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State-Level Cancer Mortality Attributable to Cigarette Smoking in the United States

Joannie Lortet-Tieulent, MSc; Ann Goding Sauer, MSPH; Rebecca L. Siegel, MPH; Kimberly D. Miller, MPH; Farhad Islami, PhD; Stacey A. Fedewa, MPH; Eric J. Jacobs, PhD; Ahmedin Jemal, PhD

IMPORTANCE State-specific information about the health burden of smoking is valuable because state-level initiatives are at the forefront of tobacco control. Smoking-attributable cancer mortality estimates are currently available nationally and by cancer, but not by state.

OBJECTIVE To calculate the proportion of cancer deaths among adults 35 years and older that were attributable to cigarette smoking in 2014 in each state and the District of Columbia.

DESIGN, SETTING, AND PARTICIPANTS The population-attributable fraction (PAF) of cancer deaths due to cigarette smoking was computed using relative risks for 12 smoking-related cancers (acute myeloid leukemia and cancers of the oral cavity and pharynx; esophagus; stomach; colorectum; liver; pancreas; larynx; trachea, lung, and bronchus; cervix uteri; kidney and renal pelvis; and urinary bladder) from large US prospective studies and state-specific smoking prevalence data from the Behavioral Risk Factor Surveillance System.

MAIN OUTCOMES AND MEASURES The PAF of cancer deaths due to cigarette smoking in each US state and the District of Columbia.

RESULTS We estimate that at least 167 133 cancer deaths in the United States in 2014 (28.6% of all cancer deaths; 95% CI, 28.2%-28.8%) were attributable to cigarette smoking. Among men, the proportion of cancer deaths attributable to smoking ranged from a low of 21.8% in Utah (95% CI, 19.9%-23.5%) to a high of 39.5% in Arkansas (95% CI, 36.9%-41.7%), but was at least 30% in every state except Utah. Among women, the proportion ranged from 11.1% in Utah (95% CI, 9.6%-12.3%) to 29.0% in Kentucky (95% CI, 27.2%-30.7%) and was at least 20% in all states except Utah, California, and Hawaii. Nine of the top 10 ranked states for men and 6 of the top 10 ranked states for women were located in the South. In men, smoking explained nearly 40% of cancer deaths in the top 5 ranked states (Arkansas, Louisiana, Tennessee, West Virginia, and Kentucky). In women, smoking explained more than 26% of all cancer deaths in the top 5 ranked states, which included 3 Southern states (Kentucky, Arkansas, and Tennessee), and 2 Western states (Alaska and Nevada).

CONCLUSIONS AND RELEVANCE The proportion of cancer deaths attributable to cigarette smoking varies substantially across states and is highest in the South, where up to 40% of cancer deaths in men are caused by smoking. Increasing tobacco control funding, implementing innovative new strategies, and strengthening tobacco control policies and programs, federally and in all states and localities, might further increase smoking cessation, decrease initiation, and reduce the future burden of morbidity and mortality associated with smoking-related cancers.

Invited Commentary

Supplemental content

Author Affiliations: Surveillance and Health Services Research, American Cancer Society, Atlanta, Georgia (Lortet-Tieulent, Goding Sauer, Siegel, Miller, Islami, Fedewa, Jemal); Epidemiology Research Program, American Cancer Society, Atlanta, Georgia (Jacobs).

Corresponding Author: Joannie Lortet-Tieulent, MSc, Surveillance and Health Services Research, American Cancer Society, 250 Williams St, NW, Atlanta, GA 30303 (joannie.tieulent@cancer.org).

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Smoking prevalence in the United States has been more than halved since the release of the first Surgeon General's Report on the health hazards of cigarette smoking in 1964, as a result of increased awareness and implementation of public health policies against smoking.[1(p33)] Nevertheless, there are still 40 million current adult cigarette smokers, and smoking remains the largest preventable cause of death from cancer and other diseases.[2] Cigarette smoking accounted for an estimated 28.7% of all cancer deaths in US adults 35 years and older in 2010.[3] However, there are no such estimates by state, despite substantial geographic variation in smoking prevalence.[4] State-specific smoking-attributable mortality is particularly valuable for public health advocates and policy makers because state-level initiatives are at the forefront of tobacco control efforts. Herein, we estimate the proportion of all cancer deaths explained by cigarette smoking in adults older than 35 years in each of the 50 states and the District of Columbia (DC). For convenience, we refer to DC as a state hereafter.

Key Points

Question What proportion of cancer deaths are attributable to cigarette smoking in each US state?

Findings In this study of population-attributed fraction of cancer deaths due to cigarette smoking, cigarette smoking explained a high proportion of cancer deaths in all states, but this proportion was highest in several Southern states, notably Kentucky, Arkansas, Tennessee, West Virginia, and Louisiana.

Meaning Strengthened tobacco control is needed to reduce the burden of cancer death in all states.

Methods

This analysis used deidentified publicly available data and thus is not considered human subjects research; no institutional review board approval was necessary. We estimated the state-specific proportion of cigarette smoking-attributable cancer mortality (SACM) using methods similar to those of the 2014 Surgeon General's Report,[1] based on 12 cancers caused by cigarette smoking (acute myeloid leukemia and cancers of the oral cavity and pharynx; esophagus; stomach; colorectum; liver; pancreas; larynx; trachea, lung, and bronchus; cervix uteri; kidney and renal pelvis; and urinary bladder). To avoid potential bias, we calculated the overall population-attributable fraction (PAF) for cancer deaths in each state using the weighted sums method.[5] Specifically, we first calculated the PAF for each sex and age group (35-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, ≥85 years) in each state, using the standard formula for multicategory exposure[6]:

$$\mathrm{PAF}_s = \frac{\left[p_{0,s} + p_{1,s}(\mathrm{RR}_{1,s}) + p_{2,s}(\mathrm{RR}_{2,s})\right] - 1}{p_{0,s} + p_{1,s}(\mathrm{RR}_{1,s}) + p_{2,s}(\mathrm{RR}_{2,s})},$$

where s represents age; p_0, p_1, and p_2, the proportion of never, former, and current smokers, respectively; and RR_1 and RR_2, the relative risk for former and current smokers, respectively, compared with never smokers.

Age-, sex-, and state-specific smoking prevalence (never, former, or current) were calculated on the basis of data from the 2014 Behavioral Risk Factor Surveillance System survey (BRFSS), which is the only national survey designed to provide reliable state-level estimates of health behaviors.[4] Smoking prevalence estimates were based on 372 759 survey participants 35 years and older who provided information on smoking status. These smoking prevalence estimates were generated from the weighted public data provided by the Centers for Disease Control and Prevention (CDC). Weighting was based on characteristics such as sex, age, race and ethnicity, education, and marital status to adjust for nonresponse bias and ensure that the sample was representative.[7] Age- and sex-specific (but not state-specific) relative risks for death for current and former smoking status were those for a composite outcome of any of the 12 smoking-related cancers as reported from analyses of the Cancer Prevention Study-II (442 960 participants) and Pooled Contemporary Cohort (954 029 participants).[3]

For each state, the number of smoking-attributable cancer deaths in each age and sex group was calculated by multiplying the age- and sex-specific PAFs by the corresponding observed 2014 cancer death counts obtained from the National Center for Health Statistics.[8] The total number of smoking-attributable cancer deaths in each state was then calculated by summing across all age and sex groups. Finally, the overall SACM in each state was calculated by dividing the number of estimated smoking-attributable cancer deaths by the total number of cancer deaths among persons 35 years and older in each state. The 95% confidence intervals on the SACM were estimated via a bootstrap method,[9] with 5000 simulations.

To illustrate the geographic variation in SACM, we mapped the results grouping states by number rank (1 being the highest SACM).

Differences in SACM between states may be partly due to differences between states in racial and ethnic composition because smoking prevalence substantially varies by race/ethnicity.[2] To compare a measure of SACM between states that was not influenced by racial and ethnic composition, we calculated SACM by state for non-Hispanic white (NHW) men. We then assessed whether variation in SACM across states in NHW men was similar to that for all races/ethnicities combined using the Spearman correlation. Sparse data precluded similar comparison for other racial/ethnic and sex groups. However, we also calculated national SACM estimates for NHWs, non-Hispanic blacks, and Hispanics using smoking prevalence from the National Health Interview Survey (NHIS) (51 637 participants 35 years and older) during 2013 to 2014[10] and relative risks of cancer death as described herein.

Finally, as a sensitivity analysis, we compared the SACM in 4 regions (South, Midwest, West, and Northeast according to the Bureau of Census classification)[11] using smoking prevalence from the NHIS with that estimated using smoking prevalence from the BRFSS. We used Stata, version 13.1, and SAS 9.4 to perform the analyses. A 2-sided P value of .05 was used to determine statistical significance.

Results

In 2014, at least 167 133 cancer deaths (28.6% of all cancer deaths) in persons older than 35 years in the United States were attributable to cigarette smoking, with 103 609 of these deaths occurring in men (62.0%) and 63 524 in women (38.0%) (**Table**). The proportion of SACM ranged from 21.8% in Utah to 39.5% in Arkansas among men, and from 11.1% in Utah to 29.0% in Kentucky among women. Many of the states with the highest proportions of SACM were located in the South, including 9 of the top 10 states for men (Arkansas, Louisiana, Tennessee, West Virginia, Kentucky, Alabama, Mississippi, North Carolina, and Oklahoma) (**Figure 1**). Notably, smoking explained nearly 40% of adult male cancer deaths in 5 of these states. Southern states dominated the top 10 SACM states among women as well, but the second- and third-ranked states were Alaska (27.5%) and Nevada (27.1%)—which ranked 18th and 20th, respectively, among men. For both sexes combined, 7 of the top 10 states were located in the South, 2 in the West (Alaska and Nevada), and 1 in the Midwest (Missouri). While California had the lowest SACM after Utah, it had the highest number of deaths explained by smoking, because of its large population.

State-specific rankings for NHW men were generally similar to those for all races/ethnicities combined (Spearman correlation coefficient = 0.91, $P < .001$), with the notable exception of DC (SACM of 18.5% in NHW men vs 33.3% in men overall) (eFigure 1 in the Supplement). Nationally, non-Hispanic blacks had the highest SACM (27.2%), followed by NHWs (26.0%) and Hispanics (19.8%) (**Figure 2**). Finally, estimates of SACM at the regional level using smoking prevalence from the NHIS were equivalent to those estimated using smoking prevalence from the BRFSS (eTable 1 in the Supplement).

Discussion

In most states, approximately one-third of cancer deaths in men and one-quarter in women were explained by cigarette smoking. However, consistent with smoking-attributable all-cause mortality,[12] cancer deaths were associated with cigarette smoking less often in Western states and more often in the South, particularly among men. For example, smoking accounted for nearly 40% of cancer deaths among men in 5 Southern states. The larger burden of SACM in men than in women likely reflects a lower prevalence of smoking among women than men in the older birth cohorts.[13,14] However, sex differences in SACM may diminish in the future because smoking histories and risk of mortality from smoking-related diseases are comparable for men and women in more recent birth cohorts.[15] In fact, female smoking prevalence recently surpassed male smoking prevalence in South Dakota, Montana, and Arkansas.[16]

Higher SACM in the South is driven by higher historic smoking prevalence, which has prevailed in large part due to weaker tobacco control policies and programs. Policy initiatives are heavily influenced by the tobacco industry in all states,[17,18] especially those in the South,[19] where 95% of the US tobacco crop is grown.[20] Although spending on tobacco control is inversely associated with smoking prevalence,[21,22] only 5 states spent at least 50% of the amount recommended by the CDC in 2016.[23] In particular, 8 of the 21 states that spend less than 10% of the CDC-recommended amount are located in the South (Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Texas, and Virginia). Tobacco control spending by all states combined was less than $500 million in 2016, far less than the $10 billion spent annually by the tobacco industry on marketing.[24]

Public smoking restrictions and high cigarette prices (through excise taxes, price promotion restrictions, and minimum price laws)[25] are among the most effective tobacco control policies,[26,27] and both are primarily legislated by states. Again, the least restrictive public smoking policies and most affordable cigarettes are found in the South. Nine of 14 states with the least comprehensive smoke-free indoor air laws are in this region[28] and the mean cigarette excise tax is $0.49 in major tobacco states, compared with $1.80 in other states (and as high as $4.35 in New York).[29] However, there are signs that the tobacco industry's influence has waned somewhat in Southern tobacco-growing states in recent years, facilitating improvement in tobacco control policies[30] and highlighting the opportunity for more rapid progress in the future.

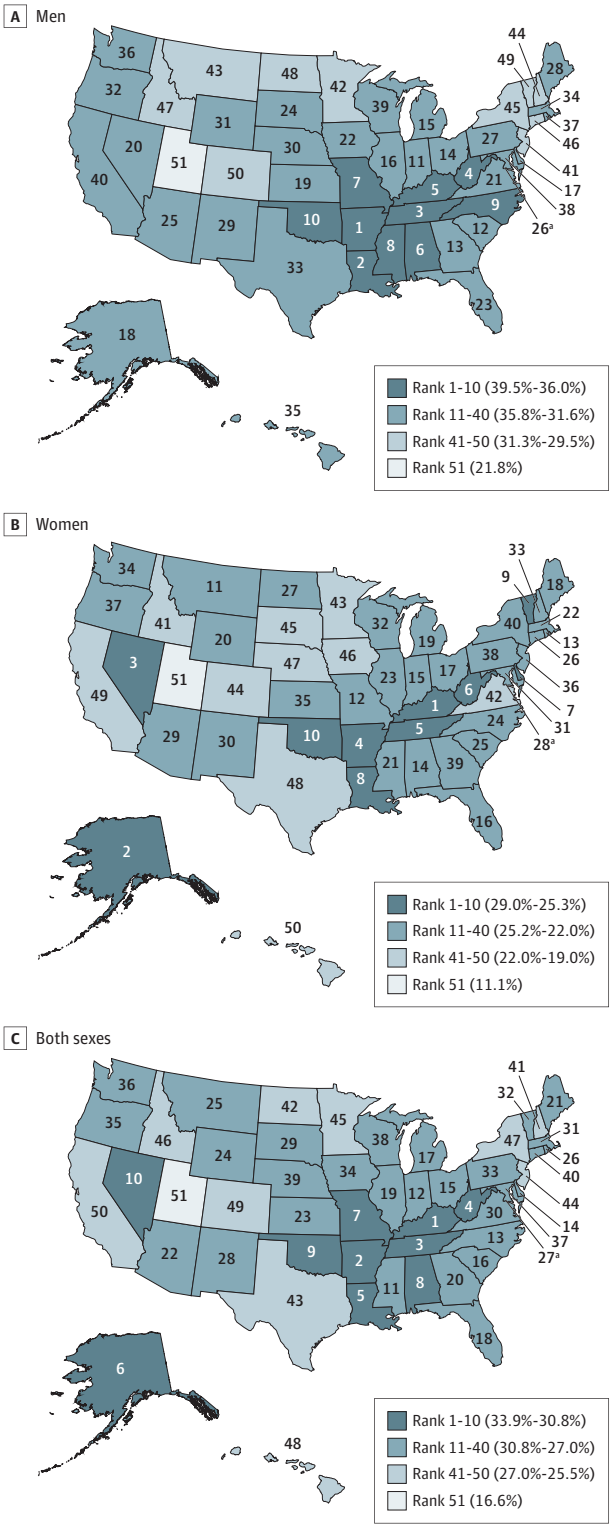
The higher SACM in Southern states may also be due in part to disproportionately high levels of low socioeconomic status, which is associated with higher smoking prevalence[2] and lower smoking cessation rates.[31] Smoking prevalence among adults with a high school education or less are 2 to 4 times those among college graduates,[2] and people with a lower educational attainment are less aware of the health hazards of smoking.[32] Only half (50%) of adults in Kentucky have more than a high school education, compared with 68% in Colorado.[31] In addition, racial differences in smoking prevalence and population distribution may account for some variation in the SACM by state. For example, black men have a higher SACM and a higher proportion of smoking-attributable all-cause mortality,[33] reflecting historically higher smoking prevalence compared with white men.[34] In some Southern states (eg, Louisiana, Mississippi), blacks account for more than 30% of the population compared with less than 5% in many Western and Northern states (eg, Utah, Connecticut).[35] Conversely, some states, such as California and Texas, are disproportionately populated by Hispanics,[35] among whom SACM is lower. Nevertheless, the SACM by state for NHW men is generally similar to that of all men, indicating that variation in racial composition is unlikely to be the driving factor for state differences in SACM. Of note, DC showed the lowest SACM for NHW men, reflecting the large proportion of highly educated men (85% with a bachelor's degree or more)[31] in whom awareness about the health hazards of smoking is highest.[32] The comparatively low SACM in Utah reflects the religious prohibition of smoking among Mormons.[36]

In addition to Southern states, Alaska and Nevada had particularly high SACM, especially among women. In Alaska, which had the second highest SACM in women, smoking prevalence was the same in men and women in 2009, in contrast to most states where it was 10% to 60% higher in men.[16] Nevada is one of a handful of non-Southern states that still

Table. Number and Proportion of Cancer Deaths Attributable to Cigarette Smoking in 2014 in Adults 35 Years and Older

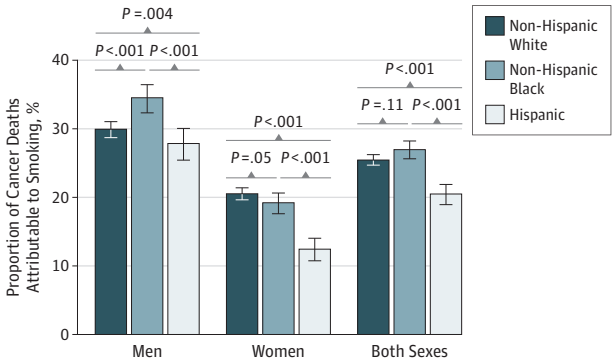
State	Men and Women				Men				Women			
	Rank	Smoking-Attributable Cancer Deaths	Cancer Deaths	Smoking-Attributable Proportion of Cancer Deaths, % (95% CI)	Rank	Smoking-Attributable Cancer Deaths	Cancer Deaths	Smoking-Attributable Proportion of Cancer Deaths, % (95% CI)	Rank	Smoking-Attributable Cancer Deaths	Cancer Deaths	Smoking-Attributable Proportion of Cancer Deaths, % (95% CI)
Kentucky	1	3452	10 165	34.0 (32.4-35.3)	5	2104	5514	38.2 (35.9-40.3)	1	1347	4651	29.0 (27.2-30.7)
Arkansas	2	2175	6490	33.5 (31.9-35.0)	1	1404	3556	39.5 (36.9-41.7)	4	771	2934	26.3 (24.4-28.1)
Tennessee	3	4613	14 031	32.9 (31.2-34.3)	3	2919	7579	38.5 (36.0-40.7)	5	1694	6452	26.3 (24.2-28.2)
West Virginia	4	1581	4845	32.6 (31.2-33.9)	4	1003	2628	38.2 (36.0-40.2)	6	578	2217	26.1 (24.2-27.8)
Louisiana	5	3044	9350	32.6 (31.0-34.0)	2	1943	5042	38.5 (36.0-40.7)	8	1101	4308	25.5 (23.7-27.2)
Alaska	6	296	943	31.4 (29.2-33.3)	18	184	536	34.3 (31.2-37.0)	2	112	407	27.5 (24.3-30.1)
Missouri	7	4047	12 932	31.3 (29.8-32.8)	7	2519	6816	37.0 (34.6-39.2)	12	1528	6116	25.0 (23.0-26.7)
Alabama	8	3183	10 180	31.3 (29.8-32.6)	6	2025	5478	37.0 (34.7-38.9)	14	1159	4702	24.6 (22.9-26.2)
Oklahoma	9	2441	7852	31.1 (29.8-32.3)	10	1529	4245	36.0 (34.0-37.8)	10	912	3607	25.3 (23.7-26.8)
Nevada	10	1535	4968	30.9 (28.7-32.8)	20	921	2703	34.1 (30.7-36.8)	3	614	2265	27.1 (24.0-29.6)
Mississippi	11	1992	6462	30.8 (28.8-32.6)	8	1290	3545	36.4 (33.5-38.9)	21	702	2917	24.1 (21.8-26.1)
Indiana	12	4099	13 407	30.6 (29.3-31.7)	11	2560	7155	35.8 (33.8-37.5)	15	1539	6252	24.6 (23.1-26.0)
North Carolina	13	5844	19 133	30.5 (29.1-31.8)	9	3723	10 241	36.4 (34.2-38.2)	24	2121	8892	23.9 (22.1-25.4)
Delaware	14	591	1949	30.3 (28.4-32.0)	17	344	999	34.4 (31.7-36.9)	7	247	950	26.0 (23.5-28.2)
Ohio	15	7598	25 211	30.1 (28.7-31.5)	14	4679	13 258	35.3 (33.1-37.2)	17	2919	11 953	24.4 (22.5-26.2)
South Carolina	16	2962	9842	30.1 (28.9-31.2)	12	1907	5349	35.7 (33.9-37.2)	25	1055	4493	23.5 (22.0-24.9)
Michigan	17	6232	20 936	29.8 (28.4-31.0)	15	3803	10 870	35.0 (32.8-36.8)	19	2429	10 066	24.1 (22.4-25.7)
Florida	18	12 596	42 818	29.4 (28.2-30.6)	23	7773	23 109	33.6 (31.9-35.3)	16	4823	19 709	24.5 (22.9-25.9)
Illinois	19	7114	24 273	29.3 (27.6-30.8)	16	4282	12 423	34.5 (31.8-36.8)	23	2832	11 850	23.9 (21.8-25.8)
Georgia	20	4816	16 465	29.2 (27.6-30.7)	13	3120	8766	35.6 (33.0-37.8)	39	1696	7699	22.0 (20.1-23.7)
Maine	21	927	3195	29.0 (27.6-30.2)	28	567	1715	33.1 (31.0-34.9)	18	359	1480	24.3 (22.7-25.8)
Arizona	22	3246	11 311	28.7 (27.6-29.7)	25	2031	6094	33.3 (31.6-34.9)	29	1215	5217	23.3 (22.0-24.5)
Kansas	23	1587	5540	28.6 (27.5-29.7)	19	1006	2943	34.2 (32.4-35.7)	35	581	2597	22.4 (20.9-23.7)
Wyoming	24	251	880	28.5 (27.2-29.9)	31	154	477	32.3 (30.2-34.3)	20	97	403	24.1 (22.3-25.7)
Montana	25	581	2049	28.4 (26.9-29.7)	43	335	1074	31.2 (29.2-33.0)	11	246	975	25.2 (23.1-27.2)
Rhode Island	26	631	2226	28.3 (26.9-29.7)	37	361	1134	31.9 (29.6-33.8)	13	269	1092	24.7 (22.5-26.6)
District of Columbia	27	310	1100	28.2 (26.1-30.0)	26	179	538	33.3 (29.6-36.3)	28	131	562	23.3 (21.1-25.2)
New Mexico	28	964	3420	28.2 (26.7-29.5)	29	601	1843	32.6 (30.4-34.6)	30	362	1577	23.0 (21.0-24.7)
South Dakota	29	476	1688	28.2 (26.2-30.0)	24	316	944	33.5 (30.7-36.0)	45	159	744	21.4 (18.7-23.9)
Virginia	30	4110	14 611	28.1 (26.7-29.4)	21	2578	7637	33.8 (31.6-35.7)	42	1532	6974	22.0 (20.2-23.5)
Massachusetts	31	3565	12 677	28.1 (26.8-29.3)	34	2085	6520	32.0 (30.1-33.7)	22	1480	6157	24.0 (22.3-25.6)
Vermont	32	382	1359	28.1 (26.6-29.4)	49	227	750	30.2 (28.1-32.2)	9	155	609	25.5 (23.3-27.4)
Pennsylvania	33	7931	28 437	27.9 (26.6-29.1)	27	4917	14 775	33.3 (31.3-35.1)	38	3014	13 662	22.1 (20.5-23.6)
Iowa	34	1793	6443	27.8 (26.5-29.0)	22	1146	3406	33.7 (31.7-35.4)	46	647	3037	21.3 (19.5-22.9)
Oregon	35	2143	7784	27.5 (26.0-28.9)	32	1315	4072	32.3 (30.0-34.4)	37	828	3712	22.3 (20.5-24.0)
Washington	36	3298	12 042	27.4 (26.1-28.6)	36	2024	6349	31.9 (30.0-33.6)	34	1275	5693	22.4 (20.7-23.9)
Maryland	37	2900	10 629	27.3 (25.8-28.5)	38	1701	5370	31.7 (29.3-33.7)	31	1199	5259	22.8 (21.1-24.3)
Wisconsin	38	3081	11 295	27.3 (25.7-28.7)	39	1884	5969	31.6 (29.1-33.8)	32	1197	5326	22.5 (20.4-24.4)
Nebraska	39	927	3422	27.1 (26.0-28.1)	30	598	1845	32.4 (30.7-33.9)	47	329	1577	20.8 (19.5-22.1)
Connecticut	40	1774	6565	27.0 (25.6-28.3)	46	1017	3325	30.6 (28.4-32.6)	26	758	3240	23.4 (21.4-25.1)
New Hampshire	41	723	2680	27.0 (25.5-28.3)	44	432	1387	31.2 (28.9-33.1)	33	290	1293	22.5 (20.5-24.2)
North Dakota	42	341	1266	27.0 (25.4-28.3)	48	200	659	30.3 (28.0-32.2)	27	142	607	23.3 (21.3-25.2)
Texas	43	10 310	38 269	26.9 (25.4-28.3)	33	6616	20 542	32.2 (29.7-34.3)	48	3695	17 727	20.8 (19.1-22.5)
New Jersey	44	4388	16 411	26.7 (25.4-28.0)	41	2520	8051	31.3 (29.1-33.3)	36	1867	8360	22.3 (20.5-24.0)
Minnesota	45	2552	9549	26.7 (25.6-27.8)	42	1561	4990	31.3 (29.5-33.0)	43	991	4559	21.7 (20.3-23.0)
Idaho	46	731	2752	26.6 (24.9-28.0)	47	455	1494	30.4 (28.0-32.6)	41	277	1258	22.0 (19.9-23.9)
New York	47	9296	35 024	26.5 (25.0-28.0)	45	5467	17 616	31.0 (28.5-33.3)	40	3830	17 408	22.0 (20.0-23.8)
Hawaii	48	642	2466	26.0 (24.2-27.7)	35	427	1340	31.9 (29.2-34.2)	50	214	1126	19.0 (16.5-21.2)
Colorado	49	1876	7310	25.7 (24.5-26.8)	50	1130	3826	29.5 (27.8-31.1)	44	746	3484	21.4 (19.8-23.0)
California	50	14 689	57 547	25.5 (24.0-26.9)	40	9388	29 755	31.6 (29.2-33.7)	49	5302	27 792	19.1 (17.0-20.9)
Utah	51	495	2979	16.6 (15.4-17.7)	51	337	1547	21.8 (19.9-23.5)	51	158	1432	11.1 (9.6-12.3)
Total		**167 133**	**585 178**	**28.6 (28.2-28.8)**		**103 609**	**307 799**	**33.7 (33.2-34.0)**		**63 524**	**277 379**	**22.9 (22.5-23.2)**

Figure 1. Rank and Proportion of Cancer Mortality Attributable to Cigarette Smoking in 2014



States are ranked by the proportion of cancer deaths attributable to cigarette smoking, from highest (1) to lowest (51). States were categorized into 4 groups (group 1, states ranked 1-10; group 2, rank 11-40; group 3, rank 41-50; and group 4, Utah alone as the proportion was substantially lower than in any other state). The color of the state indicates the rank group. [a] Washington, DC.

Figure 2. National Proportion of Cancer Deaths Attributable to Cigarette Smoking, by Race and Ethnicity, in 2014



Proportion of cancer deaths attributable to smoking for both sexes: non-Hispanic (NH) white, 26.0% (95% CI, 24.7%-26.2%); NH black, 27.2% (95% CI, 25.6%-28.2%); and Hispanic, 19.8% (95% CI, 19.0%-21.8%). For men: NH white, 30.4% (95% CI, 28.7%-31.0%); NH black, 34.9% (32.3%-36.4%); and Hispanic, 26.7% (95% CI, 25.4%-30.0%). For women: NH white, 21.1% (95% CI, 19.6%-21.4%); NH black, 19.3% (95% CI, 17.5%-20.6%); and Hispanic, 12.3% (95% CI, 10.7%-14.0%). Error bars indicate 95% confidence intervals.

allows smoking in bars and casinos.[37] A previous study of smoking-attributable all-cause mortality found that Nevada had the highest fraction of deaths explained by smoking of any state.[38] Missouri is another non-Southern state with high SACM, ranking seventh for both sexes combined. It has the lowest cigarette excise tax ($0.17) of any state, 90% lower than the national mean of $1.65.[29]

Tobacco control has been credited with preventing approximately 8 million premature deaths in the United States over the past 5 decades, equivalent to 157 million years of life saved.[39] Our data show that there remains the potential to avert many more premature deaths in light of suboptimal funding for tobacco control programs, not only in the South, but in all states. As of 2016, two-thirds of states lack 100% smoke-free laws in public places to protect the general public from second-hand smoke[40]; no state[41] has taxes on cigarettes that account for at least 75% of the retail price, as recommended by the World Health Organization[42]; and only 1 state (North Dakota) funds its tobacco control programs at the level recommended by the CDC.[23] The Affordable Care Act includes coverage of cessation treatments without cost-sharing for the privately and Medicare insured. However, for Medicaid enrollees—who are twice as likely to smoke[2]—coverage is state governed, and only 7 states provide comprehensive coverage (Connecticut, Indiana, Massachusetts, Minnesota, Nevada, Pennsylvania, and Vermont).[43] Although there has generally been a stagnation in the adoption of traditional comprehensive tobacco control,[44] some states and localities have implemented innovative approaches to fight the tobacco epidemic. For instance, California, Hawaii, and 145 smaller localities have increased the tobacco sales age to 21 years[45]—a measure supported by the Institute of Medicine.[46] Likewise, communities across the United States have passed laws that limit or prohibit smoking in multifamily housing.[47] The federal government can do more to accelerate cessation and discourage initiation, including requiring manufacturers of tobacco products to reduce nicotine content to nonaddictive

levels,[48] increasing federal tobacco taxes, and maintaining funding of antismoking campaigns.[49] With fully one-third of tobacco-related cancer deaths in men and one-quarter in women preventable with current knowledge, tobacco control should spearhead the Cancer Moonshot initiative to accelerate progress against cancer. However, it is important to realize that given the lag time between tobacco use and cancer diagnosis,[50] the impact of today's policies will be most evident on the future cancer burden.

Limitations

Our study likely underestimated deaths caused by tobacco use for several reasons. First, only 12 cancers were included, for consistency with the Surgeon General's report[1]; however, cigarette smoking is associated with excess mortality for additional cancers.[3,51] Second, self-reported data are known to underestimate smoking prevalence.[52] Third, deaths caused by tobacco exposures other than active cigarette smoking, including second-hand smoke, pipes, hookahs, cigars, smokeless tobacco, and electronic nicotine delivery systems, were not included in our analysis. Due to changing patterns of tobacco use,[53] products other than cigarettes may account for a greater proportion of all tobacco-related cancer deaths in the future. Finally, confidence intervals for SACM in some states were relatively wide due to limited precision of smoking prevalence estimates available from the BRFSS in some age groups. However, the BRFSS is the only national survey designed to provide estimates of state-level smoking status. Although the response rate for the BRFSS is lower (47%) than that for the NHIS (61%),[10] the surveys report generally comparable smoking prevalence estimates,[54] which generate similar SACM when compared at the regional level. Notably, higher SACM was less apparent in the Census Bureau–defined Southern region because it includes states such as Maryland, which has exceptionally low smoking prevalence (16.4% in 2013),[55] and Texas, which has a large lower-smoking Hispanic population.[56] This illustrates the high variability of smoking-attributable disease within regions and supports the value of state-specific analyses.

Conclusions

The proportion of cancer deaths attributable to cigarette smoking varies substantially across states and is highest in the South, where up to 40% of cancer deaths in men are caused by smoking. However, the human costs of cigarette smoking are high in all states, regardless of ranking. Increasing tobacco control funding, implementing innovative new strategies, and strengthening tobacco control policies and programs, federally and in all states and localities, might further increase smoking cessation, decrease initiation, and reduce the future burden of smoking-related cancers.

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Study concept and design: Jemal.
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