

Supplementary Material

Supplementary Box 1. SEER codes used for database queries

Data

Incidence – SEER 13 Regs Research Data, Nov 2018 Sub (1992-2016) <Katrina/Rita Population Adjustment>

Incidence-Based Mortality – SEER 13 Regs Research Data, Nov 2018 Sub (1992-2016) <Katrina/Rita Population Adjustment>

Survival—Cause-Specific Survival, Kaplan-Meier

Statistic

Rates – Age Adjusted, standard population: 2000 US Std population (19 age groups – Census P25-1130), age variable: age recode with < 1-year olds

Selection

Incidence Rate Selections:

- Select only: Malignant behavior, known age, first matching record for each person
- Origin Recode NHIA = Non-Spanish-Hispanic-Latino
- Race recode = W, B
- Other, Type of Reporting Source = 'Hospital inpatient/outpatient or clinic,' 'Radiation treatment or medical oncology center (2006+),' 'Laboratory only (hospital or private),' 'Physician's office / private medical practitioner (LMD)', 'Nursing/convalescent home/hospice,' 'Other hospital outpatient unit or surgery center (2006+)'

Survival Selections:

- Select only: Microscopically Confirmed, Malignant Behavior, Known Age.
- Exclude: All Death Certificate Only and Autopsy Only, Alive with No Survival Time,
- Exclusions to Match the Expected Survival Table: Age Values Not Found in Table, Invalid Year, Values Not Found for Other Variables in Table
- Multiple Primary Selection: First Primary Only (Sequence Number 0 or 1)

Parameters (Survival Only)

Survival Calculation: Pre-calculated Duration. Survival months (from complete dates)
 Censor When Attained Age Exceeds Expected Table Max

Papillary Thyroid Cancer

Site and Morphology Site Recode (ICD-O-3/WHO 2008) = 'Thyroid'

Site and Morphology Histologic Type ICD-O-3 = 8050/3, 8260/3, 8340/3-8344/3

ER/PR+ Breast Cancer

Site and Morphology Site Recode (ICD-O-3/WHO 2008) = 'Breast'

Race, Sex, Year Dx, Registry, County = 'Female'

Extent of Disease – CS, ER Status Recode Breast Cancer (1990+) = 'Positive'

Extent of Disease – CS, PR Status Recode Breast Cancer (1990+) = 'Positive'

Supplementary Table 1. Incidence, incidence-based mortality, and survival of persons with papillary thyroid cancer, white vs. black persons.

	White Persons, Papillary Thyroid Cancer	Black Persons Papillary Thyroid Cancer	<i>P</i> *†
Incidence, Rate (CI)‡§	14.3 (14.1-14.5)	7.7 (7.4-8.1)	<.001
Size			
≤ 2 cm	10.0 (9.8-10.2)	4.9 (4.6-5.2)	<.001
2.1-4.0 cm	2.9 (2.8-3.0)	1.4 (1.2-1.6)	<.001
>4 cm	1.4 (1.4-1.5)	1.4 (1.3-1.6)	.88
SEER Summary Stage, Rate (CI)‡§			
Localized	9.0 (8.8-9.2)	5.7 (5.4-6.0)	<.001
Regional	4.8 (4.7-4.9)	1.7 (1.5-1.9)	<.001
Distant	0.33 (0.30-0.37)	0.22 (0.16-0.30)	.008
American Joint Committee on Cancer Stage (7 th Edition), Rate (CI)‡§			
Stage I/II	11.6 (11.4-11.9)	6.2 (5.9-6.6)	<.001
Stage III/IV	2.3 (2.2-2.4)	1.3 (1.1-1.4)	<.001
Incidence-Based Mortality, Rate (CI)‡	0.16 (0.15-0.17)	0.12 (0.10-0.15)	.01
5-year Overall Survival, % (CI)	96.0% (95.8-96.2%)	94.3% (93.4%-95.0%)	<.001
5-year Disease-Specific Survival, % (CI)	98.5% (98.4-98.7%)	98.7% (98.2-99.0%)	.70
20-year Overall Survival, % (CI)	81.0% (80.2-81.8%)	76.1% (73.0-78.9%)	<.001
20-year Disease-Specific Survival, % (CI)	96.7% (96.4-97.0%)	96.1% (94.5-97.3%)	.32

*Incidence rates are compared using two-sided Chi-square test. †Survival curves are compared using log-rank test. ‡ Rates expressed are per 100,000 age-adjusted population. §Incidence data presented are from 2010-2014. ||Incidence-based mortality and survival data presented are from 1992-2014.

Supplementary Table 2. Incidence, incidence-based mortality, and survival of women with ER/PR+ breast cancer, white vs. black women.

	White Women ER/PR+ Breast Cancer ¶	Black Women ER/PR+ Breast Cancer ¶	P*†
Incidence, Rate (CI)‡§	94.8 (94.0-95.5)	70.9 (69.4-72.5)	<.001
Size			
≤ 2cm	61.2 (60.6-61.8)	38.1 (37.0-39.3)	<.001
2.1-5cm	25.4 (25.0-25.8)	23.4 (22.6-24.4)	<.001
> 5cm	9.3 (9.1-9.5)	10.1 (9.1-10.7)	<.001
SEER Summary Stage, Rate (CI)‡§			
Localized	65.1 (64.5-65.7)	43.0 (41.8-44.3)	<.001
Regional	25.6 (25.2-26.0)	22.1 (21.5-23.2)	<.001
Distant	4.6 (4.4-4.7)	5.5 (5.1-6.0)	<.001
American Joint Committee on Cancer Stage (7 th Edition), Rate (CI)‡§			
Stage I/II	81.2 (80.5-81.9)	56.3 (55.0-57.7)	<.001
Stage III/IV	12.3 (12.0-12.6)	13.3 (12.7-14.0)	.005
Incidence-Based Mortality, Rate (CI)‡¶	7.2 (7.2-7.3)	8.1 (7.9-8.4)	<.001
5-year Overall Survival, % (CI)¶	86.5% (86.3-86.6%)	80.0% (79.4-80.6%)	<.001
5-year Disease-Specific Survival, % (CI)¶	93.4% (93.3-93.5%)	87.2% (86.7-87.7%)	<.001
20-year Overall Survival, % (CI)¶	44.4% (44.0-44.8%)	37.7% (36.2-39.2%)	<.001
20-year Disease-Specific Survival, % (CI)¶	77.7% (77.3-78.1%)	66.1% (64.7-67.5%)	<.001

*Incidence rates are compared using two-sided Chi-square test. †Survival curves are compared using log-rank test. ‡ Rates expressed are per 100,000 age-adjusted population. §Incidence data presented are from 2010-2014. ¶Incidence-based mortality and survival data presented are from 1992-2014. ¶ ER/PR+, Estrogen Receptor/Progesterone Receptor positive.

Supplementary Table 3. Incidence, incidence-based mortality and survival of women less than 40 years of age with estrogen/progesterone receptor positive breast cancer, white vs. black women

	White Women <40 ER/PR+ Breast Cancer ¶	Black Women <40 ER/PR+ Breast Cancer ¶	P*†
Incidence, Rate (CI)‡§	8.5 (8.2-8.9)	7.7 (7.1-8.5)	.05
Size			
≤ 2cm	4.0 (3.7-4.2)	2.9 (2.4-3.3)	<.001
2.1-5cm	3.3 (3.1-3.5)	3.4 (3.0-3.9)	.62
> 5cm	1.3 (1.2-1.5)	1.5 (1.2-1.8)	.43
SEER Summary Stage, Rate (CI)‡§			
Localized	4.0 (3.8-4.3)	3.1 (2.7-3.6)	<.001
Regional	3.9 (3.6-4.1)	3.6 (3.1-4.1)	.29
Distant	0.69 (0.59-0.80)	1.0 (0.79-1.3)	.01
American Joint Committee on Cancer Stage (7 th Edition), Rate (CI)‡§			
Stage I/II	6.5 (6.2-6.8)	5.1 (4.6-5.7)	<.001
Stage III/IV	2.0 (1.8-2.2)	2.4 (2.1-2.9)	.03
Incidence-Based Mortality, Rate (CI)‡¶	0.34 (0.31-0.37)	0.68 (0.60-0.78)	<.001
5-year Overall Survival, % (CI)¶	91.1% (90.4-91.7%)	80.5% (78.4-82.4%)	<.001
5-year Disease-Specific Survival, % (CI)¶	91.6% (91.0-92.2%)	82.1% (80.0-84.0%)	<.001
20-year Overall Survival, % (CI)¶	65.6 (63.8-67.3)	53.2 (48.8-57.4)	<.001
20-year Disease-Specific Survival, % (CI)¶	69.5 (67.8-71.1)	57.9 (53.6-61.9)	<.001

*Incidence rates are compared using two-sided Chi-square test. †Survival curves are compared using log-rank test. ‡ Rates expressed are per 100,000 age-adjusted population. §Incidence data presented are from 2010-2014. ¶Incidence-based mortality and survival data presented are from 1992-2014. ¶ ER/PR+, Estrogen Receptor/Progesterone Receptor positive.

Papillary Thyroid Cancer (PTC)

Percent of diagnosed cancers

White (P _w)	90%
Black (P _b)	10%

Incidence per 100,000 persons

White (I _w)	14.2
Black (I _b)	7.7

Difference in incidence attributable to overdiagnosis, (I_{w-b}) 6.5 [100% of difference in incidence, see manuscript text]

20-year disease specific survival

White	96.7%
Black	96.1%

Equations #1 and 2: Calculation of overdiagnosis rates in white (O_w) and black (O_b) populations

Equation #1: Calculation of the race-specific contribution to the estimated overall overdiagnosis rate

$$O_{all} = (P_w \times O_w) + (P_b \times O_b)$$

Equation #2: Calculation of the race-specific contribution to the difference in white and black cancer rates attributable to overdiagnosis

$$I_{w-b} = (I_w \times O_w) - (I_b \times O_b)$$

Equation #3: Adjusting of survival rates for overdiagnosis using calculated overdiagnosis rates (O_w or O_b) from equations 1 and 2

$$\text{Adjusted Survival} = (\text{Survival} - \text{Overdiagnosis Rate}) / (100 - \text{Overdiagnosis Rate})$$

Candidate overall rate of overdiagnosis (O _{all})	Calculated rate of overdiagnosis, white persons (O _w)	Calculated rate of overdiagnosis, black persons (O _b)	Calculated Ratio (O _w :O _b)	Calculated adjusted survival, white persons*	Calculated adjusted survival, black persons*	Difference in adjusted survival (white vs. black)
55%	58.5%	23.5%	2.5	92.0%	94.9%	-2.9%
60%	63.1%	32.0%	2.0	91.1%	94.3%	-3.2%
65%	67.7%	40.5%	1.7	89.8%	93.4%	-3.6%
70%	72.3%	49.0%	1.5	88.1%	92.4%	-4.3%
75%	76.9%	57.5%	1.3	85.7%	90.8%	-5.1%

*20-year disease-specific survival

Supplementary Figure 1. Modeled estimates of the rates of overdiagnosis of papillary thyroid cancer in white and black persons, based on excess incidence in white persons, and estimates of rates of overdiagnosis in the population. See Methods for further description of estimates used. The 65% overall overdiagnosis estimate is from Vaccarella et al.¹⁵

Estrogen / Progesterone Receptor Positive (ER/PR+) Breast Cancer

Percent of diagnosed cancers

White (P _w)	89%
Black (P _b)	11%

Incidence per 100,000 persons

White (I _w)	91.7
Black (I _b)	68.6

Difference in incidence attributable to overdiagnosis, (I_w-I_b) 21.9 [95% of difference in incidence, see manuscript text]

20-year disease specific survival

White	77.7%
Black	66.1%

Equations #1 and 2: Calculation of overdiagnosis rates in white (O_w) and black (O_b) populations

Equation #1: Calculation of the race-specific contribution to the estimated overall overdiagnosis rate

$$O_{all} = (P_w \times O_w) + (P_b \times O_b)$$

Equation #2: Calculation of the race-specific contribution to the difference in white and black cancer rates attributable to overdiagnosis

$$I_{w-b} = (I_w \times O_w) - (I_b \times O_b)$$

Equation #3: Adjusting of survival rates for overdiagnosis using calculated overdiagnosis rates (O_w or O_b) from equations 1 and 2

$$\text{Adjusted Survival} = (\text{Survival} - \text{Overdiagnosis Rate}) / (100 - \text{Overdiagnosis Rate})$$

Candidate overall rate of overdiagnosis (O _{all})	Calculated rate of overdiagnosis, white persons (O _w)	Calculated rate of overdiagnosis, black persons (O _b)	Ratio (O _w :O _b)	Calculated adjusted survival, white persons*	Calculated adjusted survival, black persons*	Difference in adjusted survival (white vs. black)
25%	27.5%	4.8%	5.7	69.2%	64.4%	4.8%
30%	32.3%	11.3%	2.9	67.1%	61.8%	5.3%
35%	37.1%	17.7%	2.1	64.5%	58.5%	6.0%
40%	42.0%	24.2%	1.7	61.6%	55.3%	6.3%

*20-year disease-specific survival

Supplementary Figure 2. Modeled estimates of the rates of overdiagnosis of estrogen/progesterone receptor positive breast cancer in white and black women, based on excess incidence in white women, and estimates of rates of overdiagnosis in the population. ER/PR+, estrogen/progesterone receptor positive. See Methods for further description of estimates used. The 30% overall overdiagnosis estimate is from Bleyer and Welch.¹⁴