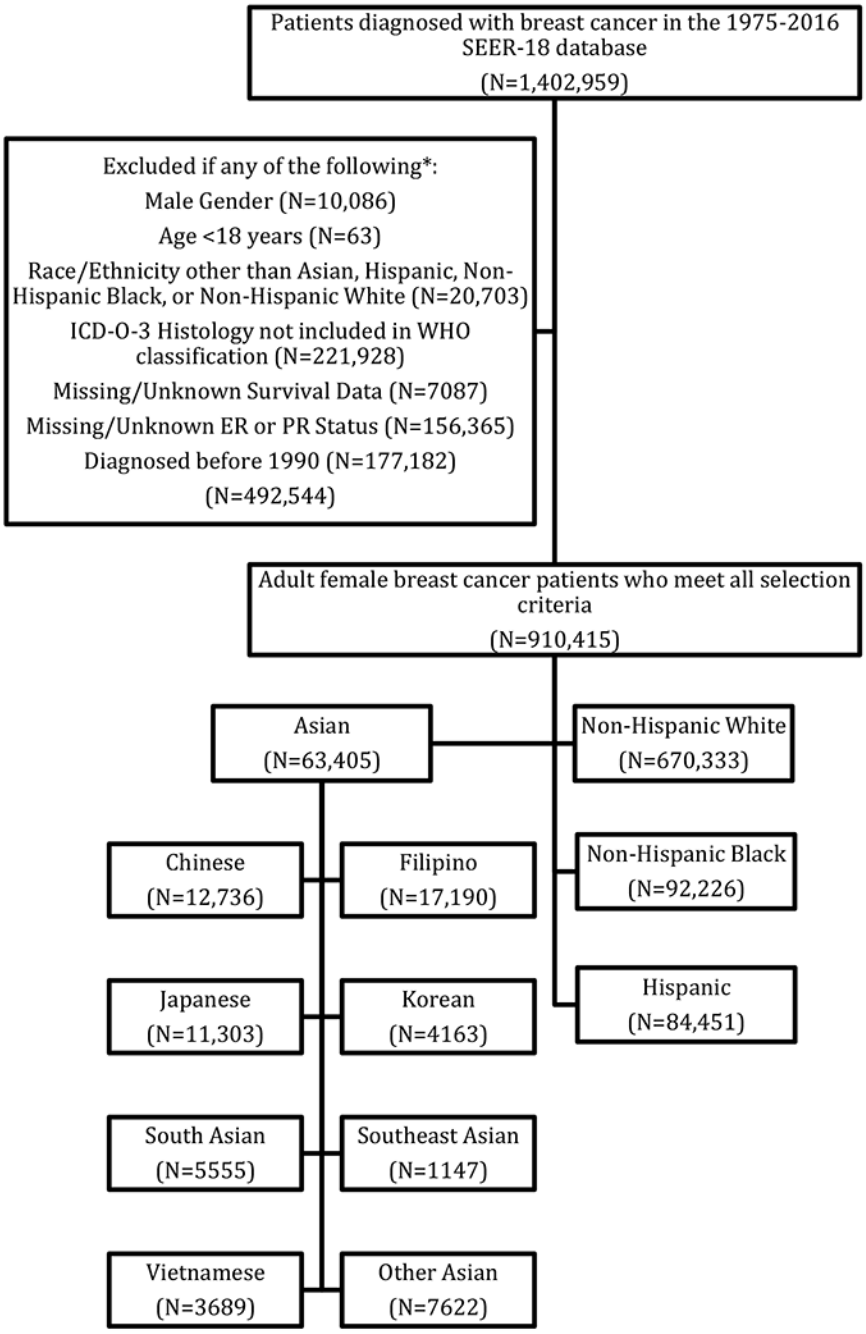
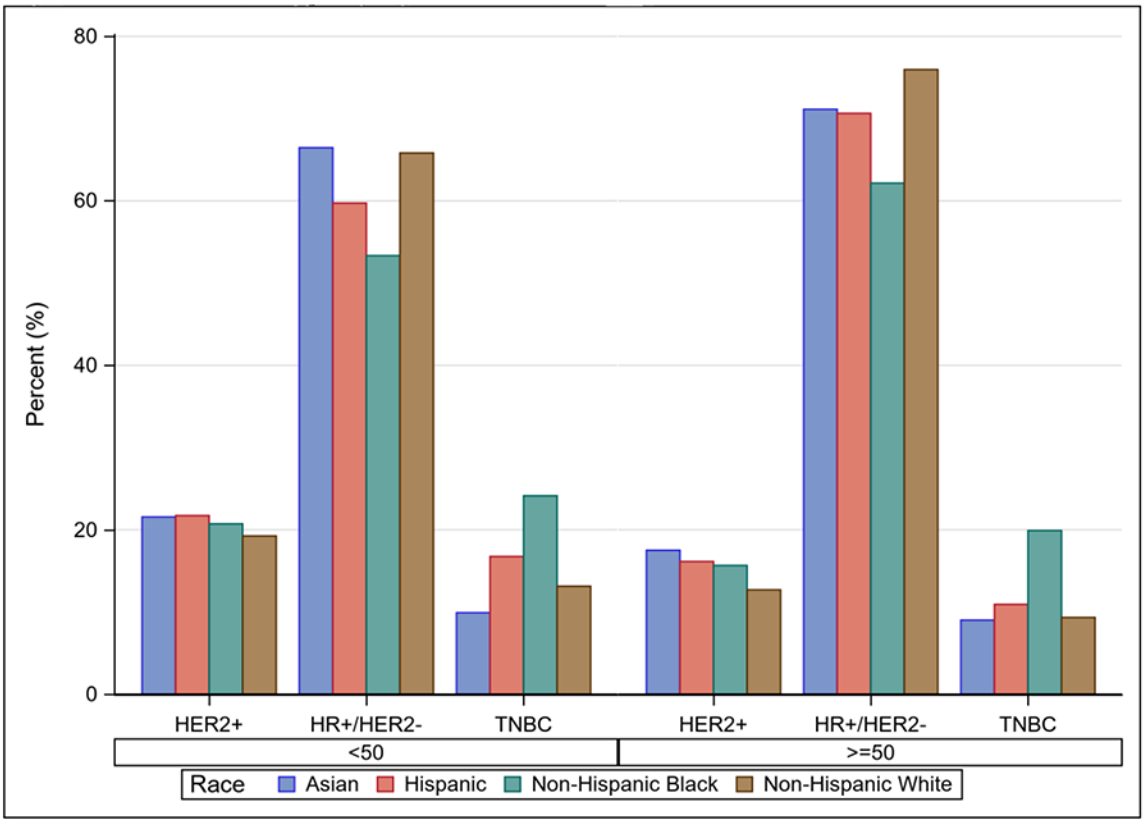
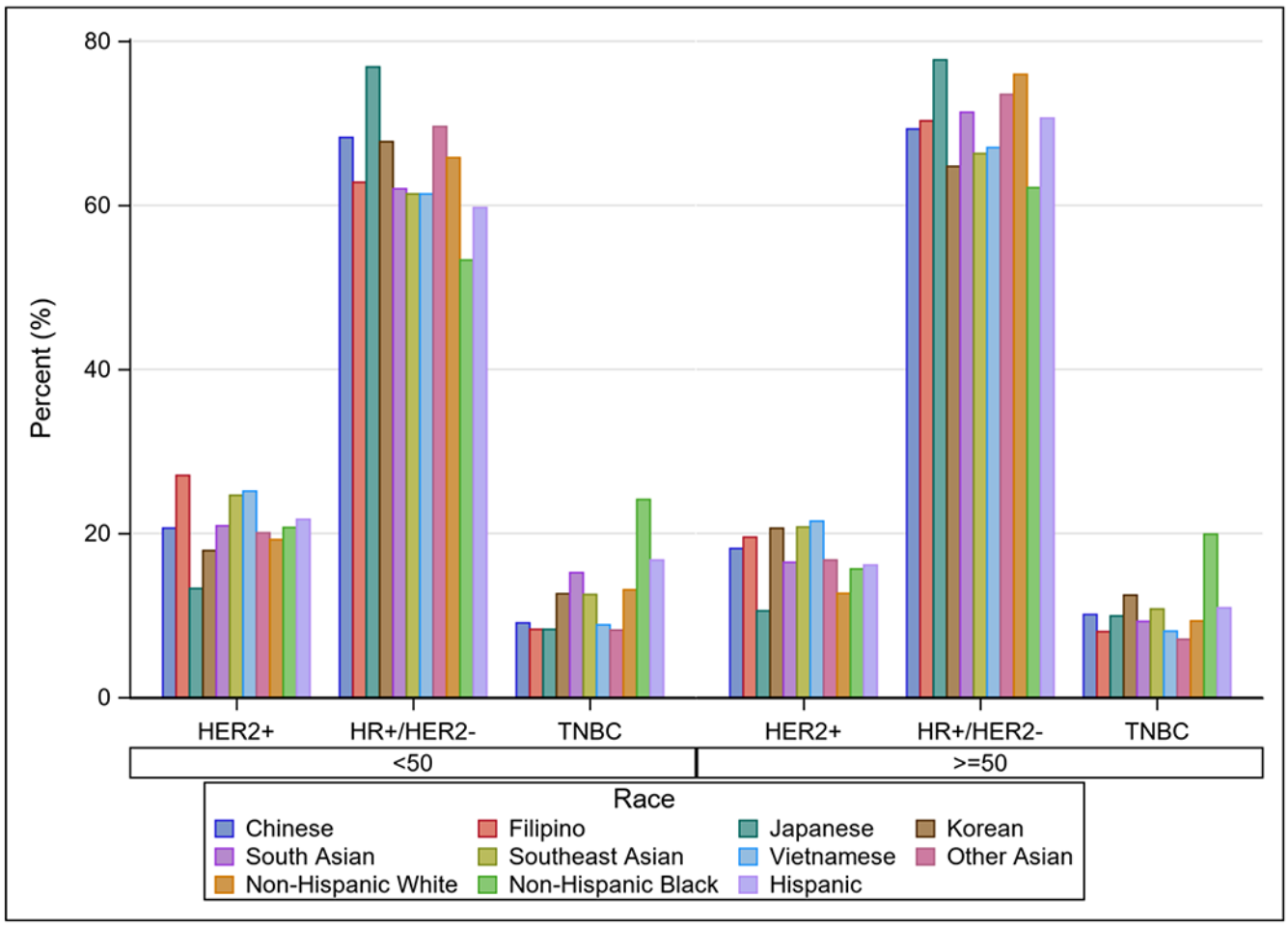


Figure 1. Women diagnosed with breast cancer, Surveillance, Epidemiology, and End Results (SEER) 18 database, 1975-2016

*Patients may have been excluded for more than one of the listed criteria; therefore, the total number of excluded patients is less than the sum of all exclusion criteria sample sizes.



Tumor Subtype	Age <50 Years				Age ≥50 Years			
	Asian	Hispanic	Non-Hispanic Black	Non-Hispanic White	Asian	Hispanic	Non-Hispanic Black	Non-Hispanic White
HER2+	1783 (21.6%)	2849 (21.7%)	2072 (20.7%)	8108 (19.3%)	3672 (17.5%)	4528 (16.1%)	4908 (15.7%)	27,005 (12.7%)
HR+/HER2-	5497 (66.5%)	7832 (59.7%)	5331 (53.3%)	27,720 (65.8%)	14,922 (71.1%)	19,811 (70.6%)	19,472 (62.2%)	161,527 (76.0%)
TNBC	820 (9.9%)	2197 (16.8%)	2413 (24.1%)	5534 (13.1%)	1893 (9.0%)	3067 (10.9%)	6237 (19.9%)	19,868 (9.3%)
p-value*	<0.001				<0.001			



Tumor Subtype	Age <50 Years										
	Chinese	Filipino	Japanese	Korean	South Asian	Southeast Asian	Vietnamese	Other Asian	Hispanic	Non-Hispanic Black	Non-Hispanic White
HER2+	334 (20.7%)	482 (27.1%)	96 (13.3%)	119 (17.9%)	242 (20.9%)	53 (24.7%)	159 (25.2%)	298 (20.1%)	2849 (21.7%)	2072 (20.7%)	8108 (19.3%)
HR+/HER2-	1104 (68.3%)	1118 (62.8%)	555 (76.9%)	450 (67.8%)	717 (62.0%)	132 (61.4%)	388 (61.4%)	1033 (69.6%)	7832 (59.7%)	5331 (53.3%)	27,720 (65.8%)
TNBC	147 (9.1%)	148 (8.3%)	60 (8.3%)	84 (12.7%)	176 (15.2%)	27 (12.6%)	56 (8.9%)	122 (8.2%)	2197 (16.8%)	2413 (24.1%)	5534 (13.1%)
p-value*	<0.001										

Tumor Subtype	Age ≥50 Years										
	Chinese	Filipino	Japanese	Korean	South Asian	Southeast Asian	Vietnamese	Other Asian	Hispanic	Non-Hispanic Black	Non-Hispanic White
HER2+	734 (18.2%)	1194 (19.5%)	321 (10.6%)	263 (20.6%)	325 (16.5%)	79 (20.8%)	263 (21.5%)	493 (16.8%)	4528 (16.1%)	4908 (15.7%)	27,005 (12.7%)
HR+/HER2-	2800 (69.3%)	4295 (70.3%)	2360 (77.7%)	825 (64.8%)	1407 (71.3%)	252 (66.3%)	820 (67.0%)	2163 (73.5%)	19,811 (70.6%)	19,472 (62.2%)	161,527 (76.0%)
TNBC	409 (10.1%)	491 (8.0%)	302 (9.9%)	159 (12.5%)	183 (9.3%)	41 (10.8%)	99 (8.1%)	209 (7.1%)	3067 (10.9%)	6237 (19.9%)	19,868 (9.3%)
p-value*	<0.001										

Figure 2.

A. Tumor subtype by age and race/ethnicity

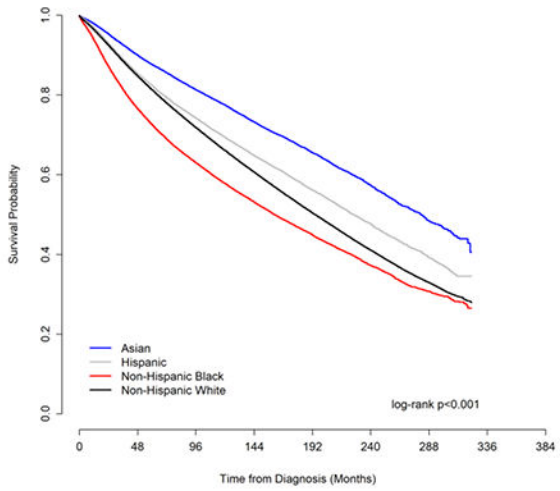
HER2, human epidermal growth factor receptor 2. HR, hormone receptor, TNBC, triple-negative breast cancer.

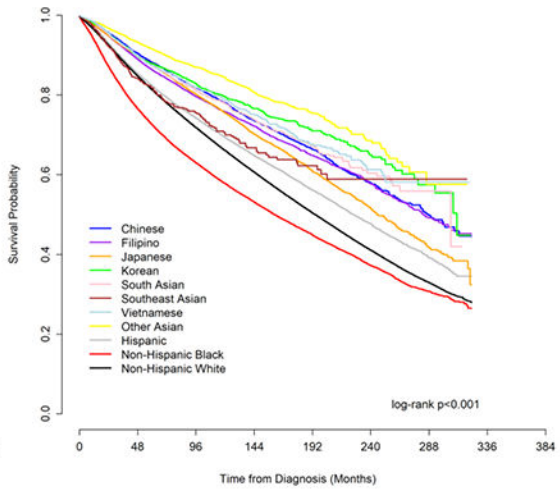
*p-value for difference in distribution of tumor subtype by race/ethnicity within each age group.

B. Tumor subtype by age and race/ethnicity including Asian subgroups

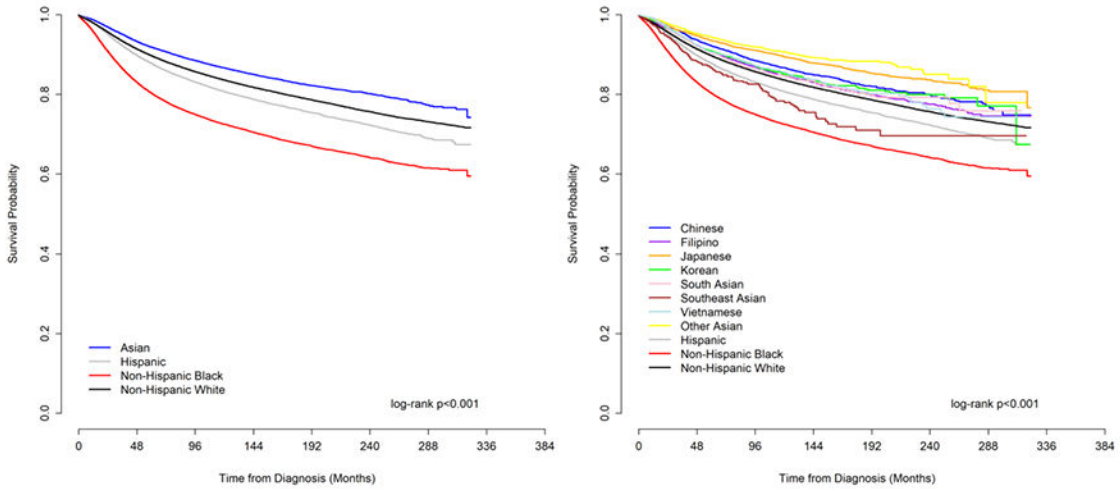
HER2, human epidermal growth factor receptor 2. HR, hormone receptor. TNBC, triple-negative breast cancer.

*p-value for difference in distribution of tumor subtype by race/ethnicity within each age group.





Race/Ethnicity	N	Deaths (%)	Overall Survival Rate (95% CI)	
			5-Year	10-Year
Chinese	12,736	2436 (19.1%)	0.881 (0.874-0.887)	0.780 (0.771-0.789)
Filipino	17,190	3397 (19.8%)	0.862 (0.856-0.868)	0.757 (0.748-0.765)
Japanese	11,303	3124 (27.6%)	0.873 (0.866-0.879)	0.754 (0.745-0.763)
Korean	4163	657 (15.8%)	0.878 (0.866-0.889)	0.794 (0.777-0.810)
South Asian	5555	810 (14.6%)	0.872 (0.861-0.882)	0.778 (0.761-0.793)
Southeast Asian	1147	236 (20.6%)	0.817 (0.789-0.841)	0.700 (0.661-0.735)
Vietnamese	3689	600 (16.3%)	0.874 (0.861-0.886)	0.787 (0.769-0.804)
Other Asian	7622	815 (10.7%)	0.915 (0.907-0.922)	0.841 (0.829-0.853)
All Asian	63,405	12,075 (19%)	0.875 (0.872-0.878)	0.774 (0.769-0.778)
Hispanic	84,451	19,597 (23.2%)	0.822 (0.819-0.825)	0.693 (0.688-0.697)
Non-Hispanic Black	92,226	31,964 (34.7%)	0.723 (0.720-0.727)	0.577 (0.573-0.581)
Non-Hispanic White	670,333	213,287 (31.8%)	0.812 (0.811-0.813)	0.660 (0.658-0.661)
Total	910,415	276,923 (30.4%)	0.808 (0.807-0.809)	0.661 (0.660-0.662)



Race/Ethnicity	N	Attributable Deaths (%)	Breast Cancer-Specific Survival Rate (95% CI)	
			5-Year	10-Year
Chinese	11,023	1141 (10.4%)	0.921 (0.915-0.927)	0.867 (0.858-0.874)
Filipino	14,743	1709 (11.6%)	0.906 (0.900-0.911)	0.846 (0.838-0.853)
Japanese	9406	930 (9.9%)	0.934 (0.929-0.940)	0.894 (0.887-0.901)
Korean	3733	398 (10.7%)	0.909 (0.897-0.919)	0.850 (0.835-0.865)
South Asian	4975	479 (9.6%)	0.904 (0.894-0.914)	0.846 (0.831-0.860)
Southeast Asian	1028	152 (14.8%)	0.865 (0.839-0.888)	0.780 (0.741-0.813)
Vietnamese	3327	352 (10.6%)	0.907 (0.895-0.918)	0.855 (0.839-0.870)
Other Asian	6958	419 (6%)	0.942 (0.935-0.949)	0.906 (0.896-0.915)
All Asian	55,193	5580 (10.1%)	0.918 (0.915-0.921)	0.866 (0.862-0.870)
Hispanic	73,365	9904 (13.5%)	0.877 (0.874-0.880)	0.806 (0.803-0.810)
Non-Hispanic Black	77,622	16,282 (21%)	0.802 (0.799-0.805)	0.725 (0.721-0.729)
Non-Hispanic White	547,012	73,796 (13.5%)	0.896 (0.895-0.897)	0.836 (0.834-0.837)
Total	753,192	105,562 (14%)	0.887 (0.886-0.887)	0.824 (0.823-0.825)

Figure 3.

A. Unadjusted Overall Survival, Women diagnosed with Breast Cancer, Surveillance, Epidemiology, and End Results (SEER) 18 database, 1990-2016

CI, confidence interval.

B. Unadjusted Cancer-Specific Survival, Women diagnosed with Breast Cancer, Surveillance, Epidemiology, and End Results (SEER) 18 database, 1990-2016

Patients with unknown cause of death or other primary cancers before this diagnosis were excluded from this analysis

CI, confidence interval.

Table 1.

Women diagnosed with breast cancer, Surveillance, Epidemiology, and End Results (SEER) 18 database, 1990-2016

	All Patients (N=910,415)	**Chinese (N=12,736)**	**Filipino (N=17,190)**	**Japanese (N=11,303)**	**Korean (N=4163)**	**South Asian (N=5555)**	**Southeast Asian (N=1147)**	**Vietnamese (N=3689)**	**Other Asian (N=7622)**	**All Asian (N=63,405)**	**Hispanic (N=84,451)**	**Non-Hispanic Black (N=92,226)**	**Non-Hispanic White (N=670,333)**	**P[1]**	**P[2]**
Age (y)														<0.001	<0.001
<50	202,233 (22.2%)	4192 (32.9%)	4715 (27.4%)	2271 (20.1%)	1622 (39%)	2138 (38.5%)	465 (40.5%)	1438 (39%)	2748 (36.1%)	19,589 (30.9%)	28,858 (34.2%)	26,110 (28.3%)	127,676 (19%)		
≥50	708,182 (77.8%)	8544 (67.1%)	12,475 (72.6%)	9032 (79.9%)	2541 (61%)	3417 (61.5%)	682 (59.5%)	2251 (61%)	4874 (63.9%)	43,816 (69.1%)	55,593 (65.8%)	66,116 (71.7%)	542,657 (81%)		
Age (y) Median (IQR)	61 (51 - 72)	56 (47 - 67)	57 (49 - 66)	64 (52 - 74)	53 (46 - 63)	54 (45 - 64)	53 (44 - 61)	53 (45 - 62)	54 (46 - 64)	57 (47 - 67)	55 (46 – 66)	58 (48 - 68)	63 (52 - 73)	<0.001	<0.001
Insurance Status[3]														<0.001	<0.001
Insured	430,167 (85.2%)	6309 (82.7%)	8720 (82.6%)	4971 (94.5%)	1853 (70.5%)	3099 (77.2%)	488 (63.6%)	1608 (65.8%)	4783 (86.5%)	31,831 (82%)	37,108 (68.1%)	42,209 (75%)	319,019 (89.7%)		
Any Medicaid	56,458 (11.2%)	1151 (15.1%)	1540 (14.6%)	141 (2.7%)	621 (23.6%)	668 (16.6%)	253 (33%)	769 (31.5%)	556 (10.1%)	5699 (14.7%)	14,132 (25.9%)	11,231 (19.9%)	25,396 (7.1%)		
Uninsured	8097 (1.6%)	87 (1.1%)	153 (1.4%)	29 (0.6%)	110 (4.2%)	162 (4%)	18 (2.3%)	39 (1.6%)	90 (1.6%)	688 (1.8%)	2036 (3.7%)	1775 (3.2%)	3598 (1%)		
Marital Status														<0.001	<0.001
Married or Domestic Partner	500,567 (55%)	8642 (67.9%)	10,922 (63.5%)	6812 (60.3%)	2882 (69.2%)	4206 (75.7%)	687 (59.9%)	2401 (65.1%)	5104 (67%)	41,656 (65.7%)	46,047 (54.5%)	32,369 (35.1%)	380,495 (56.8%)		
Divorced or Separated	103,619 (11.4%)	726 (5.7%)	1359 (7.9%)	871 (7.7%)	365 (8.8%)	222 (4%)	110 (9.6%)	246 (6.7%)	526 (6.9%)	4425 (7%)	10,369 (12.3%)	15,178 (16.5%)	73,647 (11%)		
Single	119,463 (13.1%)	1578 (12.4%)	2273 (13.2%)	1509 (13.4%)	464 (11.1%)	334 (6%)	199 (17.3%)	615 (16.7%)	987 (12.9%)	7959 (12.6%)	14,914 (17.7%)	25,425 (27.6%)	71,165 (10.6%)		
Widowed	149,668 (16.4%)	1403 (11%)	2044 (11.9%)	1844 (16.3%)	336 (8.1%)	613 (11%)	106 (9.2%)	284 (7.7%)	658 (8.6%)	7288 (11.5%)	9227 (10.9%)	14,714 (16%)	118,439 (17.7%)		
Location Type														<0.001	<0.001
Metropolitan	815,871 (89.6%)	12,273 (96.4%)	16,276 (94.7%)	8854 (78.3%)	4018 (96.5%)	5499 (99%)	1120 (97.6%)	3659 (99.2%)	7517 (98.6%)	59,216 (93.4%)	80,972 (95.9%)	86,277 (93.5%)	589,406 (87.9%)		
Urban	79,594 (8.7%)	75 (0.6%)	362 (2.1%)	545 (4.8%)	36 (0.9%)	46 (0.8%)	21 (1.8%)	22 (0.6%)	90 (1.2%)	1197 (1.9%)	3110 (3.7%)	5435 (5.9%)	69,852 (10.4%)		
Rural	10,125 (1.1%)	0 (0%)	2 (0%)	3 (0%)	1 (0%)	5 (0.1%)	2 (0.2%)	0 (0%)	9 (0.1%)	22 (0%)	139 (0.2%)	478 (0.5%)	9486 (1.4%)		

	All Patients (N=910,415)	**Chinese (N=12,736)**	**Filipino (N=17,190)**	**Japanese (N=11,303)**	**Korean (N=4163)**	**South Asian (N=5555)**	**Southeast Asian (N=1147)**	**Vietnamese (N=3689)**	**Other Asian (N=7622)**	**All Asian (N=63,405)**	**Hispanic (N=84,451)**	**Non-Hispanic Black (N=92,226)**	**Non-Hispanic White (N=670,333)**	**P[1]**	**P[2]**
Year of Diagnosis – Median (IQR)	2008 (2002 - 2012)	2008 (2002 - 2013)	2009 (2003 - 2013)	2006 (1999 - 2011)	2009 (2004 - 2013)	2011 (2006 - 2014)	2010 (2005 - 2013)	2010 (2005 – 2013)	2011 (2006 – 2014)	2009 (2003 - 2013)	2009 (2004 - 2013)	2009 (2003 - 2013)	2007 (2001 - 2012)	<0.001	<0.001
Stage														<0.001	<0.001
No Nodal Involvement	589,881 (64.8%)	8544 (67.1%)	10,986 (63.9%)	8255 (73%)	2628 (63.1%)	3300 (59.4%)	689 (60.1%)	2356 (63.9%)	5185 (68%)	41,943 (66.2%)	49,701 (58.9%)	51,991 (56.4%)	44,6246 (66.6%)		
Nodal Involvement	260,822 (28.6%)	3593 (28.2%)	5189 (30.2%)	2516 (22.3%)	1340 (32.2%)	1869 (33.6%)	366 (31.9%)	1165 (31.6%)	2108 (27.7%)	18,146 (28.6%)	29,356 (34.8%)	31,769 (34.4%)	181,551 (27.1%)		
Metastatic Disease	38,917 (4.3%)	406 (3.2%)	756 (4.4%)	302 (2.7%)	125 (3%)	292 (5.3%)	68 (5.9%)	134 (3.6%)	202 (2.7%)	2285 (3.6%)	3839 (4.5%)	6305 (6.8%)	26,488 (4%)		
Grade														<0.001	<0.001
1	177,994 (19.6%)	2276 (17.9%)	2634 (15.3%)	2753 (24.4%)	653 (15.7%)	848 (15.3%)	152 (13.3%)	536 (14.5%)	1494 (19.6%)	11,346 (17.9%)	13,713 (16.2%)	11,108 (12%)	141,827 (21.2%)		
2	357,599 (39.3%)	5231 (41.1%)	7044 (41%)	4785 (42.3%)	1533 (36.8%)	2131 (38.4%)	396 (34.5%)	1473 (39.9%)	3209 (42.1%)	25,802 (40.7%)	31,980 (37.9%)	30,205 (32.8%)	269,612 (40.2%)		
3	306,842 (33.7%)	4379 (34.4%)	6457 (37.6%)	3029 (26.8%)	1733 (41.6%)	2242 (40.4%)	543 (47.3%)	1478 (40.1%)	2534 (33.2%)	22,395 (35.3%)	33,543 (39.7%)	43,509 (47.2%)	207,395 (30.9%)		
Breast Surgery														<0.001	<0.001
Lumpectomy	422,665 (46.4%)	5393 (42.3%)	6573 (38.2%)	5102 (45.1%)	1801 (43.3%)	2558 (46%)	460 (40.1%)	1472 (39.9%)	3474 (45.6%)	26,833 (42.3%)	38,081 (45.1%)	40,144 (43.5%)	317,607 (47.4%)		
Mastectomy	325,898 (35.8%)	5293 (41.6%)	8011 (46.6%)	3575 (31.6%)	1772 (42.6%)	2368 (42.6%)	540 (47.1%)	1815 (49.2%)	3374 (44.3%)	26,748 (42.2%)	33,801 (40%)	34,829 (37.8%)	230,520 (34.4%)		
No Surgery	51,159 (5.6%)	585 (4.6%)	941 (5.5%)	366 (3.2%)	261 (6.3%)	392 (7.1%)	86 (7.5%)	169 (4.6%)	479 (6.3%)	3279 (5.2%)	6001 (7.1%)	8647 (9.4%)	33,232 (5%)		
Other or NOS	640 (0.1%)	8 (0.1%)	7 (0%)	1 (0%)	1 (0%)	8 (0.1%)	0 (0%)	1 (0%)	3 (0%)	29 (0%)	68 (0.1%)	83 (0.1%)	460 (0.1%)		
Treatment with Radiation														<0.001	<0.001
No or Unknown	449,507 (49.4%)	6516 (51.2%)	9208 (53.6%)	5215 (46.1%)	2116 (50.8%)	2534 (45.6%)	616 (53.7%)	2014 (54.6%)	4032 (52.9%)	32,251 (50.9%)	43,132 (51.1%)	46,514 (50.4%)	327,610 (48.9%)		
Yes	439,722 (48.3%)	6013 (47.2%)	7544 (43.9%)	5893 (52.1%)	1931 (46.4%)	2867 (51.6%)	485 (42.3%)	1595 (43.2%)	3358 (44.1%)	29,686 (46.8%)	38,306 (45.4%)	42,725 (46.3%)	329,005 (49.1%)		
Treatment with Chemotherapy														<0.001	<0.001

	All Patients (N=910,415)	Chinese (N=12,736)	Filipino (N=17,190)	Japanese (N=11,303)	Korean (N=4163)	South Asian (N=5555)	Southeast Asian (N=1147)	Vietnamese (N=3689)	Other Asian (N=7622)	All Asian (N=63,405)	Hispanic (N=84,451)	Non-Hispanic Black (N=92,226)	Non-Hispanic White (N=670,333)	P[1]	P[2]
No or Unknown	551,516 (60.6%)	7333 (57.6%)	9008 (52.4%)	7589 (67.1%)	2177 (52.3%)	2664 (48%)	527 (45.9%)	1852 (50.2%)	4368 (57.3%)	35,518 (56%)	43,007 (50.9%)	45,594 (49.4%)	427,397 (63.8%)		
Yes	358,899 (39.4%)	5403 (42.4%)	8182 (47.6%)	3714 (32.9%)	1986 (47.7%)	2891 (52%)	620 (54.1%)	1837 (49.8%)	3254 (42.7%)	27,887 (44%)	41,444 (49.1%)	46,632 (50.6%)	242,936 (36.2%)		
# LNs Examined – Median (IQR)	4 (1 - 12)	4 (2 - 12)	4 (2 - 13)	4 (1 - 14)	4 (2 - 13)	4 (2 - 12)	5 (2 - 12)	4 (2 - 12)	3 (1 - 9)	4 (2 - 12)	4 (2 - 13)	5 (1 - 13)	4 (1 - 12)	<0.001	<0.001
# Positive LNs – Median (IQR)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 0)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	0 (0 - 1)	<0.001	<0.001

Data presented as N (%) unless otherwise specified. Percentages may not add up to 100 due to rounding or missing values.

IQR, interquartile range. NOS, not otherwise specified. ER, estrogen receptor. PR, progesterone receptor. HER2, human epidermal growth factor receptor 2. HR, hormone receptor. TNBC, triple-negative breast cancer. LN, lymph node.

[1] P-value for Chinese vs. Filipino vs. Japanese vs. Korean vs. South Asian vs. Southeast Asian vs. Vietnamese vs. Other Asian vs. Hispanic vs. Non-Hispanic Black vs. Non-Hispanic White

[2] P-value for Asian vs. Hispanic vs. Non-Hispanic Black vs. Non-Hispanic White

[3] Insurance Type reported for patients diagnosed 2007 and after

Table 2.

Adjusted overall and cancer-specific survival by race/ethnicity, women diagnosed with breast cancer, Surveillance, Epidemiology, and End Results (SEER) 18 database, 1990-2016[1]

	Overall Survival (N=695,698)			Cancer-Specific Survival (N=575,567)		
	HR (95% CI)	**p-value**	**Overall p-value**	**HR (95% CI)**	**p-value**	**Overall p-value**
Race/Ethnicity			<0.001			<0.001
Non-Hispanic White	REF			REF		
Chinese	0.693 (0.658-0.729)	<0.001		0.814 (0.756-0.877)	<0.001	
Filipino	0.699 (0.670-0.729)	<0.001		0.825 (0.778-0.876)	<0.001	
Japanese	0.807 (0.768-0.849)	<0.001		0.762 (0.695-0.835)	<0.001	
Korean	0.617 (0.561-0.678)	<0.001		0.838 (0.744-0.943)	0.003	
South Asian	0.657 (0.605-0.712)	<0.001		0.796 (0.716-0.884)	<0.001	
Southeast Asian	0.877 (0.755-1.018)	0.08		1.045 (0.867-1.260)	0.65	
Vietnamese	0.667 (0.607-0.733)	<0.001		0.810 (0.715-0.916)	<0.001	
Other Asian	0.505 (0.466-0.548)	<0.001		0.610 (0.545-0.682)	<0.001	
Hispanic	0.938 (0.921-0.955)	<0.001		1.057 (1.031-1.085)	<0.001	
Non-Hispanic Black	1.182 (1.164-1.200)	<0.001		1.305 (1.277-1.334)	<0.001	
Age (Years)			<0.001			<0.001
<50	REF			REF		
≥50	1.787 (1.762-1.814)	<0.001		1.182 (1.161-1.204)	<0.001	
Year of Diagnosis	0.986 (0.985-0.987)	<0.001	<0.001	0.979 (0.977-0.981)	<0.001	<0.001
Marital Status			<0.001			<0.001
Married or Domestic Partner	REF			REF		
Divorced or Separated	1.274 (1.255-1.294)	<0.001		1.225 (1.196-1.254)	<0.001	
Single	1.312 (1.293-1.332)	<0.001		1.273 (1.246-1.301)	<0.001	
Widowed	2.328 (2.301-2.356)	<0.001		1.690 (1.655-1.727)	<0.001	
Location Type			<0.001			<0.001
Metropolitan	REF			REF		
Urban	1.116 (1.098-1.134)	<0.001		1.128 (1.100-1.158)	<0.001	

	Overall Survival (N=695,698)			Cancer-Specific Survival (N=575,567)		
	HR (95% CI)	**p-value**	**Overall p-value**	**HR (95% CI)**	**p-value**	**Overall p-value**
Rural	1.173 (1.126-1.223)	<0.001		1.239 (1.160-1.323)	<0.001	
Stage			<0.001			<0.001
No Nodal Involvement	REF			REF		
Nodal Involvement	1.800 (1.779-1.820)	<0.001		3.012 (2.955-3.070)	<0.001	
Metastatic Disease	6.012 (5.893-6.133)	<0.001		13.607 (13.238-13.987)	<0.001	

HR, hazard ratio. CI, confidence interval. ER, estrogen receptor. PR, progesterone receptor. NOS, not otherwise specified.

[1] Also adjusted for Tumor Grade, ER/PR status, Type of Breast Surgery, Treatment with Chemotherapy/Radiation (not shown)