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Smoking-Attributable Mortality, Years of Potential Life Lost, and Productivity Losses --- United States, 2000--2004

Cigarette smoking and exposure to tobacco smoke are associated with premature death from chronic diseases, economic losses to society, and a substantial burden on the United States health-care system. Smoking is the primary causal factor for at least 30% of all cancer deaths, for nearly 80% of deaths from chronic obstructive pulmonary disease, and for early cardiovascular disease and deaths (*1*). In 2005, to assess the economic and public health burden from smoking, CDC published results of an analysis of smoking-attributable mortality (SAM), years of potential life lost (YPLL), and productivity losses in the United States from smoking during 1997--2001 (*2*). The analysis was based on data from CDC's Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) system,* which estimates SAM, YPLL, and productivity losses based on data from the National Health Interview Survey and death certificate data from the National Center for Health Statistics. This report presents an update of that analysis for 2000--2004, the most recent years for which source data are available. The updated analysis indicated that, during 2000--2004, cigarette smoking and exposure to tobacco smoke resulted in at least 443,000 premature deaths, approximately 5.1 million YPLL, and $96.8 billion in productivity losses annually in the United States. Comprehensive, national tobacco-control recommendations have been provided to the public health community with the goal of reducing smoking so substantially that it is no longer a significant public health problem in the United States (*3*,*4*).

The adult and the maternal and child health SAMMEC software modules were used to estimate SAM, YPLL, and productivity losses attributed to diseases caused by smoking. Sex- and age-specific smoking-attributable deaths were calculated by multiplying the total number of deaths for 19 adult and four infant disease categories (Table) by estimates of the smoking-attributable fraction (SAF)† of preventable deaths. The attributable fractions provide estimates of the public health burden of each risk factor and the relative importance of risk factors for multifactorial diseases. Because of the effect of interactions between various risk factors, attributable fractions for a given disease can total more than 100%. For adults, SAFs were derived using sex-specific relative risk (RR) estimates from the American Cancer Society's Cancer Prevention Study-II (CPS-II) for current and former smokers for each cause of death for the period 1982--1988. For ischemic heart disease and cerebrovascular disease deaths, RR estimates also were stratified by age (35--64 years and ≥65 years). Sex- and age-specific (35--64 years and ≥65 years) current and former cigarette smoking prevalence estimates from the National Health Interview Survey also were used to calculate SAFs. For infants, SAFs were calculated by using pediatric RR estimates and maternal smoking prevalence estimates from birth certificates. Smoking-attributable YPLL and productivity losses were estimated by multiplying sex- and age-specific SAM by remaining life expectancy (*5*) and lifetime earnings data (*6*). In addition, smoking-attributable residential fire-related deaths (*7*) and lung cancer and heart disease deaths attributable to exposure to secondhand smoke (*8*,*9*) were included in the SAM, but not in YPLL and productivity loss estimates.

During 2000--2004, smoking resulted in an estimated annual average of 269,655 deaths among males and 173,940 deaths among females in the United States (Table). The three leading specific causes of smoking-attributable death were lung cancer (128,922), ischemic heart disease (126,005), and chronic obstructive pulmonary disease (COPD)[§] (92,915). Among adults aged ≥35 years, 160,848 (41.0%) smoking-attributable deaths were caused by cancer, 128,497 (32.7%) by cardiovascular diseases, and 103,338 (26.3%) by respiratory diseases (excluding deaths from secondhand smoking and from residential fires). Smoking during pregnancy resulted in an estimated 776 infant deaths annually during 2000--2004. An estimated 49,400 lung cancer and heart disease deaths annually were attributable to exposure to secondhand smoke. The average annual SAM estimates also included 736 deaths from smoking-attributable residential fires.

During 2000--2004, on average, smoking accounted for an estimated 3.1 million YPLL for males and approximately 2.0 million YPLL for females annually, excluding deaths from smoking-attributable residential fires and adult deaths from secondhand smoke. Estimates for average annual smoking-attributable productivity losses were approximately $96.8 billion ($64.2 billion for males and $32.6 billion for females) during this period (Table).

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Editorial Note:

During 2000--2004, an estimated 443,000 persons in the United States died prematurely each year as a result of smoking or exposure to secondhand smoke. This figure is higher than the average annual estimate of approximately 438,000 deaths during 1997--2001 (*2*). The number of smoking-attributable deaths varies according to trends in smoking prevalence and the number of deaths from diseases caused by smoking. SAM estimates also change when a causal relationship is established between smoking and a disease not previously included in SAMMEC (*1*). Although smoking prevalence has declined dramatically since its peak in the 1960s, the number of smoking-attributable deaths has remained relatively unchanged, primarily because of increases in population size (particularly among older age groups). Even with declines in the rates of various smoking-related diseases (e.g., coronary heart disease), the absolute number of deaths is increasing as the total population increases. In addition, cohorts of smokers with the highest peak prevalence have now reached the ages with the highest incidence of smoking-attributable diseases.

The relative risk estimates used in the calculation of SAM have remained the same. In general, the magnitude of the relationship between smoking and the diseases it causes has remained stable over time (*1*). However, CDC is continuing to monitor whether the RRs for smoking are changing over time. Future SAMMEC estimates might contain updated RRs, particularly for females, because their adoption of smoking (and hence their duration of smoking) lagged that of males during the early to mid-1900s. Prevalence of smoking among females peaked in the 1960s and in recent cohorts of smokers more closely follows the trend for male smokers. Smoking-attributable fractions are higher for cancers and COPD than for cardiovascular diseases; however, because the absolute number of deaths is highest for coronary heart disease, it contributes a large number of smoking-attributable deaths.

Preventing smoking and increasing cessation rates need to remain priorities of public health professionals who are working to prevent heart disease and stroke. Dramatic declines in smoking-attributable deaths can be achieved by further reducing smoking prevalence rates. Leading causes of death, such as lung cancer and COPD, could become relatively uncommon in future generations if the prevalence of smoking was substantially reduced (*1*,*3*).

The findings in this report are subject to at least six limitations. First, the estimates understate deaths attributable to tobacco use because estimates of deaths attributable to cigar smoking, pipe smoking, and smokeless tobacco use were excluded. Although the overall prevalence rates of cigar and pipe smoking and use of smokeless tobacco have remained relatively stable, increased public health concerns about these

products might warrant including estimates of deaths attributable to these tobacco products in the future. Second, RRs were based on deaths during 1982--1988 among birth cohorts who might have had different smoking histories than current or former smokers (e.g., age of initiation and duration of smoking before quitting). Third, this report used a death-certificate--based definition of COPD, including codes for bronchitis/emphysema and chronic airway obstruction (ICD-10 J44) (*1*). Therefore, the COPD SAM estimate used for this report might differ from other estimates that use other definitions of COPD (*1*). Fourth, RRs were adjusted for the effects of age but not for other potential confounders. However, research suggests that education, alcohol, and other confounders had negligible additional effects on SAM estimates for lung cancer, COPD, ischemic heart disease, and cerebrovascular disease in CPS-II. Fifth, productivity losses understate the total costs of smoking because costs associated with smoking-attributable health-care expenditures, smoking-related disability, employee absenteeism, and secondhand-smoke--attributable disease morbidity and mortality were not included. Finally, the estimates do not account for the sampling variability in smoking prevalence estimates or RRs.

Cigarette smoking continues to impose substantial health and financial costs on society. During 2001--2004, average annual smoking-attributable health-care expenditures were approximately $96 billion. Accounting for direct health-care expenditures and productivity losses (approximately $97 billion), the total economic burden of smoking is approximately $193 billion per year. By comparison, investments in comprehensive, state-based tobacco prevention and control programs in fiscal year 2007 totaled $595 million, approximately 325-times less than the smoking-attributable costs (*10*). Comprehensive statewide tobacco-control programs significantly accelerate declines in consumption and smoking prevalence (*4*). By increasing their investment in such programs to the levels recommended by CDC, states can further hasten the reduction in cigarette use and reduce the health and economic burden of smoking (*3*).

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* The computations also use other data elements; available at http://apps.nccd.cdc.gov/sammec.

† SAFs for each disease are calculated using the following equation: SAF = $[(p_1(RR_1 -- 1) + p_2(RR_2 -- 1)] / [p_1(RR_1 -- 1) + p_2$

(RR_2 -- 1) + 1] where p_1 = percentage of current smokers (persons who have smoked ≥100 cigarettes and now smoke every day or some days), p_2 = percentage of former smokers (persons who have smoked ≥100 cigarettes and do not currently smoke), RR_1 = relative risk for current smokers relative to never smokers, and RR_2 = relative risk for former smokers relative to never smokers.

§ COPD includes bronchitis/emphysema (*International Classification of Diseases, Tenth Revision* [ICD-10] codes J40--J42 and J43) and chronic airway obstruction (ICD-10 J44) (*1*).

Table

TABLE. Annual deaths and estimates* of smoking-attributable mortality (SAM), years of potential life lost (YPLL), and productivity losses, by sex and cause of death — United States, 2000–2004

	Male				Female			
Causes of death (ICD-10 code†)	Deaths	SAM	YPLL	Productivity losses (in thousands) ($)	Deaths	SAM	YPLL	Productivity losses (in thousands) ($)
Malignant neoplasm								
Lip, oral cavity, pharynx (C00–C14)	5,126	3,749	65,336	1,613,319	2,494	1,144	19,047	354,635
Esophagus (C15)	9,707	6,961	108,847	2,464,063	2,926	1,631	25,382	433,273
Stomach (C16)	7,056	1,900	27,602	600,702	5,024	584	8,971	157,891
Pancreas (C25)	14,845	3,147	50,201	1,162,577	15,481	3,536	53,334	884,761
Larynx (C32)	2,984	2,446	38,012	853,914	778	563	9,914	186,317
Trachea/lung/bronchus (C33–C34)	90,025	78,680	1,118,359	23,189,096	66,874	46,842	770,655	13,597,333
Cervix uteri (C53)	0	0	0	0	3,774	447	11,918	307,412
Kidney and renal pelvis (C64–65)	7,469	2,827	43,898	997,062	4,527	216	3,722	70,680
Urinary bladder (C67)	8,508	3,907	44,166	742,898	3,951	1,076	13,245	174,529
Acute myeloid leukemia (C92.0)	3,889	855	12,527	272,429	3,189	337	5,496	99,772
Subtotal	**149,609**	**104,472**	**1,508,948**	**31,896,060**	**109,018**	**56,376**	**921,684**	**16,266,603**
Cardiovascular diseases								
Ischemic heart disease (I20–I25)	248,506	50,884	804,551	19,019,062	238,845	29,121	389,974	6,068,242
Other heart disease (I00–I09, I26–I51)	72,312	12,944	55,621	1,134,588	95,304	8,060	31,745	428,084
Cerebrovascular disease (I60–I69)	61,616	7,896	127,280	3,075,304	97,681	8,026	140,894	2,878,017
Atherosclerosis (I70–I71)	5,000	1,282	11,814	155,198	8,430	611	5,475	40,423
Aortic aneurysm (I71)	8,861	5,628	70,512	1,339,220	5,862	2,791	34,192	445,625
Other circulatory diseases (I72–I79)	4,238	505	6,636	134,357	5,715	749	9,386	133,702
Subtotal	**400,533**	**79,139**	**1,076,414**	**24,857,729**	**451,837**	**49,358**	**611,666**	**9,994,093**
Respiratory diseases								
Pneumonia, influenza (J10–J18)	27,517	6,042	29,828	448,507	35,008	4,381	23,438	273,061
Bronchitis, emphysema (J40–J42, J43)	8,321	7,536	42,842	708,007	7,941	6,391	40,844	532,162
Chronic airways obstruction (J44)	49,774	40,217	421,721	6,306,543	52,328	38,771	462,973	5,545,304
Subtotal	**85,612**	**53,795**	**494,391**	**7,463,057**	**95,277**	**49,543**	**527,255**	**6,350,527**
Perinatal conditions								
Short gestation/low birth weight (P07)	2,557	219	16,315	—	2,030	174	13,898	—
Respiratory distress syndrome (P22)	550	18	1,358	—	382	13	1,007	—
Other respiratory (newborn) (P23–28)	786	35	2,611	—	556	25	1,983	—
Sudden infant death syndrome (R95)	1,357	173	12,878	—	935	119	9,531	—
Subtotal	**5,250**	**445**	**33,161**	**—**	**3,903**	**331**	**26,419**	**—**
Residential fire	**1,600**	**416**	**—**	**—**	**1,270**	**320**	**—**	**—**
Secondhand smoke								
Lung cancer	—	2,131	—	—	—	1,269	—	—
Ischemic heart disease	—	29,256	—	—	—	16,744	—	—
Subtotal	**—**	**31,388**	**—**	**—**	**—**	**18,012**	**—**	**—**
Total		**269,655**	**3,112,914**	**64,216,846**		**173,940**	**2,087,024**	**32,611,223**

* CDC estimates from 2000–2004 National Health Interview Survey responses and 2000–2004 National Center for Health Statistics death certificate data; smoking-attributable residential fire-related death estimates from 2002–2005 data; productivity losses in 2004 dollars.
† *International Classification of Diseases and Health Conditions, 10th Revision*; available at http://www.who.int/classifications/apps/icd/icd10online.

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