Breast Cancer Statistics, 2019

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Abstract: This article is the American Cancer Society's biennial update on female breast cancer statistics in the United States, including data on incidence, mortality, survival, and screening. Over the most recent 5-year period (2012-2016), the breast cancer incidence rate increased slightly by 0.3% per year, largely because of rising rates of local stage and hormone receptor-positive disease. In contrast, the breast cancer death rate continues to decline, dropping 40% from 1989 to 2017 and translating to 375,900 breast cancer deaths averted. Notably, the pace of the decline has slowed from an annual decrease of 1.9% during 1998 through 2011 to 1.3% during 2011 through 2017, largely driven by the trend in white women. Consequently, the black–white disparity in breast cancer mortality has remained stable since 2011 after widening over the past 3 decades. Nevertheless, the death rate remains 40% higher in blacks (28.4 vs 20.3 deaths per 100,000) despite a lower incidence rate (126.7 vs 130.8); this disparity is magnified among black women aged <50 years, who have a death rate double that of whites. In the most recent 5-year period (2013-2017), the death rate declined in Hispanics (2.1% per year), blacks (1.5%), whites (1.0%), and Asians/Pacific Islanders (0.8%) but was stable in American Indians/Alaska Natives. However, by state, breast cancer mortality rates are no longer declining in Nebraska overall; in Colorado and Wisconsin in black women; and in Nebraska, Texas, and Virginia in white women. Breast cancer was the leading cause of cancer death in women (surpassing lung cancer) in four Southern and two Midwestern states among blacks and in Utah among whites during 2016-2017. Declines in breast cancer mortality could be accelerated by expanding access to high-quality prevention, early detection, and treatment services to all women. **CA Cancer J Clin 2019;0:1-14. © 2019 American Cancer Society.**

Keywords: breast neoplasms, epidemiology, health disparities, incidence, molecular subtype, mortality

Introduction

Breast cancer is the most common cancer diagnosed among US women (excluding skin cancers) and is the second leading cause of cancer death among women after lung cancer. Herein, the American Cancer Society provides its biennial update of the latest breast cancer statistics in the United States, including the estimated numbers of new cases and deaths by age in 2019; incidence rates and trends by age, stage at diagnosis, race/ethnicity, and breast cancer molecular subtype through 2016; mortality rates and trends by race/ethnicity and state through 2017; treatment patterns in 2016; and survival by race/ethnicity, stage at diagnosis, and breast cancer subtype. Self-reported mammography prevalence in 2016 is also presented by state. Additional data are available from the companion report, *Breast Cancer Facts & Figures* (available at cancer.org/statistics).

Materials and Methods

Data Sources

Population-based cancer incidence data in the United States are collected by the National Cancer Institute's (NCI's) Surveillance, Epidemiology, and End Results (SEER) program and the Centers for Disease Control and Prevention's National Program of Cancer Registries. Long-term incidence trends since 1975 for ductal

carcinoma in situ (DCIS) and invasive breast cancer by age were based on data from the 9 oldest SEER registries, representing 9% of the US population.[1] Data from the SEER 18 registries, covering 28% of the US population, were used in analyses of breast cancer survival by stage (breast-adjusted; *American Joint Committee on Cancer Cancer Staging Manual*, sixth edition),[2] race/ethnicity, and molecular subtype.[3]

Combined SEER and National Program of Cancer Registries data, as provided by the North American Association of Central Cancer Registries (NAACCR) for use in the American Cancer Society's *Facts & Figures* publications and accompanying statistics articles, were the data source for projected new breast cancer cases in 2019; incidence rates (2012-2016) by race/ethnicity, age, molecular subtype, and state; and contemporary incidence trends by stage, race/ethnicity (2001-2016), and hormone receptor (HR) status (2004-2016).[4,5] These data were also used to describe the distributions of breast cancer cases by age, SEER Summary Stage, tumor size, grade, and molecular subtype. The NAACCR database for this study included all US states except Kansas, because this registry did not consent to our use of their data, and Nevada and the District of Columbia, because their data did not meet NAACCR quality standards for all years from 2004 through 2016. Mississippi, Tennessee, and Virginia were additionally excluded from 2001 through 2016 trend analyses by stage and race/ethnicity because data from these states did not meet NAACCR data quality standards for one or more years during 2001 through 2003.

Mortality data obtained from the National Center for Health Statistics (NCHS) covering all 50 states and the District of Columbia, as reported by the SEER program, were the source for death rates in the most recent time period (2013-2017) and trends by race/ethnicity and state.[6,7] Trend analyses by Hispanic ethnicity (1990-2017) exclude data from states for any years that information on Hispanic origin was not collected: Louisiana (1990), New Hampshire (1990-1992), and Oklahoma (1990-1996). Incidence and mortality rates for American Indians/Alaska Natives (AIANs) were based on cases/deaths in the Purchase/Referred Care Delivery Area counties (formerly referred to as Contract Health Services Delivery Areas), which are counties that include all or part of a reservation as well as those that share a common boundary with a reservation.

Initial treatment data obtained from the National Cancer Data Base (NCDB) are provided for breast cancer cases diagnosed in 2016 and were previously presented in *Cancer treatment and survivorship statistics, 2019* in this journal.[8] The NCDB is a hospital-based cancer registry jointly sponsored by the American Cancer Society and the American College of Surgeons and includes greater than 70% of all invasive cancers in the United States from more than 1500 facilities accredited by the American College of Surgeons' Commission on Cancer.[9,10] Data on chemotherapy include targeted therapy and immunotherapies because many common targeted therapies are classified as chemotherapy in the NCDB.

Prevalence data on mammography by state were obtained from the 2016 Behavioral Risk Factor Surveillance System, an ongoing system of surveys conducted by the state health departments in cooperation with the Centers for Disease Control and Prevention.[11] A median of the state-based Behavioral Risk Factor Surveillance System estimates is also presented. Mammography prevalence estimates do not distinguish between examinations for screening and diagnosis.

Statistical Analyses

The overall estimated number of new invasive breast cancers in 2019 was published previously.[12] The total number of DCIS cases diagnosed in 2019 was estimated by: 1) approximating the actual number of cases in the 10 most recent data years (2007-2016) by applying annual age-specific incidence rates (based on 48 states) to corresponding population estimates for the overall US; 2) calculating the average annual percent change (AAPC) in cases over this time period; and 3) using the AAPC to project the number of cases 3 years ahead. These estimates were also partially adjusted for expected reporting delays using invasive delay factors. Estimated cases by age at diagnosis were calculated by applying the proportion of DCIS and invasive cases diagnosed in each age group during 2012-2016 from the NAACCR analytic file to the total number of estimated cases of DCIS and invasive breast cancer in 2019. Similarly, we calculated the estimated number of breast cancer deaths by age at death by applying the proportion of deaths that occurred in each age group during 2013-2017 to the total estimated breast cancer deaths in 2019.

The estimated number of female breast cancer deaths averted because of the reduction in breast cancer death rates since 1989 was estimated by summing the differences between the number of breast cancer deaths that would have been expected if the death rate had remained at its peak and the actual number of recorded breast cancer deaths for each year. The expected number of deaths for each year was estimated by applying 5-year age-specific cancer death rates in 1989 to the corresponding age-specific female populations from 1990 through 2017.

By using the approach of Anderson et al,[13] we imputed missing estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) status assuming that status was missing at random, conditional on year of diagnosis, age, race/ethnicity, and ER/PR/HER2 status. Specifically, 2-step imputation was performed based on the joint distribution of ER (positive, negative, and missing) and PR (positive, negative, and missing) status. In the first step, those cases

TABLE 1. Estimated New Ductal Carcinoma In Situ and Invasive Breast Cancer Cases and Deaths Among Women by Age, United States, 2019

	DCIS CASES		INVASIVE CASES		DEATHS	
AGE, Y	NO.	%	NO.	%	NO.	%
<40	1180	2%	11,870	4%	1070	3%
40-49	8130	17%	37,150	14%	3250	8%
50-59	12,730	26%	61,560	23%	7460	18%
60-69	14,460	30%	74,820	28%	9920	24%
70-79	8770	18%	52,810	20%	8910	21%
80+	2830	6%	30,390	11%	11,150	27%
All ages	**48,100**		**268,600**		**41,760**	

Abbreviation: DCIS, ductal carcinoma in situ.
Note: Estimates are rounded to the nearest 10. Percentages may not sum to 100 due to rounding.

TABLE 2. Age-Specific 10-Year Probability of Breast Cancer Diagnosis or Death for US Women

CURRENT AGE	DIAGNOSED WITH INVASIVE BREAST CANCER		DEATH FROM BREAST CANCER	
20	0.1%	(1 in 1479)	<0.1%	(1 in 18,503)
30	0.5%	(1 in 209)	<0.1%	(1 in 2016)
40	1.5%	(1 in 65)	0.2%	(1 in 645)
50	2.4%	(1 in 42)	0.3%	(1 in 310)
60	3.5%	(1 in 28)	0.5%	(1 in 193)
70	4.1%	(1 in 25)	0.8%	(1 in 132)
80	3.0%	(1 in 33)	1.0%	(1 in 101)
Lifetime risk	**12.8%**	**(1 in 8)**	**2.6%**	**(1 in 39)**

Note: Probability is among those who have not been previously diagnosed with breast cancer. Percentages and "1 in" numbers may not be numerically equivalent due to rounding.

with missing ER or PR (not both) status were allocated to ER/PR-positive and ER/PR-negative groups according to the distribution of known ER/PR status in each diagnosis year, age, race/ethnicity, and ER/PR group. In the second step, those cases with both ER and PR status missing were allocated to HR-positive (defined as either ER-positive or PR-positive) and HR-negative (defined as both ER-negative and PR-negative) groups according to the updated distribution of HR status obtained in step 1. Similarly, for joint categories of ER, PR, and HER2, we first imputed HR status among cases with known HER2 status. Then, we allocated those with unknown HER2 status to the 4 subtypes according to their updated distributions obtained in the previous step.

All incidence and death rates were age-standardized to the 2000 US standard population and expressed per 100,000 women, as calculated by the NCI's SEER*Stat software (version 8.3.5).[14] We examined trends in incidence and mortality rates using the Joinpoint Regression Program to calculate AAPC.[15] All incidence trends were adjusted for delays in reporting based on SEER delay factors to account for the additional time required for the complete registration of cases. The age-specific probability of developing breast cancer (2014-2016) was calculated using the NCI's DevCan software (version 6.7.7).[16]

Selected Findings

Estimated Cases and Deaths in 2019

In 2019, approximately 268,600 new cases of invasive breast cancer and 48,100 cases of DCIS will be diagnosed among US women, and 41,760 women will die from this disease. Eighty-two percent of breast cancers are diagnosed among women aged ≥50 years, and 90% of breast cancer deaths occur in this age group (Table 1). The median age at diagnosis for female breast cancer is 62 years, and it is slightly younger for black women (60 years) than for white women (63 years).[17] The median age at breast cancer death is 68 years overall, 70 years for white women, and 63 years for black women.[17]

Estimated Number of Breast Cancer Survivors in 2019

As of January 1, 2019, there were more than 3.8 million women with a history of breast cancer living in the United States. This estimate includes more than 150,000 women living with metastatic disease, three-quarters of whom were originally diagnosed with stage I, II, or III breast cancer.[18]

Ten-Year Probability of Invasive Breast Cancer Diagnosis or Death

Approximately 13% of women (1 in 8) will be diagnosed with invasive breast cancer in their lifetime (Table 2). Lifetime risk reflects an average woman's risk accounting for deaths from other causes that may preempt a breast cancer diagnosis. By 10-year age group, the probability of a breast cancer diagnosis is highest for women in their 70s (4.1%), while breast cancer death is most likely among women in their 80s (1.0%).

Characteristics of Breast Cancers Diagnosed in the United States

Table 3 indicates the substantial racial/ethnic variation in breast cancer tumor characteristics among patients aged ≥20 years who were diagnosed during 2012 through 2016. For example, non-Hispanic black (black), Hispanic, and AIAN patients are less likely to be diagnosed with local-stage breast cancers (56%-60%) compared with Asian/Pacific Islander (API) and non-Hispanic white (white) patients (64%-66%). Likewise, 8% of black patients with breast cancer are diagnosed with distant-stage (metastatic) breast cancer compared with 5% to 6% of patients of other races/ethnicities. Black women are also most likely to be diagnosed with tumors that are ≥5.0 cm (12%) or high

TABLE 3. Characteristics of Invasive Female Breast Cancers by Race/Ethnicity, Ages ≥20 Years, United States, 2012-2016

	ALL RACES		NH WHITE		NH BLACK		HISPANIC		ASIAN/PACIFIC ISLANDER		AMERICAN INDIAN/ALASKA NATIVE	
CHARACTERISTIC	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Age at diagnosis, y												
20-29	6168	1%	3476	<1%	1239	1%	964	1%	381	1%	30	1%
30-39	45,632	4%	27,054	3%	7513	6%	7039	7%	3273	7%	241	5%
40-49	162,458	14%	107,054	12%	22,105	16%	20,459	21%	10,694	23%	690	15%
50-59	269,163	23%	193,197	22%	35,771	27%	24,555	26%	12,223	26%	1204	27%
60-69	327,135	28%	253,474	29%	35,398	26%	22,619	24%	11,931	25%	1256	28%
70-79	230,933	20%	188,076	21%	20,966	16%	13,325	14%	6217	13%	739	17%
80+	132,857	11%	111,646	13%	10,995	8%	6263	7%	2682	6%	292	7%
SEER Summary Stage												
Local	755,005	64%	586,317	66%	74,999	56%	55,465	58%	30,531	64%	2670	60%
Regional	318,100	27%	226,681	26%	43,778	33%	30,818	32%	13,442	28%	1318	30%
Distant	68,072	6%	48,250	5%	11,258	8%	5583	6%	2296	5%	267	6%
Unknown	33,169	3%	22,729	3%	3952	3%	3358	4%	1132	2%	197	4%
Tumor size[a]												
<2.0 cm	512,227	55%	404,254	57%	48,500	46%	35,384	47%	19,219	52%	1759	49%
2.0-4.9 cm	291,609	31%	212,135	30%	37,665	35%	25,925	35%	12,818	34%	1231	34%
5+ cm	77,925	8%	53,077	8%	13,266	12%	7502	10%	3305	9%	314	9%
Unknown	51,941	6%	35,742	5%	6840	6%	5790	8%	1828	5%	268	8%
Grade												
Low	242,660	21%	197,710	22%	17,857	13%	15,955	17%	8427	18%	928	21%
Intermediate	482,695	41%	373,552	42%	46,398	35%	37,512	39%	20,068	42%	1724	39%
High	340,430	29%	234,076	26%	55,714	42%	31,745	33%	15,133	32%	1375	31%
Unknown	108,561	9%	78,639	9%	14,018	10%	10,012	11%	3773	8%	425	10%
ER status												
Positive	924,129	79%	715,521	81%	90,307	67%	71,226	75%	37,617	79%	3357	75%
Negative	191,252	16%	127,467	14%	36,602	27%	17,325	18%	7865	17%	792	18%
Unknown	58,965	5%	40,989	5%	7078	5%	6673	7%	1919	4%	303	7%
Subtype												
HR+/HER2−	778,416	66%	608,578	69%	73,788	55%	57,790	61%	30,605	65%	2772	62%
HR+/HER2+	115,174	10%	83,600	9%	13,968	10%	10,636	11%	5689	12%	467	10%
HR−/HER2+	47,819	4%	32,569	4%	7020	5%	4783	5%	4182	9%	467	10%
HR−/HER2−	123,156	10%	81,189	9%	25,911	19%	10,692	11%	2865	6%	234	5%
Unknown	109,781	9%	78,041	9%	13,300	10%	11,323	12%	4060	9%	512	12%

Abbreviations: ER, estrogen receptor; HER2, human epidermal growth factor receptor 2; HR, hormone receptor; NH, non-Hispanic.
Note: percentages may not sum to 100 due to rounding.
[a]Data by tumor size was limited to cases diagnosed during 2012-2015 due to the high proportion of missing data in 2016.

grade (42%). Moreover, black women are the only group for which high-grade tumors are more common than low-grade or intermediate-grade tumors. The distributions of breast cancer by molecular subtypes, as defined by the presence or absence of hormone (estrogen or progesterone) receptors (HR-positive/HR-negative) and expression of the human epidermal growth factor receptor 2 (HER2-positive/HER2-negative) protein, are also described in Table 3. HR-positive/HER2-negative breast cancers are by far the most common subtype in each racial/ethnic group. Approximately 19% of breast cancers diagnosed in black women are HR-negative/HER2-negative (triple negative) compared with 11% in Hispanics, 9% in whites, 6% in APIs, and 5% in AIANs.

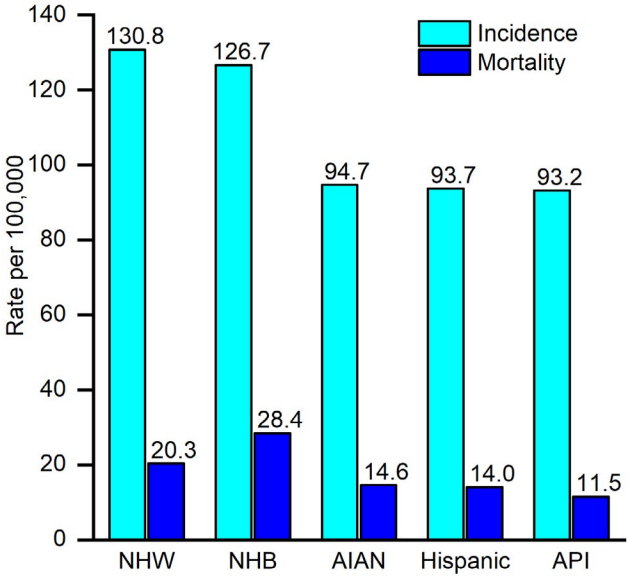

FIGURE 1. Female Breast Cancer Incidence (2012-2016) and Mortality (2013-2017) Rates by Race/Ethnicity, United States. Rates are age adjusted to the 2000 US standard population. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

Cancer Occurrence in the Most Recent Time Period

Incidence and mortality rates

Female breast cancer incidence and mortality rates by race/ethnicity are shown in Figure 1. Breast cancer incidence rates are highest in whites (130.8 per 100,000), followed closely by blacks (126.7 per 100,000), and are lowest in APIs (93.2 per 100,000). However, black women have the highest breast cancer death rate (28.4 per 100,000), which is 40% higher than the rate in white women (20.3 per 100,000) and more than double the rate in API women (11.5 per 100,000). As shown in Figure 2, these racial/ethnic differences in breast cancer rates vary somewhat by age. Black women have the highest breast cancer incidence rate before age 40 years and are most likely to die from breast cancer at every age. Black-white disparities in breast cancer incidence and mortality are largest in young women and decline with age (Fig. 3). For example, death rates for blacks are 1.9-2.6 times higher than for whites in the age groups ≤ 50 years but 1.1-1.2 times higher in the groups aged 70 to 79 years and ≥80 years. Greater racial disparities in younger women may in part reflect the higher proportion of triple-negative breast cancers that are diagnosed in younger women.[19]

Incidence rates for breast cancer subtypes

Racial/ethnic variations in incidence rates by breast cancer subtype and age are shown in Figure 4. Among women 20 years and older, incidence rates of HR-positive/HER2-negative breast cancer are highest in white women (138 cases per 100,000), with rates 23% higher than in blacks (112 per 100,000) and about 45% higher than in Hispanics and AIANs, who have the lowest incidence rates (94-97 per 100,000). Furthermore, lower overall breast cancer incidence rates in Hispanic, API, and AIAN women primarily result from their lower rates of the HR-positive/HER2-negative subtype. In contrast, incidence rates for triple-negative breast cancers are about twice as high in blacks (38 per 100,000) compared with whites (19 per 100,000). There is less racial/ethnic variation in the HER2-positive subtypes. These patterns are remarkably similar to those in younger (ages 20-49 years) and older (ages ≥50 years) women, except for HR-positive/HER2-negative breast cancer. For example, APIs have the second highest rate of HR-positive/HER2-negative breast cancer among younger women (46 per 100,000, only slightly lower than in young white women,

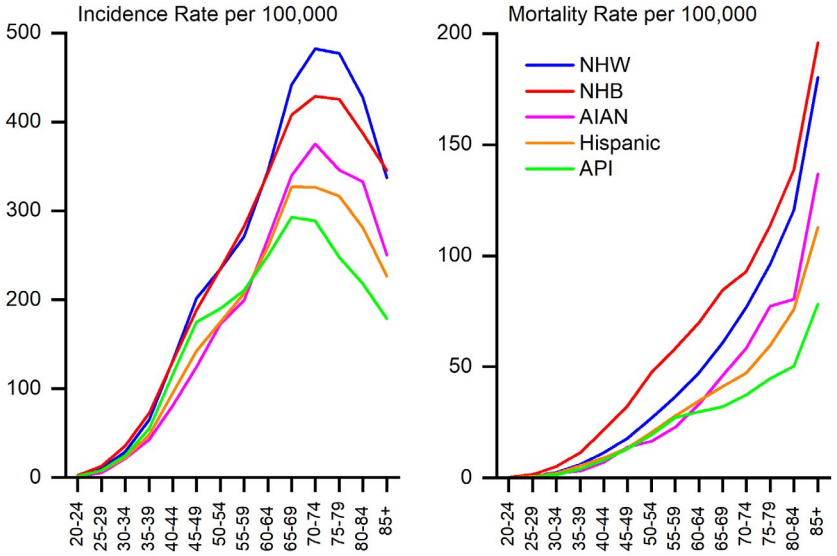

FIGURE 2. Age-Specific Female Breast Cancer Incidence (2012-2016) and Mortality (2013-2017) Rates by Race/Ethnicity, United States. Rates are age adjusted to the 2000 US standard population. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

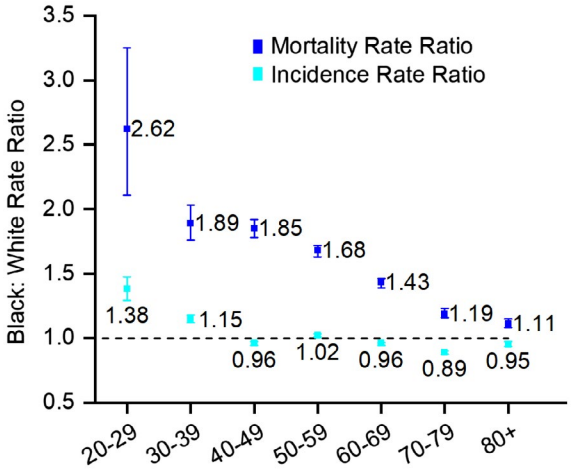

FIGURE 3. Rate Ratios Comparing Breast Cancer Incidence (2012-2016) and Mortality (2013-2017) Rates in Black and White Women by Age. White women served as the reference group, and rate ratios are based on unrounded rates. Error bars indicate 95% confidence intervals.

51 per 100,000), but they have the lowest rate among older women (177 vs 275 per 100,000 in whites). This may partly reflect age-related differences in the make-up of the Asian population in the United States, which includes women from more than 30 countries that differ in their immigration patterns and risk factor profiles.[20]

Importantly, studies suggest that the distribution of breast cancer subtypes varies within broadly defined racial/ethnic groups. For example, a recent study reported that the prevalence of the triple-negative subtype in black women in the United States varied substantially by country of birth; compared with US-born blacks, the prevalence was 47% lower in women born in countries in Eastern Africa but only 8% lower in Western Africa-born blacks.[21] In another study of women in California, those of Korean, Filipina, Chinese, and Southeast Asian descent had a higher risk of HER2-positive breast cancers compared with white women, whereas those of Japanese and Asian Indian descent had a lower risk.[22] Differences in breast cancer subtype within and between racial/ethnic groups likely reflect variations in the prevalence of breast cancer risk factors[23] and mammography use,[24] but may also be related to genetic variations.[21,25-27]

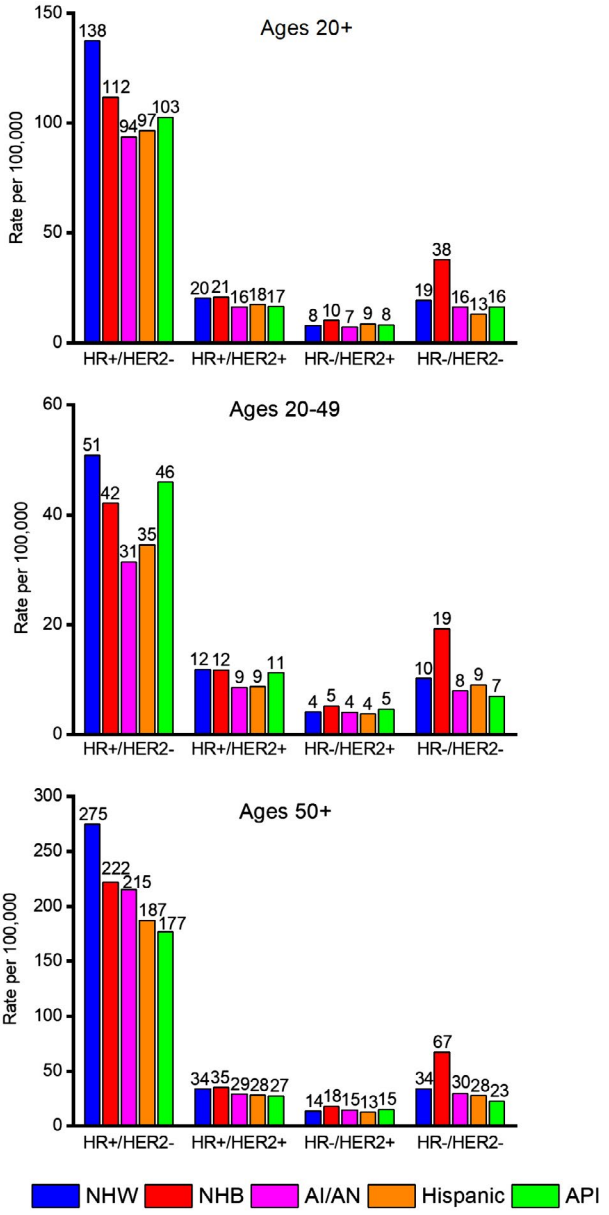

FIGURE 4. Female Breast Cancer Incidence Rates by Subtype, Race/Ethnicity, and Age, 2012 to 2016, United States. Rates are age adjusted to the 2000 US standard population. Hormone receptor (HR) and/or human epidermal growth factor receptor 2 (HER2) statuses were imputed for cases with missing information. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

Temporal Trends in Incidence and Mortality

Incidence

Much of the historic increase in breast cancer incidence rates reflects changes in reproductive patterns, such as delayed childbearing and fewer births, associated with increased breast cancer risk.[28] During the 1980s and 1990s, incidence rates of DCIS and invasive breast cancer rose rapidly, particularly among women aged ≥50 years (Fig. 5), largely because of increased use of mammography screening which increased from 29% in 1987 to 70% in 2000.[29] Among women aged ≥ 50 years, DCIS rates increased more than 11-fold, from 7 cases per 100,000 in 1980 to 83 cases per 100,000 in 2008. However, in the most recent period (2012-2016), the DCIS incidence rate decreased by 2.1% per year.[4]

In contrast, there was a sharp drop (nearly 13%) in the invasive breast cancer incidence rate between 1999 and 2004, largely attributed to the decreased use of menopausal hormones after publication of the Women's Health Initiative randomized trial results linking use of estrogen plus progesterone menopausal hormone therapy to breast cancer and heart disease.[30-32] The drop in incidence may also reflect small declines in mammography screening

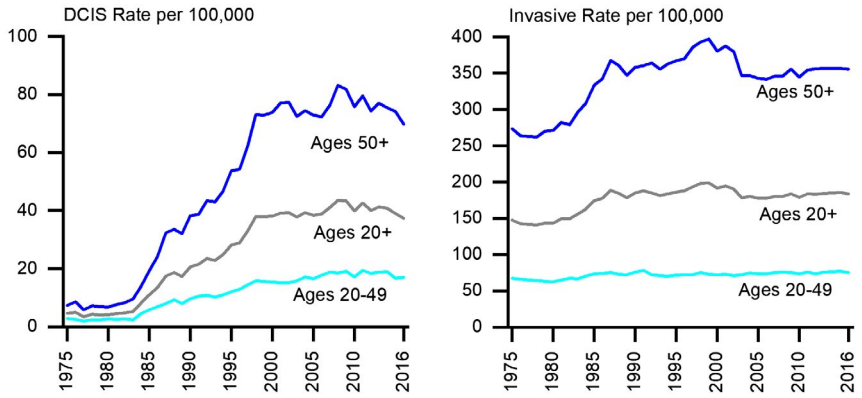

FIGURE 5. Long-Term Trends in Incidence Rates of Ductal Carcinoma in Situ (DCIS) and Invasive Female Breast Cancer by Age, United States, 1975 to 2016. Rates are age adjusted to the 2000 US standard population.

prevalence since 2000.[29] The decrease in breast cancer incidence was limited to white women, primarily for ER-positive disease.[31,33]

Since 2004, the overall invasive breast cancer incidence rate has risen by about 0.3% per year.[17] A recent ecologic study concluded that increases in body mass index and continued declines in the fertility rate likely contributed to the increase in incidence.[34] The overall increase in breast cancer incidence largely reflects a rise in local-stage disease (Fig. 6). From 2012 to 2016, the incidence rate for local-stage breast cancer increased by 1.1% per year, in contrast to an annual decline of 0.8% for regional disease, which may reflect a shift toward earlier stage at diagnosis. The incidence rate for distant-stage disease increased by 2.5% annually during 2001 through 2011, but has since stabilized. The increase in incidence rates of metastatic disease may be caused in part by improvements in classification as opposed to increased occurrence because the rate for unknown stage declined in parallel. However, a study of young women concluded that the decline in unknown stage did not fully account for the increase in distant-stage disease, particularly among black women.[35] Alternatively, this trend may also reflect increased detection of asymptomatic metastases, as more patients with newly diagnosed breast cancer are undergoing advanced body imaging (computed tomography and positron emission tomography-computed tomography scans).

Trends in breast cancer incidence rates by race/ethnicity are shown in Figure 7. During 2012 through 2016, incidence rates increased among APIs (1.5% per year), AIANs (0.8% per year), and blacks and whites (both 0.5% per year), but were relatively stable among Hispanic women.[4,5] We further examined these trends by hormone receptor status from 2004 to 2016 (Fig. 8) (trends for HER2 subtypes could not be examined because HER2 status was not required to be collected by cancer registries until 2010). During 2012 through 2016, incidence rates of HR-positive breast cancers increased annually by 1.1% per year in white and Hispanic women and by 2.2% in

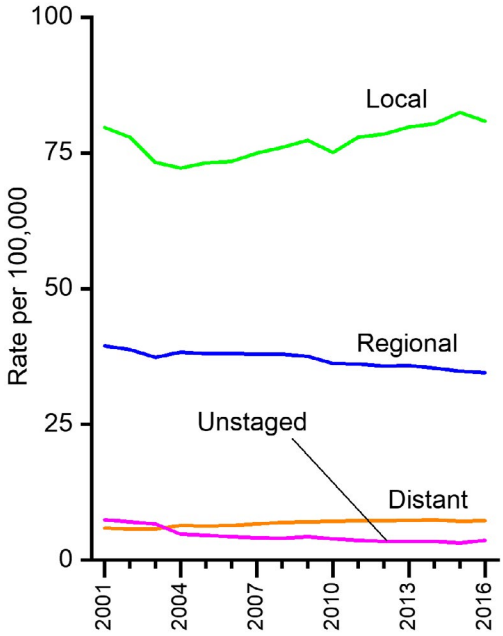

FIGURE 6. Trends in Female Breast Cancer Incidence Rates by Stage at Diagnosis, 2001 to 2016, United States. Rates are age adjusted to the 2000 US standard population.

API women. In black women, the incidence rate for HR-positive breast cancer increased 2.8% per year during 2004 through 2011, but has since stabilized. A similar pattern was observed for AIAN women. In contrast, HR-negative tumors decreased in all racial/ethnic groups by 1.5%-2.6% per year. We also examined these patterns among women aged 20 to 49 years and ≥50 years, and the trends were similar, although the decrease in HR-negative tumors was not significant in young AIAN women or older Hispanic women (data not shown). Reasons for the divergent trends are not known but likely reflect changes in subtype-specific breast cancer risk factors. For example, parity is associated with a lower risk of HR-positive breast cancer and a higher risk of triple-negative breast cancer.[23,36] In the United States, the fertility rate, which was once as high as

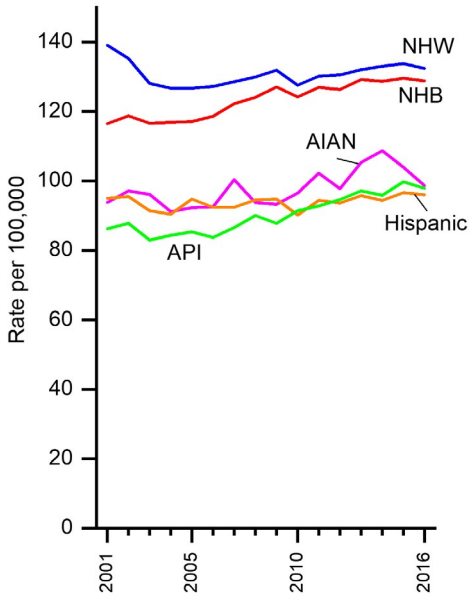

FIGURE 7. Trends in Female Breast Cancer Incidence Rates by Race/Ethnicity, 2001 to 2016, United States. Rates are age adjusted to the 2000 US standard population. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

118 births per 1000 women aged 15 to 44 years, declined from 69.4 births per 1000 women aged 15 to 44 years in 2007 to an all-time low of 60.3 in 2017.[37]

Mortality

The overall breast cancer death rate increased by 0.4% per year from 1975 to 1989, but since has decreased rapidly, for a total decline of 40% through 2017. As a result of this decline, 375,900 breast cancer deaths have been averted in US women through 2017. Declines in breast cancer mortality have been attributed both to improvements in treatment and to early detection by mammography.[38,39] However, not all women have benefitted equally from these advances, as indicated by the striking divergence in mortality trends between black and white women that emerged in the early 1980s with the introduction of mammography and adjuvant hormonal therapy (tamoxifen) and continued to widen (Fig. 9) with additional therapeutic advances.

Higher breast cancer death rates in black women reflect a combination of factors that are difficult to parse, including later stage at diagnosis and other unfavorable tumor characteristics, higher prevalence of obesity and comorbidities, as well as less access to timely and high-quality prevention, early detection, and treatment services.[26,40] For example, because of lower rates of HR-positive disease, black women as a group have benefitted less from the approval of tamoxifen in 1977 by the US Food and Drug Administration, which improved survival for HR-positive breast cancers.[41] In addition, black women are more likely to be screened at lower resourced and nonaccredited facilities and to experience longer intervals between screening mammograms and between abnormal findings and follow-up.[42,43]

Notably, the decline in breast cancer mortality has slowed in the most recent time period—from an annual decrease of 1.9% during 1998 through 2011 to 1.3% during 2011 through 2017, largely driven by the trend in white women. In the most recent 5-year period (2013-2017), the breast cancer death rate declined annually by 2.1% in Hispanics, 1.5% in blacks, 1.0% in whites, and 0.8% in APIs, but was relatively stable in AIANs (Fig. 9). Because of the slower

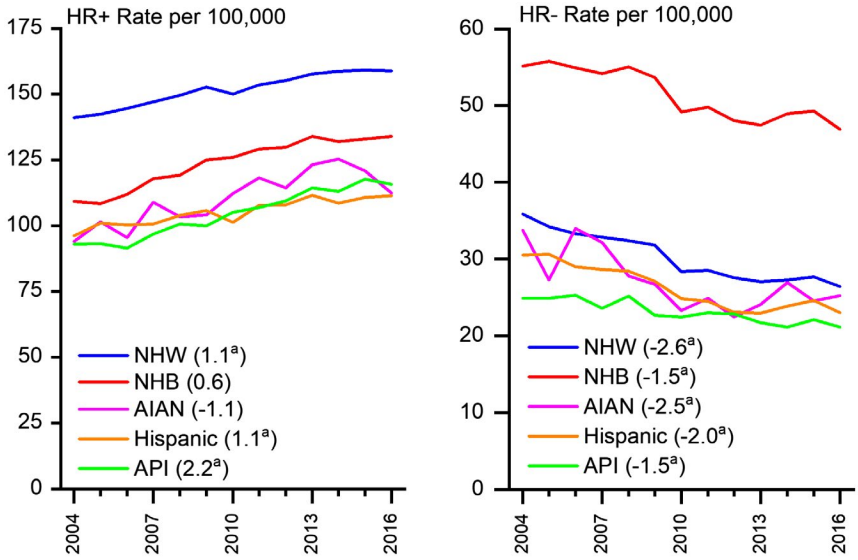

FIGURE 8. Trends in Breast Cancer Incidence Rates by Hormone Receptor Status and Race/Ethnicity Among Women Ages ≥20 Years, 2004 to 2014, United States. Rates are age adjusted to the 2000 US standard population. Hormone receptor (HR) status was imputed for cases with missing information. The average annual percent change (AAPC) during 2012 through 2016 is indicated in parentheses. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white. [a]The trend (as measured by the AAPC) was significantly different from zero ($P < .05$).

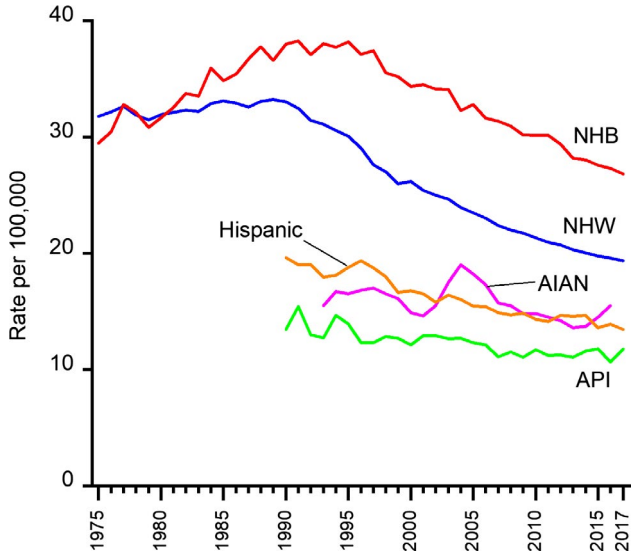

FIGURE 9. Trends in Female Breast Cancer Death Rates by Race/Ethnicity, United States, 1975 to 2017. Rates are age adjusted to the 2000 US standard population. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

decline in recent years among white women, the black-white disparity in breast cancer mortality, which had widened over the 3 prior decades, has remained stable since 2011. The black-white breast cancer disparity peaked in 2011 with death rates 44% higher in blacks than in whites (30.2 per 100,000 compared with 20.9 per 100,000, respectively). Nevertheless, in the most recent period (2013-2017), the breast cancer death rate was 40% higher in black women versus white women (Fig. 1).

Treatment

Breast cancer treatment patterns by stage at diagnosis are described in Figure 10. In 2016, nearly one half of patients with early-stage (stage I or II) breast cancer underwent breast-conserving surgery with adjuvant radiation therapy, and one-third underwent mastectomy. Despite equivalent survival when combined with radiation, breast-conserving surgery–eligible patients are increasingly electing mastectomy for a variety of reasons, including reluctance to undergo radiation therapy, fear of recurrence, and a desire for symmetry.[44,45] Younger patients (aged <40 years) and those with larger and/or more aggressive tumor characteristics are more likely to be treated with mastectomy as well as contralateral prophylactic mastectomy.[46-48] The proportion of women undergoing surgery for nonmetastatic disease in one breast who receive contralateral prophylactic mastectomy has increased rapidly, from 10% in 2004 to 33% in 2012 among women aged 20 to 44 years and from 4% to 10% during the same time period among those aged ≥45 years.[48]

Approximately 18% of patients with early-stage disease received treatment that included chemotherapy. The 21-gene recurrence-score assay, Oncotype DX, is one of several commercially available gene-expression assays that is used to predict the benefit of chemotherapy (in addition to hormonal therapy) for patients with HR-positive/HER2-negative, lymph node-negative breast cancer; patients with high scores are at increased risk of distant recurrence and are most likely to benefit from chemotherapy. Evidence is less clear for patients with intermediate risk scores; however, recent results from the TAILORx (Trial Assigning Individualized Options for Treatment) clinical trial based on 9 years of follow-up indicate that most patients aged >50 years with intermediate recurrence scores are unlikely to benefit from chemotherapy.[49] Although most patients receive chemotherapy after surgery, a recent study has documented an increase in the use of neoadjuvant chemotherapy, particularly among patients with HER2-positive and triple-negative breast cancers.[50] The extent of residual disease at the time of surgery (ie, pathologic response) provides important prognostic information and may inform additional therapeutic recommendations. Recent research has focused on identifying therapies that can improve outcomes among patients with breast cancer who receive neoadjuvant treatment but fail to achieve a complete pathologic response.[51,52]

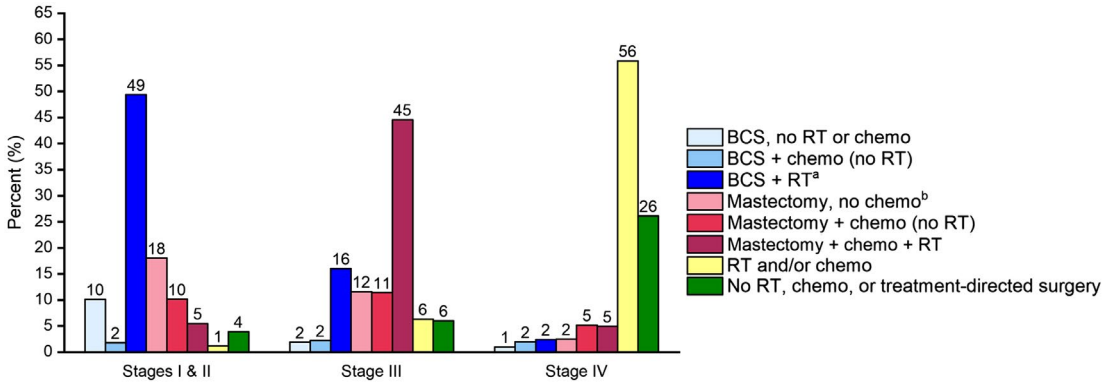

FIGURE 10. Female Breast Cancer Treatment Patterns (%) by Stage at Diagnosis, 2016. BCS indicates breast-conserving surgery; chemo, chemotherapy (includes targeted therapy and immunotherapy). [a]A small number of these patients received chemotherapy. [b]A small number of these patients received RT.

Treatment advances for HR-negative/HER2-negative breast cancers have lagged behind those for other molecular subtypes and thus far have been limited to chemotherapy for nonmetastatic disease.[53] However, immunotherapy drugs are an emerging area of breast cancer treatment, particularly for patients with this subtype. For example, among patients with metastatic HR-negative/HER2-negative breast cancer, the PD-L1 checkpoint inhibitor, atezolizumab, in combination with nanoparticle albumin-bound paclitaxel, has been shown to prolong progression-free survival.[54] Clinical trials are currently evaluating combinations of immunotherapies and targeted therapies in all subtypes of breast cancer.[55]

Most patients with stage IV breast cancer are managed with palliative/noncurative-intent treatment: 56% received radiation/chemotherapy alone, and 26% received no treatment (although some of these patients received hormonal therapy). However, the expanded spectrum of targeted systemic therapies for breast cancer, especially for HR-positive and HER2-positive disease, has improved survival for metastatic disease over the past 3 decades.[56]

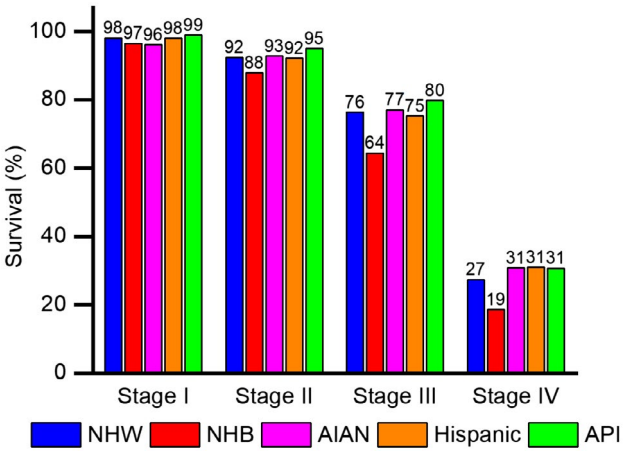

FIGURE 11. Five-Year Breast Cancer-Specific Survival Rates (%) by Stage at Diagnosis and Race/Ethnicity, United States, 2009 to 2015. Survival was based on patients who were diagnosed during 2009 through 2015 and followed through 2016. Stage was based on the American Joint Committee on Cancer (AJCC) *Cancer Staging Manual*, sixth edition. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; NHB, non-Hispanic black; NHW, non-Hispanic white.

Survival

Breast cancer survival varies substantially by stage at diagnosis. The overall 5-year breast cancer survival rate for patients diagnosed during 2009 through 2015 was 98% for stage I, 92% for stage II, 75% for stage III, and 27% for stage IV. For every stage at diagnosis, breast cancer survival is highest for APIs and lowest for blacks, with racial disparities most striking for patients diagnosed with stage III breast cancer (Fig. 11). Note that survival rates for API and Hispanic patients may be overestimated because of incomplete or inaccurate vital statistics information in cancer registry data.[57]

We also examined 5-year breast cancer survival by subtype (Fig. 12). Although black women with breast cancer have lower 5-year survival for every subtype, differences in survival between black and white women across subtypes were similar (5%-7% lower in blacks). This is in contrast to previous studies, which documented that racial disparities in survival were greatest for HR-positive/luminal breast cancers.[58-60] Triple-negative breast cancers have a poorer prognosis compared with other subtypes, in part because this subtype is more likely to be diagnosed at an advanced stage, and the development of targeted therapies has lagged behind.[61,62] Notably, a recent US population-based study

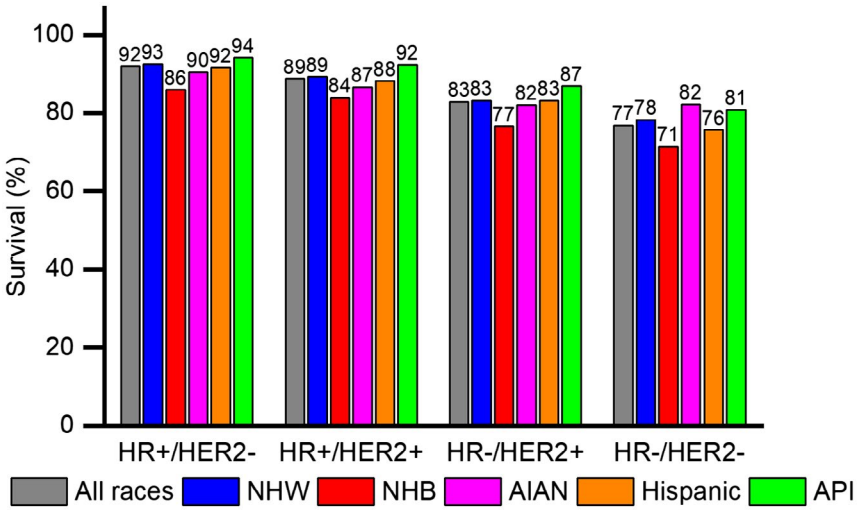

FIGURE 12. Five-Year Breast Cancer-Specific Survival Rates (%) by Subtype and Race/Ethnicity, United States, 2010 to 2015. Survival was based on patients who were diagnosed during 2010 through 2015 and followed through 2016. AIAN indicates American Indian/Alaska Native; API, Asian/Pacific Islander; HER2, human epidermal growth factor receptor 2; HR, hormone receptor; NHB, non-Hispanic black; NHW, non-Hispanic white.

TABLE 4. State Variation in Female Breast Cancer Incidence and Mortality Rates and Rate Ratios in White and Black Women and Mammography Screening Prevalence

	INCIDENCE (2012-2016)			MORTALITY (2013-2017)					MAMMOGRAPHY PREVALENCE (2016)	
	RATE		RATE RATIO	RATE		RATE RATIO	AAPC		UP-TO-DATE ACS[a]	BIENNIAL
STATE	NHB	NHW	NHB:NHW	NHB	NHW	NHB:NHW	NHB	NHW	(AGES 45+ Y)	(AGES 50-74 Y)
Alabama	125.7	121.2	1.04	26.8	20.0	1.34[b]	−1.2[b]	−1.4[b]	72	78
Alaska	132.0	122.5	1.08	—	19.5	—	—	−1.8[b]	58	68
Arizona	111.7	122.1	0.91[b]	26.0	20.0	1.30[b]	—	−1.8[b]	66	76
Arkansas	118.3	116.3	1.02	29.5	19.9	1.48[b]	−1.0[b]	−1.2[b]	65	73
California	128.1	138.8	0.92[b]	30.9	22.2	1.39[b]	−1.0[b]	−1.5[b]	71	82
Colorado	120.2	130.0	0.92	28.7	19.1	1.50[b]	2.2	−1.8[b]	64	74
Connecticut	127.2	144.3	0.88[b]	21.8	18.0	1.21[b]	−2.1[b]	−2.6[b]	77	86
Delaware	135.7	139.1	0.98	24.8	21.2	1.17	−2.0[b]	−2.3[b]	76	82
District of Columbia[c]	135.5	139.9	0.97	33.2	18.1	1.83[b]	−1.8[b]	−2.2[b]	72	84
Florida	110.1	123.4	0.89[b]	25.6	19.5	1.32[b]	−1.4[b]	−1.4[b]	75	82
Georgia	129.3	127.2	1.02	28.6	20.0	1.43[b]	−1.1[b]	−1.5[b]	72	79
Hawaii	110.7	147.0	0.75	—	20.2	—	—	−2.1[b]	74	84
Idaho	—	125.7	—	—	22.4	—	—	−1.3[b]	58	64
Illinois	135.3	138.0	0.98	30.2	21.2	1.42[b]	−1.3[b]	−1.4[b]	69	78
Indiana	129.1	123.1	1.05	28.3	20.6	1.37[b]	−1.3[b]	−1.8[b]	64	72
Iowa	112.6	126.1	0.89	20.3	18.7	1.08		−2.2[b]	71	78
Kansas	125.4	127.8	0.98	28.3	19.2	1.47[b]	−1.6[b]	−1.6[b]	68	75
Kentucky	128.3	127.2	1.01	25.2	21.1	1.19[b]	−2.1[b]	−1.5[b]	71	77
Louisiana	134.7	122.8	1.10[b]	32.3	19.9	1.63[b]	−1.0[b]	−1.8[b]	70	78
Maine	—	126.1	—	—	18.5	—	—	−2.2[b]	73	81
Maryland	133.2	136.7	0.97	28.2	20.3	1.39[b]	−1.4[b]	−2.1[b]	74	81
Massachusetts	120.7	143.3	0.84[b]	20.1	18.1	1.11	−2.7[b]	−3.0[b]	78	86
Michigan	127.0	124.7	1.02	28.8	20.0	1.44[b]	−1.3[b]	−2.0[b]	71	79
Minnesota	102.0	132.4	0.77[b]	20.3	18.1	1.12	—	−2.4[b]	73	82
Mississippi	122.2	116.4	1.05[b]	31.6	19.8	1.59[b]	−0.5[b]	−1.3[b]	65	72
Missouri	133.7	130.0	1.03	30.5	20.8	1.47[b]	−1.0[b]	−1.6[b]	69	76
Montana	—	124.0	—	—	19.9	—	—	−1.9[b]	66	74
Nebraska	107.5	127.8	0.84[b]	25.8	20.6	1.25	—	0.7	64	73
Nevada[c]	109.5	120.9	0.91[b]	29.7	23.9	1.24[b]	—	−1.1[b]	62	73
New Hampshire	94.0	146.4	0.64	—	19.3	—	—	−2.4[b]	73	82
New Jersey	132.2	143.2	0.92	31.0	21.6	1.43[b]	−1.3[b]	−2.3[b]	73	81
New Mexico	110.8	123.0	0.90	—	21.8	—	—	−1.5[b]	60	72
New York	121.7	141.9	0.86[b]	25.3	19.4	1.30[b]	−1.6[b]	−2.2[b]	70	80
North Carolina	133.9	134.8	0.99	27.8	19.5	1.43[b]	−1.4[b]	−1.7[b]	72	79
North Dakota	—	127.5	—	—	18.2	—	—	−2.2[b]	69	75
Ohio	128.4	128.8	1.00	29.8	21.7	1.37[b]	−1.1[b]	−1.9[b]	70	77
Oklahoma	126.9	118.2	1.07[b]	31.3	22.5	1.39[b]	−1.3[b]	−1.1[b]	66	74
Oregon	127.6	127.8	1.00	27.9	20.6	1.36	—	−1.8[b]	66	74
Pennsylvania	130.5	134.8	0.97[b]	30.8	20.7	1.49[b]	−1.4[b]	−2.2[b]	68	76
Rhode Island	118.9	144.1	0.82[b]	24.8	18.2	1.37	—	−3.0[b]	79	85
South Carolina	128.6	130.9	0.98	28.0	19.7	1.42[b]	−1.2[b]	−1.7[b]	68	76
South Dakota	—	132.6	—	—	19.3	—	—	−1.9[b]	72	79
Tennessee	124.8	123.8	1.01	29.8	20.6	1.45[b]	−2.8[b]	−1.6[b]	68	77
Texas	120.9	123.5	0.98	28.5	20.5	1.39[b]	−1.3[b]	−0.4	64	73
Utah	80.6	116.4	0.69[b]	—	20.8	—	—	−1.1[b]	65	77
Vermont	—	132.6	—	—	17.9	—	—	−2.4[b]	70	79
Virginia	134.6	131.8	1.02	28.9	21.0	1.38[b]	−1.7[b]	1.3	73	80
Washington	124.1	139.1	0.89[b]	22.8	20.9	1.09	−2.1[b]	−1.8[b]	66	76
West Virginia	128.2	117.5	1.09	31.2	21.8	1.43[b]	—	−1.3[b]	71	78
Wisconsin	141.1	132.0	1.07[b]	28.0	19.0	1.48[b]	−0.9	−2.0[b]	72	80
Wyoming	—	114.9	—	—	18.5	—	—	−2.2[b]	57	64
United States	**126.7**	**130.8**	**1.04[b]**	**28.4**	**20.3**	**1.40[b]**	**−1.5[b]**	**−1.0[b]**	**70**	**78**

Abbreviations: AAPC, average annual percent change; ACS, American Cancer Society; NHB, non-Hispanic black; NHW, non-Hispanic white.
Note: Incidence and mortality rates are per 100,000 and are age-adjusted to the 2000 US standard population. Statistics not shown if there ≤ 25 cases or deaths.
[a]Up to date according to ACS screening guideline: mammogram within the past year for women ages 45 to 54 years or in the past 2 years for women aged ≥55 years.
[b]The black:white rate ratio is significantly different from 1.00 or the AAPC is significantly different from 0.0 ($P < .05$).
[c]Data from these registries are not included in US combined rates.

found that 4-year relative survival was ≥95% for patients diagnosed with stage I disease across all breast cancer subtypes.[63]

Geographic Variations in Incidence, Mortality, and Mammography

State variations in breast cancer incidence and mortality rates and black-white rate ratios, mortality trends, and mammography screening prevalence are presented in Table 4. Breast cancer incidence rates ranged from 80.6 per 100,000 in Utah to 141.1 per 100,000 in Wisconsin among black women and from 114.9 per 100,000 in Wyoming to 147.0 per 100,000 in Hawaii among white women. Among 43 states and the District of Columbia with available data, incidence rates during 2012 through 2016 were significantly higher among black women than among white women living in 4 states (Louisiana, Mississippi, Oklahoma, and Wisconsin) and were not statistically significantly different in 26 other states and the District of Columbia (Table 4). Importantly, these rates reflect screening prevalence as well as disease occurrence.

Breast cancer death rates were higher among black women than among white women in every US state during 2013 through 2017 and ranged from 20.1 per 100,000 in Massachusetts to 33.2 per 100,000 in the District of Columbia among black women and from 17.9 in Vermont to 23.9 in Nevada among white women. The excess death rate in blacks, as measured by the black-white mortality rate ratio (MRR), also varies widely in the United States, ranging from 19% (MRR, 1.19; 95% CI, 1.03-1.37) in Kentucky to 83% in the District of Columbia (MRR, 1.83; 95% CI, 1.45-2.33). There was no statistically significant difference in the breast cancer death rate between black and white women in 8 states, although this may reflect a lack of statistical power (ie, a small number of breast cancer deaths in black women) except for Massachusetts (MRR, 1.11; 95% CI, 0.97-1.26). Massachusetts has achieved near-universal health insurance coverage, which may have contributed to their elimination of racial disparities in breast cancer mortality.[64] However, the growth of the black immigrant population in the United States, which is highly concentrated in the Northeast and South, may also be a factor because those born in other countries tend to be healthier than those born in the United States.[65,66]

We also examined trends in breast cancer death rates by state (Table 4). During 2013 through 2017, breast cancer death rates decreased in all states except Nebraska. After an annual decline of 2.5% from 1990 to 2010, the breast cancer death in Nebraska was stable during 2010 through 2017. We further examined these trends by race/ethnicity and found that the decline in breast cancer mortality had also levelled off in recent years for black women in Colorado and Wisconsin and for white women in Nebraska, Texas, and Virginia. These results are consistent with a recent study that found an increase in breast cancer death rates through 2014 among women in major cities in each of these states, including Denver, Colorado and Milwaukee, Wisconsin, for black women and Austin and San Antonio in Texas; Omaha, Nebraska; and Virginia Beach, Virginia, for white women, among others.[67] Moreover, during 2016-2017, breast cancer was the leading cause of cancer deaths (surpassing lung cancer) in 6 states (Arizona, Colorado, Florida, Georgia, Mississippi, and South Carolina) among black women, as well as in Utah among white women (data not shown). In 4 other states (Alabama, Massachusetts, New York, and Texas), the numbers of breast and lung cancer deaths among black women were generally similar.

With regard to screening, in 2016, the reported prevalence of up-to-date screening according to the American Cancer Society guideline[68] (annual screening for women aged 45-54 years and biennial screening for those aged ≥55 years) ranged from 57% in Wyoming to 79% in Rhode Island. We also examined the prevalence of biennial mammography among women aged 50 to 74 years, corresponding to screening recommendations from the US Preventative Services Task Force,[69] which ranged from 64% in Idaho and Wyoming to 86% in Connecticut and Massachusetts.

Conclusions

Incidence rates of HR-positive breast cancer are increasing in the United States, likely due in part to increasing prevalence of excess body weight and declining fertility rates. Decreasing incidence rates for HR-negative breast cancer, which are associated with poorer survival, may have contributed to the declines in breast cancer mortality. Although the black-white disparity in breast cancer mortality is no longer widening because the decline in death rates has slowed among white women, the breast cancer death rate in black women remains 40% higher than that in white women overall and is 2-fold higher among young women. Reasons for the slowing of the decline in breast cancer mortality in recent years are not known, but may reflect widespread diffusion of the major treatment advances of the past several decades, particularly among white women, as well as the increase in incidence. Of note, the past few years have witnessed exciting advances in targeted and immunotherapeutic management of all breast cancer subtypes. Declines in breast cancer mortality could be accelerated by expanding access to high-quality prevention, early detection, and treatment services to all women in the United States. ■

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