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The Impact of State-Specific Life Tables on Relative Survival

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Abstract

Background—Relative survival is based on estimating excess cancer mortality in a study population compared to expected mortality of a comparable population without cancer. In the United States, expected mortality is estimated from national life tables matched by age, sex, race, and calendar year to each individual in the study population. We compared five-year relative survival using state life tables to five-year relative survival using US decennial life tables. We assessed variations by age, race, and cancer site for all cancers combined, lung, colorectal, prostate, and female breast cancers.

Methods—We used data from 17 National Cancer Institute Surveillance, Epidemiology, and End Results Program registries, including diagnoses from January 1, 2000 to December 31, 2009 with follow-up through December 31, 2010. Five-year relative survival was calculated using US-based life tables (USLT) and state-specific life tables (SLT).

Results—Differences in SLT- and USLT-based survival were generally small (SLT < 4 survival percentage points lower than USLT). Differences were higher for states with high SES and low

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mortality and for prostate cancer. Differences were largest for all cancers combined, colon and rectum, and prostate cancer among males aged 85+ ranging from −10 to −17 survival points for whites and +9 to +17 for blacks.

Conclusion—Differences between relative survival based on USLT and SLT were small and state-based estimates were less reliable than US-based estimates for older populations aged 85+. Our findings underscore the need to develop more appropriate life tables that better represent the varying mortality patterns in different populations in order to obtain accurate estimates of relative survival.

There is little debate that measures of survival are a valuable tool available to clinicians, epidemiologists, and public health professionals (1). First proposed by Ederer et al. (2) relative survival compares the survival probabilities of a diseased population (ie, cancer patients) to the survival probabilities of the general population. The resulting value, known as *relative survival*, is the ratio of observed survival to expected survival which represents the excess mortality associated with a cancer diagnosis. Relative survival is often used as the primary measure in population-based descriptive studies as in general it provides a more reliable estimate of the net survival from cancer than cause-specific survival because it does not rely on death certificate information, which is generally prone to errors in the coding of cause of death and has been shown to have high degrees of misclassification for cancer causes of death (3–5). Unlike crude probabilities of death, net survival represents cancer survival in the absence of competing risks (6). In this issue, Howlader et al. (7) and Mariotto et al. (8) further discuss differences between net and crude survival measures.

A key challenge of relative survival is in choosing the population with which to compare to the cancer cohort or in choosing the best life tables to represent the background mortality of the study population. There is a growing body of research questioning the accuracy of relative survival estimates that use life tables from populations that are either not comparable to the cancer cohort [eg, background mortality risk is substantially higher or lower than the cancer cohort, misclassification or unmeasured factors such as race/ethnicity that contribute to differential death rates in the comparison population (9–11)] or when the reference population has a high rate of deaths due to cancer (12).

In the United States, researchers using cancer surveillance data from the Surveillance Epidemiology and End Results (SEER) Program often use the US population life tables as the reference group for relative survival estimates, matched by age, sex, race, and calendar year to the cancer cohort (13). The use of US population life tables in and of itself is not necessarily a problem if the cancer cohort has comparable background death rates and characteristics. However, we know that background mortality varies by sex, age, race, and geographic areas as well as socioeconomic status (SES) (14–16).

The use of national life tables to calculate state-specific or regional survival has *overestimated* relative survival in states with *lower* background death rates and *underestimated* relative survival in states with *higher* background death rates (9). Baili et al. (9) reported that even after matching on age, sex, year, and race, relative survival for several US states and regional registry populations were systematically higher when using US-matched life tables compared to the relative survival estimates using SLT [aka: the

CONCORD approach (9)]. The only exception was found in Louisiana, which had higher US-matched relative survival estimates as compared to its state-matched relative survival estimates. The authors attributed these differences to the lower background death rates in all states/regions in their study with the exception of Louisiana, which had higher background death rates. Moreover, for early stage prostate and breast cancer, relative survival has been shown to be higher than 100%, indicating that the life tables may not be appropriate for representing survival from other causes when examining cancer survival for these populations (9).

With the recent release of the 2000 state decennial life tables by the National Center for Health Statistics (NCHS) (17), this study expands on the work by Baili et al. (9) by comparing five-year relative survival using state- or regionally-matched life tables to US-matched five-year relative survival, focusing on a more contemporary cohort of cancer patients diagnosed from 2000 to 2009. We also examine the underlying characteristics of each state/region to identify potential root causes of variations in survival estimates and assess the variations in survival estimates by age, race, and cancer site for lung and bronchus cancer, colorectal cancer, prostate cancer, and female breast cancer.

Methods

Study Population

We used cancer surveillance data from 17 states/regions that are a part of the SEER Program, including the states of California, Connecticut, Georgia, Hawaii, Iowa, Kentucky, Louisiana, New Jersey, New Mexico, and Utah; and, the metropolitan areas of Detroit and Seattle. The cancer cohort included individuals who were diagnosed from January 1, 2000 to December 31, 2009 with follow-up through December 31, 2010. We excluded cancer patients whose initial date of diagnosis was derived solely from death certificates or at autopsy and patients who were alive but without sufficient follow-up time for analysis (eg, survival time of 0 days), and restricted analyses to the only cancer (sequence 00) or the first of multiple primary diagnoses (sequence 01).

Male and female cancer patients of all races and ages were included if they were diagnosed with a primary malignant cancer as defined by the International Classification of Diseases for Oncology Second Edition, Third Edition (ICD-O-3) (18) for site and histology and SEER Behavior Recode for Analysis for malignancy (http://seer.cancer.gov/behavrecode/). SEER Behavior Recode for Analysis was used to account for changes in behavior coding, starting with 2001 diagnoses. We chose SEER Behavior Recode for Analysis of 3 (malignant), which meant that cancers were classified as malignant in both ICD-O-3 and its predecessor ICD-O-2. SEER Site Recode, which is based on ICD-O-3 site and histology definitions, were used to identify the four specific cancer sites (http://seer.cancer.gov/siterecode/icdo3_dwhoheme/index.html).

Regional and State Population Characteristics

We examine the underlying characteristics of each of the 12 states and 2 regions (Detroit and Seattle) with SEER registries, identifying potential root causes of in variations survival estimates, by race/ethnicity, age, cancer staging and mortality, and tobacco use using several sources. Median age by sex and race distributions were collected from the 2000 Census (19) for each state and region. Cancer death rates and the percent of cancer cases diagnosed at localized stage for each region/state were obtained using SEER*Stat (20,21). Mortality data included deaths from any malignant neoplasm from 2000 to 2009 for both sexes and all races. Rates per 100 000 were age-adjusted to the 2000 US Standard Population. The percent of malignant cancers diagnosed at localized stage was identified using SEER Summary Stage 2000, and are defined as cancers that are confined to the original organ site (22). Finally, we used 2000 data from the Centers for Disease Control and Prevention's (CDC) Behavioral Risk Factor Surveillance System (BRFSS) to describe the prevalence of tobacco use (23), which is associated with higher morbidity and mortality rates in the underlying population (9). BRFSS surveys are a cross-sectional, state-based cluster sample of individuals identified via random-digit dialing. Prevalence of tobacco use was defined as the percent of respondents who smoked at least 100 cigarettes in their lifetime and were current smokers at the time of the survey.

Cause of Death

Cancer registries use an algorithm to assign a single, disease-specific, underlying cause of death using information from death certificates. In some cases, attribution of a single cause of death may be difficult and misattribution may occur (eg, a death may be erroneously coded to the site of the metastasis). To capture deaths related to the specific cancer but not coded as such, SEER created an improved algorithm to calculate cause of death, the SEER cause-specific death classification variable (http://seer.cancer.gov/causespecific/) that takes into account causes of deaths in conjunction with tumor sequence (ie, only one tumor or the first of subsequent tumors), site of the original cancer diagnosis, comorbidities [eg, AIDS and/or site-related diseases (3)].

Life Tables

In this study, we used two sets of life tables: US-based life tables (USLT) and state-specific life tables (SLT). Both sets of life tables were constructed using decennial life tables from the NCHS and an interpolation method to calculate life tables for the individual years between the census years. The USLT have been the default life tables used in SEER*Stat to calculate relative survival for the SEER registries. The method used to derive them is described in detail at http://seer.cancer.gov/expsurvival/. Recently NCHS published 1999–2001 decennial SLT for all races, whites, and, for most states, blacks (17). Life tables for blacks in Hawaii and Utah were not available because of extremely small black populations.

Statistical Analysis

Relative survival was calculated by actuarial methods as the ratio of all-cause survival and expected survival. Although relative survival could be adjusted when relative cumulative survival increased from a prior interval or was over 100%, we report unadjusted estimates in order to compare rates. Differences based on adjusted estimates were similar to the unadjusted. Expected survival is estimated using both the USLT and SLT by matching the survival cohort on age, sex, and race and year. Life tables for all races combined were matched to individuals with unknown or unspecified races. Individuals were matched by the state of registration to the specific SLT.

Cancer-specific survival (CS) was calculated using the SEER cause-specific death classification variable. The events of interest were defined as deaths attributed to the cancer using the SEER cause-specific death classification variable (http://seer.cancer.gov/causespecific/), and deaths due to other causes were censored. Significance was determined at *P* values less than .05 and 95% confidence intervals (CIs) are presented where appropriate. Analyses were conducted using SEER*Stat software.

Results

Although blacks accounted for just 12.3% of the total US population in 2000, they accounted for as much as 32.5%, 28.7%, and 25% of the population in Louisiana, Georgia, and Detroit, respectively (Table 1). Most SEER regions fell within 1–2 years of the US median age of 34 years for men and 36.5 years for women.

The background age-adjusted cancer death rate in the US from 2000 to 2009 was 185.5 per 100 000 (95% CI: 185.4 to 185.7) (Table 1). Kentucky (KY) and Louisiana (LA) had the two highest age-adjusted cancer death rates among all SEER states/regions at 217.7 (95% CI: 216.3 to 219.1) and 213.8 (95% CI: 212.5 to 215.2), respectively. With the exception of Michigan women (22.4%), they also have some of the highest prevalence rates of current smokers (KY men 33.4%; LA men 26.8%; KY women 27.9%; LA women 21.7%). Utah had the lowest cancer mortality at 135.1 (95% CI: 133.5 to 136.8) and the lowest tobacco use (men 14.5%, women 11.3%).

The percent of all malignant cancers diagnosed at localized stage from 2000 to 2009 was 44.8% in the United States (SEER 17). The state with the lowest percentage was Kentucky at 42.9% and the state with the highest percentage was Utah at 51.9%.

Five-Year Cancer Survival Comparisons

Five-year cause-specific survival and relative survival estimates using SLT and USLT for males diagnosed from 2000 to 2009 are described in Table 2 for all cancers combined, colorectal, lung and bronchus, and prostate cancers. Overall, differences in relative survival were small. For all SEER 17 regions combined, relative survival based on SLT was approximately 1 (%) point lower than survival based on USLT for all cancers (−0.9), colorectal (−1.1), and prostate (−1.2). Utah and Connecticut had the most pronounced differences at −2.3 and −2.2 points, respectively. In the two states with the highest cancer death rates, Kentucky and Louisiana, SLT relative survival was statistically significantly higher than USLT relative survival: +1.1 and +1.2 points, respectively. The differences between SLT and USLT relative survival followed the same pattern for prostate cancer but the differences were more pronounced in Utah (−3.5), Connecticut (−3.3), and Louisiana (+2.8). There were no significant differences between SLT and USLT relative survival for lung cancer and few significant differences for colorectal cancer.

We saw similar patterns for women, although differences were generally smaller (Table 3). SLT-derived and USLT-derived survival differences were most pronounced in Connecticut for all cancers combined (−1.7), colorectal cancer (−3.5), and breast cancer (−2.0) when compared to other SEER regions. There were more significant differences between SLT and USLT relative survival estimates for colorectal cancers among women as compared to men, ranging from −2.4 in Los Angeles County to −3.5 in Connecticut.

For men diagnosed at younger ages (<75) differences between relative survival estimates using USLT as compared to SLT were small (Figures 1A–D). However, in the older age groups (aged 85+), there were substantial differences in survival. Among white males, SLT-based relative survival for all sites combined, colorectal, and prostate cancer were 10, 12, and 17 points lower than USLT-based relative survival, respectively. For black males, there were also marked differences but in the opposite direction: 10, 9, and 17 points higher for all sites combined, colorectal, and prostate cancer, respectively. Furthermore, and counter to known prostate cancer racial disparities between blacks and whites (25), the five-year relative survival generated using SLT for whites aged 85 and older was *lower* (63%) than blacks (81%).

Five-year relative survival estimates based on SLT were consistently lower than those based on USLT across all cancer sites for black and white women aged 85 and older (Figure 2A–D). Marked differences were found for colorectal (−11) and breast (−17) cancer among white women, whereas the differences for blacks were only −6 and −10 survival points, respectively. Unlike the pattern we saw for black and white men, white women had consistently *higher* survival rates than black women.

Discussion

By using recently published SLT (17) this study expanded the work by Baili et al. (9) by comparing five-year relative survival using state- and regionally-matched life tables to traditional US-matched five-year relative survival. We hypothesized that relative survival using SLT would yield more accurate estimates than relative survival using USLT because it takes some state variability in background mortality into account. Indeed, we found that for states with higher background mortality (lower survival) than the United States (ie, Kentucky, Louisiana, and Georgia), relative survival using SLT were generally higher than relative survival using USLT. In other words, the relative survival estimates based on USLT were *underestimated*. For states with lower background mortality (higher survival) than the United States (ie, Utah, Connecticut) relative survival using SLT were generally lower than relative survival using USLT (*overestimated*). These findings support those of Baili et al. (9).

We would have expected to see a larger degree of overestimation in Hawaii as it has one of the lowest cancer death rates among SEER program registries. The null finding for blacks in Hawaii was not surprising as SLT for blacks in Hawaii were not available and we used USLT for that group, and whites only account for 24% of the population. Future research will include developing life tables for Asian/Pacific Islanders and Hispanics as well as by socioeconomic status.

When we examined the variability in relative survival by race and age, we found that among older populations (aged 85+), SLT were not as reliable as USLT. SLT for ages 85 and older were not derived from observed data but were extrapolated from a statistical model (17) since population and vital statistics data for single ages above age 85 at the state level are not available. On the other hand, US decennial life tables were estimated from individual population and mortality data up to age 100 and augmented with Medicare data to better ascertain age at death of older patients who may have had misreported age from death certificates (26). Post hoc analysis of conditional life expectancies after age 85 calculated from SLT (Figure 3 dots) compared to the ones calculated from USLT (Figure 3 line) supported our findings, wherein substantial variability exists in these older ages, especially among the black population. For the male white population, the state-specific conditional life expectancies after 85 years clearly show a bias since for all states with the exception of Montana they are above the US value of 5.4 years. In our study, the imprecision in SLT in this age group resulted in erroneous relative survival estimates that ran counter to known relationships between race and cancer survival (eg, black males aged 85+ had *higher* prostate cancer survival than white males in the same age group). This finding underscores the need for more effective approaches to estimating life tables at the state or regional level, and draws attention to the challenge investigators face in generating life tables for smaller geographic units.

SLT for blacks in Utah and Hawaii could not be created due to small population sizes. This was borne out in the results as cause-specific survival in Utah and Hawaii was higher than relative survival estimates due to their lower cancer death rates. We were also unable to evaluate the effect of SLT for other minority populations including Hispanics, although some work is currently being done to generate life tables for other underserved populations including Native Americans/Alaskan Natives (27) and Appalachian populations (28).

An important caveat to our study is that while some differences in relative survival were statistically significant, the absolute differences between each of the measures only varied by a few (<5) percentage points and, therefore, were not materially significant. However, we only controlled for sex, age, and race in this study. There is some evidence to suggest that other sociodemographic or socioeconomic (SES) factors may impact relative survival estimates (29,30). It is possible that we would have found larger differences in relative survival if state/regional life tables were available for SES subgroups in addition to sex, age, and race/ethnicity. And, given the high degree of socioeconomic disparities in the United States (31–33), future studies of cancer survival should consider accounting for SES differences. Caution should be taken to refrain from making state or regional comparisons as survival estimates were not age-standardized.

Howlader et al. (3) showed that cause-specific survival may be a better estimate for cancer sites with effective screening or that tend to be diagnosed at earlier stages, such as cancers of the breast, prostate, colon and rectum, and melanoma. Cho et al. (34) later confirmed these findings for breast and prostate cancers, providing evidence that men and women diagnosed with these cancers at early stages have better health status than the US population; therefore, relative survival based on the expected survival estimated from the USLT would be biased. For states with high screening uptake and medical care utilization, the death rates may be lower and therefore lead to overestimates in relative survival when using USLT. Indeed, we found this to be true for male prostate and female breast cancers. With notable exceptions in Kentucky and Louisiana which have the highest cancer death rates among the SEER registries, relative survival using SLT is lower than relative survival using USLT and closer to cause-specific survival. For cancers with poor prognosis, such as lung cancer, we found a similar *underestimation* previously reported by Howlader et al. (3) as USLT produced lower survival estimates as compared to cause-specific survival (Figures 1 and 2). In our study, we found the same bias using SLT, which resulted in very similar estimates. The similarities in relative survival estimates for lung cancer is likely due to the fact that the same biases present in the USLT remain in SLT. Namely, that the expected survival estimated from the life table for lung cancer cohorts overestimates their actual other-cause survival given the higher prevalence of smoking and other comorbid conditions in this population than either the US or the state comparison populations (2,34).

Our study is one of the first comprehensive assessments of survival estimates generated using three approaches. Overall differences between relative survival based on USLT and SLT tended to be small but in the direction we would expect; however, some differences were large, particularly among older populations aged 85 and older where data were sparse. Generally, SLT should not be used to estimate relative survival for ages 85 and up, but might provide slightly better relative survival estimates for specific cancer types. Our findings underscore the need for continued development of life tables that better describe life expectancy for ethnic minorities, older age groups, and other regional, geographic, and socioeconomic subgroups.

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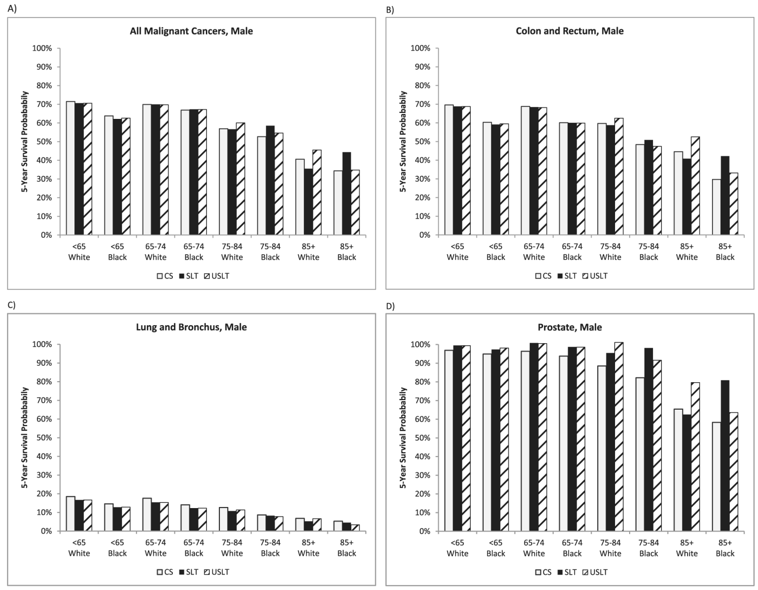

Figure 1.

Five-year survival probability comparisons for males by cancer site, age, and race SEER-17 (2000-2009). Relative survival based on state-specific life tables (SLT) and US-based life tables (USLT). CS = cause-specific survival.

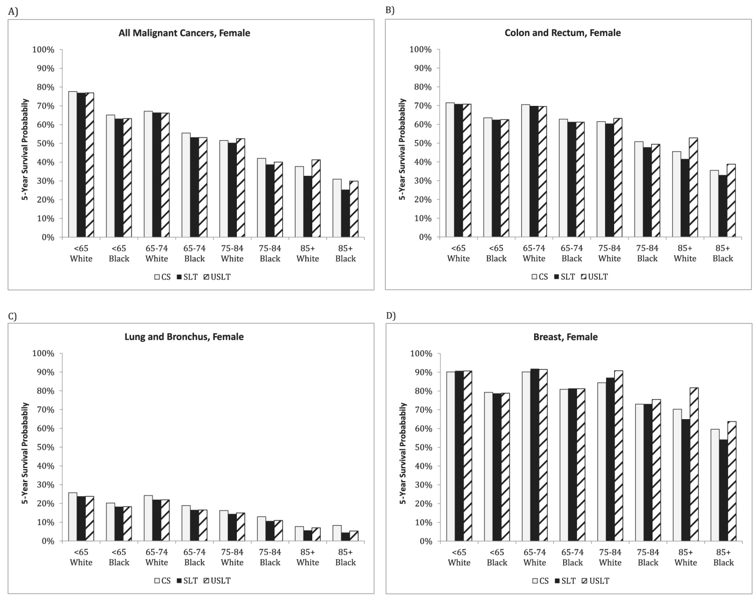

Figure 2.

Five-year survival probability comparisons for females by cancer site, age, and race SEER-17 (2000-2009). Relative survival based on state-specific life tables (SLT) and US-based life tables (USLT). CS = cause-specific survival.

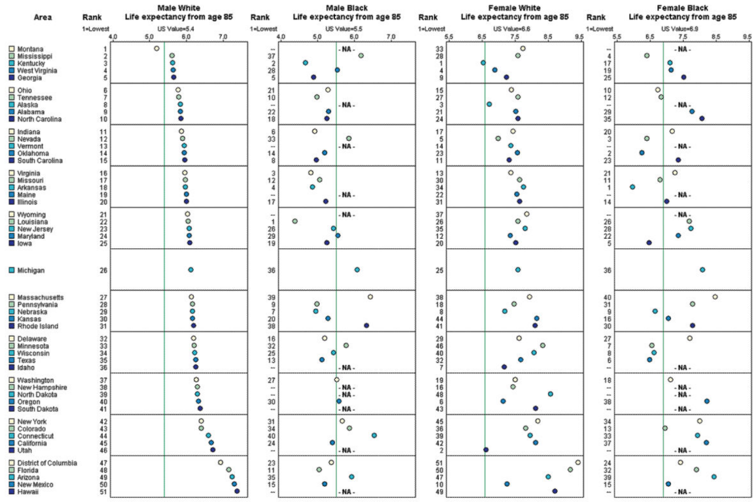

Figure 3.

Comparison of 2000 decennial National Center for Health Statistics (NCHS) state life and US tables. **Dots** represent life expectancy estimated from state life tables. The **vertical line** represents the life expectancy estimated from US national life tables.

Table 1

US and Surveillance, Epidemiology, and End Results (SEER) regional/state population characteristics[†]

							Cancer[‡] stage at diagnosis	Cancer mortality[§]	Tobacco use[//]	
	Race[†]				Age			(2000–2009)	(2000–2009)	(2000)
	White	Black	Asian/Pacific Islander	Native/American/ Other/ 2+ races[†]	Median, y		Localized	Rate per 100 000 (95% CI)	Prevalence	
State/Region	%	%	%	%	Men	Women	%		Men, %	Women, %
US	75.1	12.3	3.7	8.8	34.0	36.5	44.8	185.5 (185.4 to 185.7)	24.4	21.2
California	59.6	6.7	11.3	22.6	32.2	34.4	44.3	169.4 (168.9 to 169.8)	20.1	14.4
Connecticut	81.6	9.1	2.4	6.8	36.1	38.6	46.6	179.9 (178.6 to 181.3)	20.4	19.4
Georgia	65.1	28.7	2.2	4.1	32.1	34.6	45.6	188.3 (187.3 to 189.3)	26.3	20.9
Hawaii	24.3	1.8	51.0	23.0	35.1	37.4	45.5	150.5 (148.5 to 152.5)	22.9	16.3
Iowa	93.9	2.1	1.3	2.7	35.2	38.0	43.5	183.0 (181.5 to 184.4)	25.7	20.9
Kentucky	90.1	73	0.7	1.9	34.6	37.1	42.9	217.7 (216.3 to 219.1)	33.4	27.9
Louisiana	63.9	32.5	1.2	2.4	32.6	35.3	43.7	213.8 (212.5 to 215.2)	26.8	21.7
Michigan	80.2	13.6	1.8	3.8	34.3	38.0	NA	192.4 (191.5 to 193.2)	26.0	22.4
Detroit[¶]	68.9	25.0	2.5	3.6	34.2	36.6	45.2	196.7 (195.3 to 198.0)		25.5#
New Jersey	72.6	13.6	5.7	8.1	35.5	38.0	44.6	188.5 (187.6 to 189.3)	23.6	18.6
New Mexico	66.8	1.9	1.2	30.2	33.4	35.6	46.6	163.3 (161.5 to 165.1)	26.2	21.2
Utah	89.2	0.8	2.4	7.6	26.7	27.7	51.9	135.1 (133.5 to 136.8)	14.5	11.3
Washington	81.8	3.2	5.9	9.1	34.4	36.3	NA	183.3 (182.2 to 184.4)	21.8	19.7
Seattle[¶]	75.7	5.4	11.3	7.6	34.9	36.6	46.2	181.3 (180.0 to 182.6)		18.2#

[*] Population characteristics for race and age based on 2000 US Census Data; cancer staging data based on SEER data for all states and Detroit, MI, and Seattle, WA. CI = confidence interval; NA = not available.

[†] Individuals reporting race as white, black, Asian/Pacific Islander, Native American, Other; “2+ races” include individuals who reported more than one race.

[‡] US = SEER-17, all malignant cancers; SEER Program SEER*Stat Database (20).

[§] SEER Program SEER*Stat Database (21). Underlying mortality data provided by National Center for Health Statistics (NCHS) (www.cdc.gov/nchs).

[//] Percent current smokers (23).

[¶] Detroit = Wayne County; Seattle = King County.

[#]Based on 2002 prevalence data, men and women combined (sex-specific data not available) (24).

Table 2

Comparison of five-year relative survival using state life table versus US life table by cancer type and Surveillance, Epidemiology, and End Results (SEER) state/region: males diagnosed from 2000 to 2009, followed through December 31, 2010[*]

	All malignant cancers					Colon and rectum					Lung and bronchus					Prostate				
			Relative survival[†]					Relative survival[†]					Relative survival[†]					Relative survival[†]		
State/region	N	CS	SLT	USLT	Diff.[‡]	N	CS	SLT	USLT	Diff.[‡]	N	CS	SLT	USLT	Diff.[‡]	N	CS[†]	SLT	USLT	Diff.[‡]
SEER-17	1 587 699	65.8	65.3	66.2	−0.9[§]	156 178	64.8	63.9	65.0	−1.1[§]	207 130	15.6	13.7	13.8	−0.1	512 340	93.5	98.2	99.4	−1.2[§]
California, total	615 288	65.9	65.2	66.7	−1.5[§]	60 155	64.8	63.6	65.5	−1.9[§]	69 957	15.0	13.3	13.7	−0.4	196 592	93.3	97.6	100.0	−2.4
California[//]	341 191	65.1	64.1	65.7	−1.6[§]	32 734	64.2	62.7	64.7	−2.0[§]	41 174	14.8	13.0	13.3	−0.3	105 912	93.0	97.0	99.5	−2.5[§]
Los Angeles	152 610	65.8	65.0	66.5	−1.5[§]	15 714	64.7	63.3	64.9	−1.6	16 187	14.8	13.3	13.6	−0.3	49 565	93.1	97.4	99.6	−2.2[§]
San Francisco-Oakland	80 920	67.3	67.5	69.0	−1.5[§]	7926	66.1	66.2	67.9	−1.7	8801	15.9	14.6	14.9	−0.3	27 089	93.9	98.9	100.9	−2.0
San Jose-Monterey	40 567	69.7	70.5	72.2	−1.7[§]	3781	67.0	67.2	68.9	−1.7	3795	15.8	14.4	14.8	−0.4	14 026	94.9	101.1	103.5	−2.4
Connecticut	80 320	68.1	67.3	69.5	−2.2[§]	7885	68.3	66.1	69.0	−2.9	9946	19.4	17.2	17.8	−0.6	25 940	93.7	97.7	101.0	−3.3
Detroit	89 679	67.9	66.8	67.6	−0.8	7963	64.2	62.8	63.7	−0.9	12 566	17.6	15.4	15.6	−0.2	32 295	95.1	99.0	100.1	−1.1
Georgia, total	166 302	64.7	64.1	63.4	0.7[§]	16 006	64.2	63.7	63.0	0.7	26 305	15.9	13.3	13.2	0.1	53 862	93.5	99.0	97.5	1.5[§]
Atlanta	49 382	70.0	70.9	70.2	0.7[§]	4334	64.8	65.6	64.9	0.7	5678	17.2	14.8	14.7	0.1	17 818	94.8	101.3	100.0	1.3
Greater Georgia[¶]	113 753	62.5	61.3	60.6	0.7	11 349	64.1	63.0	62.3	0.7	20 082	15.7	13.0	12.8	0.2	34 929	92.9	97.8	96.2	1.6[§]
Rural Georgia	3167	62.4	61.9	61.0	0.9	323	60.4	61.8	60.8	1.0	545	11.8	10.1	10.0	0.1	1115	92.3	98.6	96.8	1.8
Hawaii	25 560	64.3	61.3	62.3	−1.0	3261	66.9	63.7	64.6	−0.9	3337	16.7	13.5	13.7	−0.2	7321	93.4	94.1	95.7	−1.6
Iowa	67 110	64.7	64.0	65.4	−1.4[§]	7351	66.3	66.0	67.8	−1.8	9960	14.8	12.7	13.0	−0.3	19 886	92.3	96.1	98.4	−2.3[§]
Kentucky	98 005	59.5	58.9	57.8	1.1[§]	10 381	64.0	63.0	61.8	1.2	20 215	15.1	13.2	12.9	0.3	25 605	92.2	97.7	95.4	2.3[§]
Louisiana	92 547	61.0	61.5	60.3	1.2[§]	9779	61.7	62.2	61.1	1.1	15 078	13.1	11.9	11.7	0.2	29 683	92.6	99.3	96.5	2.8[§]
New Jersey	193 898	68.0	68.3	69.2	−0.9[§]	19 243	64.4	64.0	65.2	−1.2	23 063	16.8	15.1	15.3	−0.2	66 284	94.3	100.0	101.1	−1.1
New Mexico	35 256	65.2	64.6	66.2	−16[§]	3520	61.0	61.0	62.9	−1.9[§]	3690	12.6	11.0	11.4	−0.4	12 012	92.8	96.0	98.6	−2.6[§]
Seattle	87 921	69.0	69.1	70.4	−1.3[§]	7642	68.3	67.7	69.2	−1.5	10 583	16.7	14.7	15.0	−0.3	28 803	94.2	99.2	101.1	−1.9
Utah	35 813	73.6	73.2	75.5	−2.3[§]	2992	66.1	65.8	68.1	−2.3	2430	13.8	11.5	11.8	−0.3	14 057	94.0	97.4	100.9	−3.5

[*] Relative survival estimated using state life tables (SLT) for expected survival calculation; relative survival estimated using US life table (USLT) for expected survival calculation. CS = cause-specific survival.

[†] The actuarial method was used. Expected survival was calculated using Ederer II method.

[‡] Difference between relative survival estimates: 5-year relative survival based on state life table minus 5-year relative survival based on US life table.

[§] 95% confidence intervals for 5-year relative survival estimates using state life table and those using US life table do not overlap (excludes estimates at or above 100% as 95% confidence intervals were not calculated for estimates at or above 100%).

[//] Excluding San Francisco, San Jose-Monterey, Los Angeles.

[¶] Excluding Atlanta and Rural Georgia.

Table 3

Comparison of five-year relative survival using state life table versus US life table by cancer type and Surveillance, Epidemiology, and End Results (SEER) state/region: females diagnosed from 2000 to 2009, followed through December 31, 2010[*]

	All malignant cancers					Colon and rectum					Lung and bronchus					Breast				
			Relative survival[*]					Relative survival[†]					Relative survival[†]					Relative survival[†]		
State/region	N	CS	SLT	USLT	Diff.[‡]	N	CS	SLT	USLT	Diff.[‡]	N	CS	SLT	USLT	Diff.[‡]	N	CS	SLT	USLT	Diff.[‡]
SEER-17	1 467 618	65.7	64.3	65.2	−0.9[§]	150 660	63.9	62.6	64.4	−1.8[§]	175 721	20.5	18.4	18.7	−0.3	452 929	87.5	88.3	89.3	−1.0[§]
California, total	579 393	66.0	64.6	65.9	−1.3[§]	56 861	63.9	62.2	64.8	−2.6[§]	63 464	19.6	17.7	18.1	−0.4	185 305	88.4	88.9	90.4	−1.5[§]
California[‖]	317 875	65.5	64.0	65.2	−1.2[§]	30 098	63.5	61.8	64.4	−2.6[§]	37 753	19.2	17.2	17.6	−0.4	100 880	88.4	88.7	90.2	−1.5[§]
Los Angeles	148 101	65.8	64.3	65.4	−1.1[§]	15 354	63.8	61.1	63.5	−2.4[§]	13 832	20.7	19.0	19.4	−0.4	46 659	87.2	87.7	89.1	−1.4[§]
San Francisco-Oakland	75 483	67.0	66.1	67.4	−1.3[§]	7781	64.5	64.0	66.7	−2.7	8208	19.1	17.5	17.9	−0.4	25 138	89.7	90.6	92.0	−1.4[§]
San Jose-Monterey	37 934	69.1	68.5	69.8	−1.3[§]	3628	66.3	66.5	69.2	−2.7	3671	20.3	18.5	19.0	−0.5	12 628	90.5	91.9	93.3	−1.4
Connecticut	76 898	67.3	65.8	67.5	−1.7[§]	8001	65.2	63.4	66.9	−3.5[§]	9593	24.8	22.4	23.0	−0.6	23 266	88.9	89.6	91.6	−2.0[§]
Detroit	81 883	64.4	62.1	62.8	−0.7	8,546	62.7	60.4	61.9	−1.5	11 437	22.6	19.5	19.7	−0.2	23 822	85.8	86.2	87.1	−0.9
Georgia, total	148 478	65.4	63.8	63.8	0.0	15 322	64.7	63.3	63.7	−0.4	18 747	20.9	18.3	18.2	0.1	47 189	86.0	86.7	86.7	0.0
Atlanta	46 391	68.8	67.8	67.9	−0.1	4452	64.9	63.2	63.6	−0.4	4790	21.9	19.4	19.3	0.1	15 843	86.5	87.8	87.8	0.0
Greater Georgia[¶]	99,691	63.9	61.9	61.9	0.0	10 606	64.5	63.3	63.6	−0.3	13 667	20.7	17.9	17.8	0.1	30 586	85.8	86.1	86.1	0.0
Rural Georgia	2396	63.2	60.9	60.9	0.0	264	65.4	64.8	65.5	−0.7	290	16.3	14.7	14.6	0.1	760	85.6	85.5	85.4	0.1
Hawaii	23 010	70.1	67.9	68.5	−0.6	2475	69.6	67.2	68.2	−1.0	2290	23.6	20.8	21.0	−0.2	7443	91.0	90.5	91.2	−0.7
Iowa	62 059	65.5	64.8	66.0	−1.2[§]	7488	65.0	65.3	67.7	−2.4	7505	20.0	17.9	18.2	−0.3	18 072	88.3	89.3	90.8	−1.5[§]
Kentucky	89 699	62.2	61.4	60.4	1.0[§]	9986	63.1	62.7	61.3	1.4	15 041	20.0	17.7	17.3	0.4	24 740	85.7	88.0	86.5	1.5[§]
Louisiana	78 527	60.6	58.9	59.2	−0.3	9065	62.7	61.0	61.9	−0.9	10 818	17.5	15.8	15.8	0.0	23 637	83.6	83.9	84.2	−0.3
New Jersey	186 476	65.3	64.0	65.3	−1.3[§]	20 161	62.7	61.0	63.5	−2.5[§]	22 436	22.0	20.3	20.7	−0.4	54 355	86.4	87.2	88.6	−1.4[§]
New Mexico	30 587	65.6	65.4	66.1	−0.7	2983	60.3	61.3	62.5	−1.2	3052	17.6	16.5	16.7	−0.2	9652	86.4	87.6	88.5	−0.9
Seattle	80 933	69.6	69.0	69.8	−0.8	7,072	66.7	66.5	68.2	−1.7	9613	20.5	18.3	18.5	−0.2	26 116	91.0	92.2	93.0	−0.8
Utah	29 675	72.1	71.8	72.0	−0.2	2700	65.9	65.7	66.0	−0.3	1725	19.4	17.7	17.8	−0.1	9332	87.4	88.8	89.1	−0.3

[*] Relative survival estimated using state life tables (SLT) for expected survival calculation; relative survival estimated using US life table (USLT) for expected survival calculation. CS = cause-specific survival.

[†]The actuarial method was used. Expected survival was calculated using Ederer II method.

[‡]Difference between relative survival estimates: 5-year relative survival based on state life table minus 5-year relative survival based on US life table.

[§]95% confidence intervals for 5-year relative survival estimates using state life table and those using US life table do not overlap (excludes estimates at or above 100% as 95% confidence intervals were not calculated for estimates at or above 100%).

[//]Excluding San Francisco, San Jose-Monterey, Los Angeles.

[¶]Excluding Atlanta and Rural Georgia.