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Recent Trends and Geographic Patterns of the Burden of Disease Attributable to Smoking

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ABSTRACT

Purpose: Quality-adjusted life-years (QALYs) use a single number to provide an assessment of the overall health burden of diseases associated both with mortality and morbidity. This study examined the trend and geographic variation of the burden of smoking by calculating smoking-related QALYs lost from 1993 to 2008 for the US adults and individual states.

Methods: Population health-related quality of life scores were estimated from the 1993 to 2008 Behavioral Risk Factor Surveillance System. The smoking-related QALYs lost are the sum of QALYs lost due to morbidity and future QALYs lost in expected life years due to premature deaths (mortality).

Results: From 1993 to 2008, the percent of US adults who smoked declined from 22.7% to 18.5%, but the smoking-related QALYs lost were relatively stable at 0.0438 QALYs lost per population. Although smoking contributed more QALYs lost for men (0.0535) than for women (0.0339), smoking-related QALYs lost decreased by 2.5% for men but increased by 12.6% for women. Kentucky, Oklahoma, Mississippi, West Virginia, and Tennessee had the most smoking-related QALYs lost wheras Utah, California, Connecticut, Minnesota, and Hawaii had the least QALYs lost. The state tobacco tax rate was strongly and negatively associated with both the percent smoked ($r = -0.60$) and QALYs lost ($r = -0.54$), as well as the percentage change in both.

Conclusions: This analysis quantified the overall burden of smoking for the nation and individual states from 1993 to 2008. Such data might assist in providing specified quantitative targets for the *Healthy People 2020* smoking-related health objectives and for tracking changes on a yearly basis.

Keywords: burden of illness, health-related quality of life, health-state utility, quality-adjusted life years, smoking cessation.

Introduction

Tobacco use has been considered to be the leading modifiable behavioral risk factor and the leading cause of premature death in the United States [1]. *Healthy People 2010* had listed smoking as a leading health indicator and included the objective of reducing the prevalence of smoking to 12% among US adults aged 18 and older [2]. Yet, when the draft version of *Healthy People 2010* was circulated, researchers questioned the attainability of the current goal based upon the inability to meet the previous goal (of 15%) [3]. In response to the tobacco goal, investigators noted that, where feasible, data-driven analysis can and should be used in setting Healthy People objectives [3,4].

When examining the progress for a given subgroup or geographical region, investigators tend to focus on the impact of smoking on mortality. Recently, the US Centers for Disease Control and Prevention (CDC) calculated the smoking-attributable mortality (SAM) and years of potential life lost both for the United States and for the individual states between 2000 and 2004 and compared these numbers with rates from 1996 to 1999 [5,6]. Because of declines in the smoking prevalence in the majority of states, SAM rates decreased in 49 states and the District of Columbia. Nevertheless, the absolute SAM within states did not decline over time, most likely because of the long-term increases in the population and additional diseases known to be associated with smoking [7].

These studies do not measure the nonfatal impact of smoking, as assessed by health-related quality of life (HRQOL) and such an omission is important, given that smoking affects both morbidity and mortality [8,9]. As noted by the Secretary's Advisory Committee on Health Promotion and Disease Prevention, a single number, such as quality-adjusted life-years (QALYs), would be particularly useful in quantifying the overall health impact of risk factors such as smoking [10,11]. QALYs use preference-based measurements of HQROL to provide an assessment of the overall burden of diseases associated with both mortality and morbidity [12]. Analyses of QALYs are especially useful for quantifying the impact of particular modifiable risk factors, analyzing health disparities at the national or local (community) levels and for small sociodemographic subgroups, and examining changes over time.

The main purpose of this study is to examine both the trend and the geographic variation of the overall health burden of smoking in the United States by calculating smoking-related QALYs lost from 1993 to 2008 for the entire nation and for each of the 50 states and District of Columbia. We also examined the impact of the state cigarette excise tax on the state smoking-related QALYs lost. Because tobacco has been the target of interventions at the national, state, and local levels, most of which were enacted over the past two decades, trend data would be particularly valuable [13–15].

Materials and Methods

Data and Measurements

Population HRQOL scores were from the 1993 to 2008 Behavioral Risk Factor Surveillance System (BRFSS), the largest ongoing state-based health survey in the United States The BRFSS sampled noninstitutionalized civilian adult residents aged 18 years and older from each of the 50 states, the District of Columbia, and the three US territories [16]. In this analysis, we

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excluded respondents from the three territories because of a lack of detailed mortality data in these areas, giving a total sample size of 3,590,540. The annual sample sizes ranged from 102,263 in 1993 to 406,749 in 2008. The calculations of mean scores and standard error of estimates were adjusted for the complex sampling design of combined state-level data as well as the unequal probability sampling weights and poststratification weights.

Since 1993, the BRFSS asked three questions about respondents' physically unhealthy days, mentally unhealthy days, and days with activity limitation during the past 30 days (with the exception of 2002 when only 22 states asked these questions) [17]. To calculate QALYs, these unhealthy days measures need to be converted to preference-based scores [18]. We applied the previously constructed formula for estimating EQ-5D index scores, a QALY compatible preference-based HRQOL measure, from the unhealthy days of the BRFSS respondents [18]. The respondents' EQ-5D scores were calculated based on the three unhealthy days questions, self-rated general health, and age.

The National Center for Health Statistics produced the National Health Interview Survey (NHIS) Linked Mortality Files by linking eligible adults in the NHIS data to the National Death Index to obtain mortality follow-up through December 31, 2002 [19]. The NHIS contains sociodemographics and health behavior questions similar to the BRFSS. We used the 1997 to 2000 cohort of the NHIS Linked Mortality File and the annual mortality data (available at: http://wonder.cdc.gov) compiled by the CDC to estimate premature deaths due to smoking.

Statistical Analyses

The smoking associated excess deaths (Δ_i) in age interval i were estimated based on: 1) hazard ratios (H_i) of current smokers versus nonsmokers estimated from the NHIS Linked Mortality File; 2) smoking prevalence (p_i) estimated from the BRFSS; and 3) the mortality rate (m_i) for the United States and the individual states from the detailed annual mortality statistics:

$$\Delta_i = \frac{(H_i - 1)\, p_i m_i}{H_i p_i + (1 - p_i)}.$$

QALYs are defined using preference-based HRQOL scores (e.g., EQ-5D index) which provide an assessment of the burden of disease [20]. The EQ-5D index uses summary scores with anchors at 0 (death) to 1 (perfect health) that represent population preferences for different health states. Thus, 1 year of life lived at an EQ-5D index value of 0.8 is equal to 0.8 QALYs.

The total QALYs lost contributed by a risk factor is the sum of the QALYs lost in the current year because of the decrease in HRQOL score (morbidity) and the future QALYs lost in the expected life years due to premature deaths (mortality) [20]. To compare QALYs lost between states and in different years, we used the proportion of the population to calculate QALYs, which can be converted to absolute total QALYs by multiplying the adult population in each state/year. The QALYs lost due to morbidity contributed by a risk factor is defined as the potential annual QALYs that would be gained if those at risk (current smokers) had a mean EQ-5D index score that was equal to the score of the reference group (nonsmokers). Let p_i be the percent of adults who smoked for age interval i, estimated from the BRFSS data. The QALYs lost due to morbidity contributed by smoking is:

$$morb = \sum_i (x_i^0 - x_i^1)\, p_i,$$

where x_i^0 and x_i^1 are the mean EQ-5D scores for the age interval i of nonsmokers and smokers, respectively.

The future QALYs lost in the expected life years due to excess deaths (Δ_i) is the product of smoking-related excess deaths and the potential quality-adjusted life expectancy that would be gained if those at risk had a mean EQ-5D index score that was equal to the score of the reference group. The quality-adjusted life expectancy is defined as the mean EQ-5D index score multiplied by each corresponding expected life year [20]:

$$mort = \sum_i^{\text{Lexp}} (\Delta_i (x_i^0 - x_i^1)\, p_i),$$

where Lexp is life expectancy at 18 years old for the general population of each of the US states.

Results

Figure 1 depicts both the smoking prevalence over time and the EQ-5D index scores for nonsmokers and smokers. From 1993 to 2008, the percent of US adults who smoked decreased from 22.7% to 18.5%, or an 18.4% decrease. During this period, the population mean HRQOL score (EQ-5D index) decreased from 0.886 to 0.865. Although EQ-5D index scores decreased for both nonsmokers and smokers, the rate of decline was much faster for smokers, as illustrated by the difference in EQ-5D scores between nonsmokers and smokers increasing from 0.016 (= 0.889–0.873) in 1993 to 0.047 (= 0.874–0.827) in 2008, or a 194% increase. This trend of widening EQ-5D index score gaps between nonsmokers and smokers was more pronounced for women than for men. Specifically, the difference of EQ-5D index scores between nonsmokers and smokers increased 126% for men and 266% for women. Women also had worse mean HRQOL scores than men did, about 0.024 points lower, and, despite EQ-5D index scores declining for both men and women, the difference of EQ-5D index scores between men and women was relatively stable over time. Of note, despite worsening HRQOL, quality-adjusted life expectancy increased slightly over this time period for both smokers and nonsmokers because of an increase in life expectancy (figure not shown).

Although the percent of adults who smoked declined significantly from 1993 to 2008 (i.e., decreased 14.6% for men and 22.8% for women) (Fig. 2), smoking-related QALYs lost remained relatively stable at approximately 0.0438 QALYs lost per population overall. With regard to gender, smoking contributed 0.0535 QALYs lost per population for men in 2008, much higher than the number for women (0.0339 QALYs in 2008) (Fig. 2). Nevertheless, the trend analysis showed that the smoking-related QALYs lost decreased by 2.5% for men but increased by 12.6% for women.

Disaggregating the QALYs lost into morbidity and mortality, the majority of QALYs lost was from mortality, particularly for men. For men, 81% of smoking-related QALYs lost was due to mortality whereas, for women, 68% of QALYs lost was due to mortality (Fig. 3). This difference in the mortality component of QALYs lost between men and women accounted for most of the gender difference in total smoking-related QALYs lost. By contrast, the morbidity component of QALYs lost was approximately the same for men and women. Also, although the smoking-related QALYs lost due to mortality decreased by 11% for men and 4% for women, the QALYs lost due to morbidity increased by 59% for men and 83% for women.

As noted in Table 1, smoking prevalence decreased for nearly all of the states (with the exception of Alabama, Mississippi, Oklahoma, and the District of Columbia) from the 1993 to 1997 to 2004 to 2008 time periods. Utah had the greatest percentage improvement over time (27.7% decline) whereas the District of

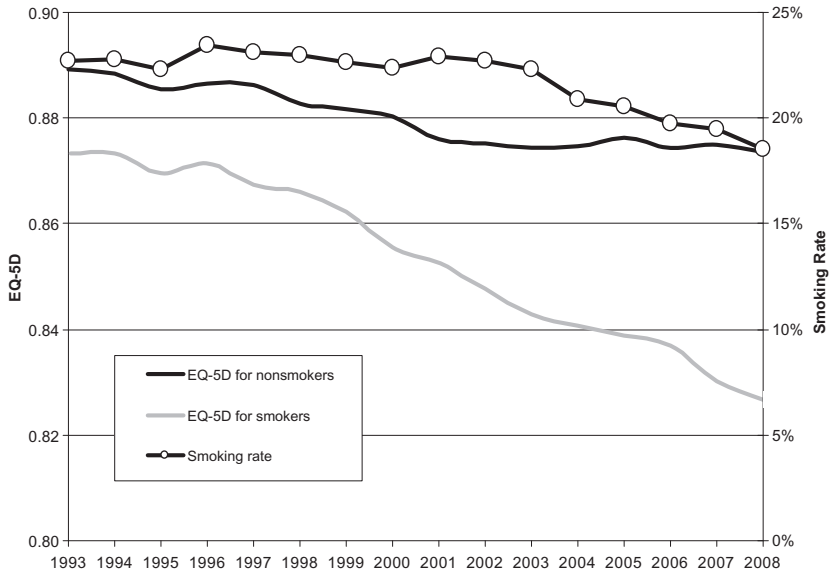

Figure 1 Smoking prevalence rate and EQ-5D index score by smoking status among US adults, 1993 to 2008.

Columbia had the greatest (or worst) percentage increase in smoking prevalence by 5.0%. Utah also had the lowest smoking prevalence in the nation at 10.5% in 2004 to 2008, whereas Kentucky had the highest smoking prevalence at 27.6%. By contrast, smoking-related QALYs lost increased slightly (by 3.2%) between these two time periods for the entire nation and increased for 37 states. States with the worst smoking-related QALYs lost are located in the southeast and southwest. During the 2004 to 2008 period, the top five states with the most smoking-related QALYs lost were Kentucky, Oklahoma, Mississippi, West Virginia, and Tennessee. The five states with the least smoking-related QALYs lost were Utah, California, Connecticut, Minnesota, and Hawaii. This pattern resembled the ranking of smoking prevalence, with the correlation coefficient between the smoking prevalence and smoking-related QALYs lost being 0.87. Regarding percentage changes from 1993 to 1997 to 2004 to 2008, smoking-related QALYs lost decreased more than 5% in Connecticut, Utah, California, District of Columbia, New York, Colorado, and New Jersey but increased more than 15% in Mississippi, Arkansas, Oklahoma, Kentucky, Alabama, Tennessee, and New Mexico. The percentage change in smoking-related QALYs lost between the 1993 to 1997 period and the 2004 to 2008 period also was positively correlated to the percentage change in smoking prevalence ($r = 0.63$).

Finally, we examined the association between the state tobacco tax rate (per pack of 20 cigarettes) and the smoking prevalence, smoking-related QALYs lost, and percentage change over time (between 1993–1997 and 2004–2008) for both (Table 2). The analysis demonstrated that states with the lowest state tobacco tax (less than $0.60 in 2009), including South Carolina, Missouri, Mississippi, Virginia, Florida, North Carolina, Louisiana, Georgia, Alabama, and North Dakota, had the

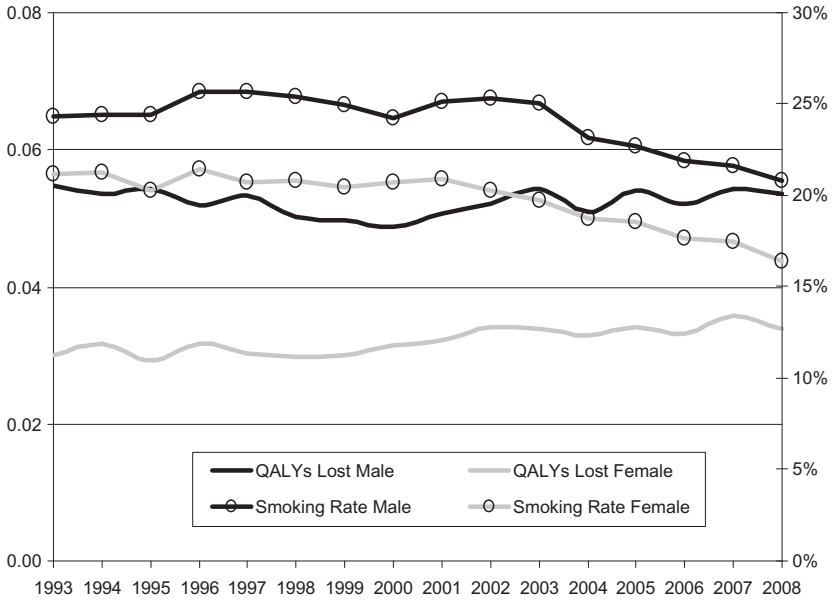

Figure 2 Smoking rate and smoking-related quality-adjusted life-years (QALYs) lost by gender, 1993 to 2008.

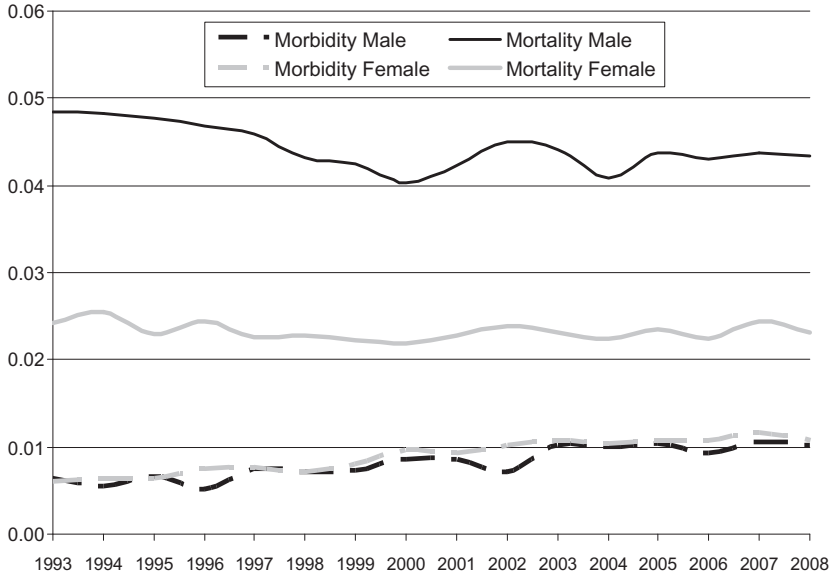

Figure 3 Smoking-related quality-adjusted life-years lost due to mortality and morbidity by gender, 1993 to 2008.

highest smoking prevalence, the smallest decline in smoking prevalence, the most smoking-related QALYs lost, and the largest increase in smoking-related QALYs lost.

Such strong and negative relationships between tax rate and burden of smoking also were observed for tax rates in different years (1995 and 2009). In fact, the relationships were stronger between the 1995 tax rate and smoking prevalence and smoking-related QALYs lost a decade later (2004–2008) than the same time period (during 1993–1997). In particular, the state tobacco tax rate in 1995 had the biggest (and negative) association with both the smoking prevalence ($r = -0.60$) and smoking-related QALYs lost ($r = -0.54$) in 2004 to 2008 values. The tax rate in 1995 also had the biggest (and negative) association with the percentage change in smoking prevalence ($r = -0.47$) and smoking-related QALYs lost ($r = -0.63$) from the 1993 to 1997 time period to the 2004 to 2008 time period. Additionally, regression analysis shows that for each \$0.10 increase in state tobacco tax rate in 1995, on average, smoking prevalence would decrease by 2.4% over the 2004 to 2008 time period and there would be a gain in QALYs of 6.2% (or approximately 0.0026 QALYs per adult population) during this time.

Discussion

Overall, progress has been made with regard to decreasing rates of smoking initiation and increasing rates of smoking cessation but the smoking prevalence for the United States remains above the *Healthy People 2010* target [2,21]. Although the percent of smoking was lower for women than men and the percentage of smoking prevalence decrease was higher among women, the smoking-related QALYs lost increased for women. Such a difference may be attributed to consistently lower HRQOL scores for women compared with men as well as possibly a greater adverse impact on HRQOL due to smoking [22] and greater susceptibility to smoking-associated diseases such as chronic obstructive pulmonary disease for women compared with men [23]. In addition, the overall pattern of a greater decline in HRQOL scores for smokers compared to nonsmokers may be reflective of changes in the sociodemographics of current smokers between 1993 and 2008. Despite more widespread implementation of tobacco programs and policies designed to curtail smoking initiation and promote cessation at the local, state, and national levels, persons who continue to smoke may differ in age, educational attainment, number of cigarettes per day smoked, and mental health than former smokers [24–27].

The prevalence of smoking varies tremendously among the 50 states and the District of Columbia. By 2008, only Utah met the *Healthy People 2010* target for reducing the smoking prevalence to 12% (objective 27-1a) [2]. Between 1993 and 1997, the smoking prevalence varied more than twofold between the states (from a low of 14.6% in Utah to a high of 29.9% in Kentucky). Between 2004 and 2008, these statewide disparities increased, as illustrated by the 2.6 times difference between the same two states (i.e., 10.5% in Utah and 27.6% in Kentucky). The change in QALYs lost tended to resemble the smoking prevalence and the correlation between the percent change of smoking prevalence in different states and the percent change of QALYs lost was noted to be large ($r = 0.627$) [28]. But, whereas smoking prevalence decreased, the smoking-related QALYs lost increased for the general US adult population (and for nearly three-fourths of the states). Similar to the trends in smoking prevalence, the disparities in state smoking-related QALYs lost widened during the 2004 to 2008 time period, ranging from 0.0192 in Utah to 0.0671 in Kentucky (or by more than threefold).

One of the *Healthy People 2010* objectives was to increase the combined federal and average state excise tax to at least \$2.00 per pack [2]. This objective was achieved on April 1, 2009 when the average combined federal and average state excise tax was \$2.21 per pack as a result of the new federal excise tax increasing to \$1.01 per pack, representing a 321% increase since 1995 (where the tax was 24 cents per pack). Although the average state excise tax increased 267% during the same time period, tremendous variability exists among individual states. Our results illustrate the linkage between the magnitude of state cigarette excise tax and both smoking prevalence and smoking-related QALYs lost. In particular, states with a higher excise tax had a greater percentage decline in smoking prevalence as well as fewer smoking-related QALYs lost.

Our method may assist in providing a data-driven means to assess progress on specific *Healthy People* objectives and provide trend data that previously were unavailable. Because the EQ-5D currently is not being administered nationally, at best, such

Table 1 Smoking prevalence and smoking-related QALYs lost by US states for 1993 to 1997, 1998 to 2003, and 2004 to 2008

State	Smoking prevalence				QALYs lost			
	1993–1997 (%)	1998–2003 (%)	2003–2008 (%)	% change*	1993–1997	1998–2003	2004–2008	% change*
United States	22.8	22.6	19.8	−13.4	0.0417	0.0411	0.0431	3.2
Alabama	22.4	24.5	23.5	4.7	0.0512	0.0516	0.0606	18.2
Alaska	27.0	26.7	23.5	−13.0	0.0406	0.0433	0.0438	7.7
Arizona	22.3	21.1	18.5	−17.2	0.0407	0.0395	0.0415	2.0
Arkansas	26.4	25.8	23.5	−11.1	0.0495	0.0558	0.0603	21.7
California	17.9	17.6	14.6	−18.0	0.0344	0.0295	0.0292	−15.3
Colorado	23.0	21.0	18.8	−18.3	0.0361	0.0322	0.0335	−7.2
Connecticut	21.0	20.4	16.6	−20.9	0.0367	0.0333	0.0305	−16.9
Delaware	25.6	24.0	20.7	−19.3	0.0459	0.0423	0.0467	1.7
District of Columbia	17.6	21.1	18.4	5.0	0.0625	0.0573	0.0567	−9.2
Florida	22.9	22.4	19.9	−13.0	0.0448	0.0459	0.0472	5.5
Georgia	21.9	23.4	20.2	−8.1	0.0430	0.0469	0.0478	11.2
Hawaii	19.6	19.4	16.7	−14.6	0.0310	0.0296	0.0321	3.4
Idaho	20.1	20.5	17.6	−12.4	0.0329	0.0345	0.0359	9.2
Illinois	23.8	23.3	20.8	−12.5	0.0420	0.0402	0.0412	−1.9
Indiana	26.8	26.8	25.3	−5.7	0.0447	0.0472	0.0511	14.3
Iowa	22.6	22.8	20.3	−10.3	0.0362	0.0336	0.0378	4.4
Kansas	21.8	21.3	18.7	−14.2	0.0356	0.0383	0.0406	14.0
Kentucky	29.9	30.9	27.6	−7.5	0.0566	0.0624	0.0671	18.6
Louisiana	24.7	24.7	22.5	−9.0	0.0515	0.0505	0.0563	9.3
Maine	24.3	23.4	20.2	−16.8	0.0377	0.0390	0.0422	11.7
Maryland	20.5	21.1	17.6	−14.3	0.0407	0.0408	0.0396	−2.7
Massachusetts	21.6	19.6	17.4	−19.7	0.0378	0.0337	0.0366	−3.1
Michigan	25.5	25.4	21.8	−14.4	0.0425	0.0454	0.0451	6.1
Minnesota	21.4	20.4	18.6	−13.1	0.0314	0.0294	0.0317	0.9
Mississippi	23.4	24.8	24.0	2.6	0.0520	0.0554	0.0636	22.4
Missouri	26.5	26.7	24.0	−9.4	0.0473	0.0499	0.0527	11.4
Montana	21.1	20.6	19.3	−8.4	0.0412	0.0419	0.0450	9.2
Nebraska	21.5	21.8	19.7	−8.5	0.0348	0.0376	0.0359	2.9
Nevada	28.2	28.0	22.4	−20.7	0.0578	0.0551	0.0559	−3.3
New Hampshire	22.9	23.2	19.4	−15.0	0.0371	0.0365	0.0380	2.4
New Jersey	21.0	20.0	17.3	−17.5	0.0375	0.0359	0.0355	−5.4
New Mexico	21.9	22.6	20.4	−6.9	0.0415	0.0440	0.0486	16.9
New York	22.5	22.4	18.9	−16.2	0.0415	0.0358	0.0380	−8.4
North Carolina	26.2	25.5	22.3	−14.9	0.0448	0.0482	0.0499	11.4
North Dakota	21.6	21.6	19.7	−8.9	0.0318	0.0304	0.0348	9.6
Ohio	26.2	26.6	22.8	−13.2	0.0447	0.0481	0.0512	14.6
Oklahoma	24.2	25.5	25.4	4.9	0.0529	0.0542	0.0641	21.2
Oregon	21.8	21.2	18.0	−17.2	0.0394	0.0396	0.0402	2.1
Pennsylvania	23.9	24.3	22.0	−8.0	0.0450	0.0433	0.0477	6.1
Rhode Island	23.7	22.8	18.9	−20.2	0.0402	0.0395	0.0397	−1.3
South Carolina	24.0	25.2	22.2	−7.4	0.0471	0.0505	0.0530	12.7
South Dakota	21.8	23.2	19.6	−10.2	0.0365	0.0392	0.0392	7.4
Tennessee	26.9	25.7	24.5	−8.7	0.0521	0.0532	0.0609	17.0
Texas	22.8	22.3	19.2	−15.8	0.0399	0.0391	0.0430	7.6
Utah	14.6	13.1	10.5	−27.7	0.0229	0.0215	0.0192	−15.9
Vermont	22.7	21.4	18.3	−19.2	0.0365	0.0347	0.0351	−3.8
Virginia	24.0	22.5	19.1	−20.3	0.0373	0.0393	0.0385	3.5
Washington	22.4	21.3	17.2	−23.0	0.0367	0.0372	0.0362	−1.3
West Virginia	26.7	27.5	26.5	−0.7	0.0572	0.0564	0.0634	10.9
Wisconsin	23.1	23.3	20.6	−11.1	0.0325	0.0347	0.0358	10.1
Wyoming	23.0	23.5	21.2	−7.8	0.0385	0.0437	0.0434	12.8

*Percent change of QALYs lost from 1993–1997 to 2004–2008.
QALYs, quality-adjusted life-years.

Table 2 Relationship of state excise tobacco tax rate and state smoking prevalence and smoking related QALYs lost

State tobacco tax*	Smoking prevalence			Smoking related QALYs lost		
	1993–1997	2004–2008	% change†	1993–1997	2004–2008	% change†
Tax rate in 2009						
≥$2.00	22.4%	18.6%	−17.0%	0.0401	0.0386	−3.7%
$0.60–$1.99	22.3%	19.3%	−13.4%	0.0402	0.0410	2.1%
<$0.60	24.3%	21.8%	−10.5%	0.0464	0.0513	10.4%
Correlation coefficients						
Year of tax						
1995	−0.44	−0.60	−0.47	−0.40	−0.54	−0.63
2009	−0.28	−0.47	−0.42	−0.28	−0.40	−0.50

*Tax per pack of 20 cigarettes.
†Percent change of QALYs lost from 1993–1997 to 2004–2008.
QALYs, quality-adjusted life-years.

tracking data used to assess progress would not become available for a number of years. Additionally, these data might enable better decisions with regard to setting "challenging but realistic" targets for the next *Healthy People* iteration [3]. Because the BRFSS data are released in a timely manner, targets might be refined based upon a (proposed) continuous quality improvement approach with ongoing monitoring of trends. For example, knowing that a 10% increase in the real price of cigarettes has been estimated to reduce consumption by nearly 4% would be helpful in examining changes in smoking prevalence geographically as well as for targeted population subgroups after increases in cigarette excise taxes [21]. Increasing tobacco taxes also has been shown to be a cost-effective intervention to reduce the burden of disease contributed by tobacco use [29].

Two limitations in this analysis should be noted. First, in 2002, 28 states and the District of Columbia did not ask the Healthy Days questions. The estimated values for 2002 should be for only the 22 states which administrated these questions. Instead, we used a 3-year average for the 2002 estimation. Second, the relationship of state excise tobacco tax rate and burden of smoking should be interpreted cautiously due to the ecological nature of the analysis with regard to the impact of the tax rate on the smoking prevalence and burden of smoking.

In conclusion, this study illustrates a method that uses large, currently existing data sets representative of the US general adult population to calculate QALYs lost contributed by smoking for the general adult population and the individual states and District of Columbia between 1993 and 2008. Resultant data might assist in providing specified quantitative targets for the *Healthy People 2020* health objectives and for tracking changes on a yearly basis. Additionally, the method assists in setting priorities for prevention for a given population at the national, state, and local levels, as well as according to sociodemographic subgroup. The proposed method takes the advantages of the richness of the BRFSS data for the tracking of population health outcomes and provides data that have been unavailable but are necessary for examining the burden of disease contributed by smoking as well as the cost-effectiveness of interventions to reduce the prevalence of smoking.

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