Smoking-attributable Mortality by State in 2014, U.S.

Jiemin Ma, PhD, MHS,1 Rebecca L. Siegel, MPH,1 Eric J. Jacobs, PhD,2 Ahmedin Jemal, DVM, PhD1

Introduction: Contemporary state-specific estimates of mortality caused by cigarette smoking are important for tobacco control advocacy and healthcare planning in the U.S., but are currently lacking.

Methods: The population-attributable fraction (i.e., proportion of deaths in the population caused by smoking), number of deaths, and number of years of potential life lost because of active cigarette smoking were estimated for each state based on state-specific smoking prevalence data from the 2014 Behavioral Risk Factor Surveillance System, recently updated relative risks of smoking, and numbers of deaths from smoking-attributable diseases. Analyses were performed in 2017.

Results: In 2014, active cigarette smoking caused an estimated 448,865 deaths (258,456 men and 190,409 women), representing 17.8% (95% CI = 17.7%, 17.9%) of all deaths at age > 35 years in the U.S. These deaths resulted in the premature loss of 6,387,021 years of life in 2014. Across states, population-attributable fractions ranged from 12.4% in Utah to 25.2% in Arkansas in men, and from 7.0% in Utah to 20.0% in Nevada in women. Cigarette smoking caused > 20% of all deaths in seven states (Kentucky, Arkansas, Nevada, Tennessee, West Virginia, Oklahoma, and Missouri). California had the highest number of smoking-attributable deaths (n = 38,182) and years of potential life lost (508,370 years), despite a relatively low population-attributable fraction (16.2%).

Conclusions: Cigarette smoking continues to cause a substantial proportion of deaths in every state, with the highest population-attributable fractions in Nevada and the South. The continuing high burden in states with longstanding tobacco control, like California, highlights the need for enhanced tobacco control in all states.

INTRODUCTION

The U.S. has among the highest smoking-attributable mortality (SAM) worldwide, with more female smokers than any other country.1 Contemporary state-specific estimates of SAM are a vital public health measure in the U.S. because most tobacco control programs are designed and implemented at the state level. However, the most recent published estimates of these for all smoking-related diseases were for 2000–2004 based on relative risks (RRs) of death from smoking generated from follow-up of the Cancer Prevention Study II (CPS-II) from the 1980s2 and for 2004 based on lung cancer death rates in nonsmokers and association between lung cancer mortality and mortality from other causes of death.3 State-specific SAM may have changed in recent decades because of both varying rates of decline in state smoking prevalence and the RR of death associated with smoking has increased.4,5 The 2014 Surgeon General’s Report (SGR) showed that the overall SAM for 2005–2009 based predominantly on updated RRs from pooled data of five contemporary cohort studies was about 15% higher than what would have been obtained using RRs from CPS-II only.6

Therefore, the present study used up-to-date information on smoking prevalence and RRs of death from cigarette smoking to estimate the total number of smoking-attributable deaths from all causes, the
METHODS

Study Sample

Similar to previous studies, this study only included deaths from diseases that have been established as causally related to cigarette smoking in the calculation of all-cause SAM. According to the 2014 SGR, these diseases include 12 types of cancer (oral cavity and pharynx; esophagus; stomach; colon and rectum; liver and intrahepatic bile duct; pancreas; larynx; lung, bronchus, and trachea; uterine cervix; urinary bladder; kidney and renal pelvis; and acute myeloid leukemia), six types of cardiovascular disease (coronary heart disease, other heart disease, cerebrovascular disease, atherosclerosis, aortic aneurysm, and other arterial disease), diabetes mellitus, influenza and pneumonia, bronchitis and emphysema, chronic airway obstruction, and tuberculosis. ICD-10 codes for these conditions are listed in Appendix Table 1 (available online).

Measures

PAFs, numbers of smoking-attributable deaths, and YPLL were estimated using the weighted-sum method for each state, stratified by sex and age (35–54, 55–64, 65–74, and ≥75 years). First, age, sex, and state-specific PAFs for each disease were estimated using the following formula:

\[ PAF = \frac{p0 + p1 \times RR1 + p2 \times RR2 - 1}{p0 + p1 \times RR1 + p2 \times RR2}, \]

where \( p0, p1, \) and \( p2 \), represent the proportion of never, former, and current smokers, respectively; and \( RR1 \) and \( RR2 \) are the RRs for former and current smokers, respectively, compared with never smokers.

The prevalence of cigarette smoking was obtained from a publicly available data set from the 2014 survey of the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is an ongoing telephone-based data collection system on health-related risk behaviors among U.S. residents in all 50 states and DC. For convenience, DC is referred to as a state hereafter. Smoking prevalence in each state and the District of Columbia (DC) in 2014. All-cause PAFs by sex, both at the state and national level, were calculated as the total number of smoking-attributable deaths across all disease categories and age groups, divided by the total number of deaths observed in people aged ≥35 years. These statistical methods match those used in SAM calculations in the 2014 U.S. SGR. Using an approach similar to that adopted in previous CDC reports, smoking-attributed YPLLs were calculated based on 2014 U.S. life tables. First, age-, sex-, and cause-specific YPLLs were estimated by multiplying the number of smoking-attributable deaths by remaining life expectancy at the time of death. The overall YPLL was then obtained by summing these age-, sex-, and cause-specific YPLLs in each state. In addition, YPLL rates (per 100,000 population) were calculated for each state using the 2014 population estimates obtained from National Center for Health Statistics.

Some state variation in PAF reflects racial/ethnic differences in smoking prevalence and state of residence. Racial/ethnic-specific PAFs could not be estimated at the state level using BRFSS data because of sparse data for non-Hispanic blacks (NHBs) and Hispanics in some states. However, PAFs by race/ethnicity (non-Hispanic white [NHW], NHB, and Hispanic) were calculated nationally using the method described and smoking prevalence from the 2014 National Health Interview Survey (NHIS). The NHIS is designed to provide national estimates for health behaviors and collects data through yearly in-person computer-assisted interviews among non-institutionalized U.S. adults aged ≥18 years. In 2014, a total of 24,803 participants aged ≥35 years provided complete smoking status information and were included in analysis.

Statistical Analysis

Uncertainty in the estimates was quantified using Monte Carlo simulations, with 10,000 random draws from the normal distribution of estimated prevalence of former and current smokers. Corresponding 95% CIs were derived from the 2.5th and 97.5th percentiles of 10,000 estimated PAFs, SAMs, and YPLLs. Although NHIS data lack precision and representativeness to provide state-level smoking prevalence, they can be used to generate regional estimates. As a sensitivity analysis, PAFs and SAMs based on smoking prevalence from the 2014 BRFSS survey were compared with those based on the 2014 NHIS survey by sex and region (South, Midwest, West, and Northeast) to evaluate the extent to which the use of different data sources would influence these estimates.

SAS callable SUDAAN, version 11.0 was used to estimate smoking prevalence and all other analyses were performed using SAS, version 9.4. R, version 3.4.0 was used to map the PAF for both sexes combined by state for visual inspection of the geographic variations in PAF. All significance tests were two-sided, and statistical significance level was set at \( p < 0.05 \).

RESULTS

In 2014, active cigarette smoking caused a total of 448,865 deaths (258,456 in men and 190,409 in women), representing 17.8% (95% CI = 17.7%, 17.9%) of all deaths occurring in individuals aged ≥35 years in the U.S. (Table 1). The PAF was 20.6% (95% CI = 20.4%, 20.7%)
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