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Department of Public Health

Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) Massachusetts 2004

Division of Research and Epidemiology
Bureau of Health Statistics, Research and Evaluation
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Background

The Division of Research and Epidemiology in the Bureau of Health Statistics, Research and Evaluation in the Department of Public Health used Centers for Disease Control and Prevention's Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) application to examine the impact of smoking on Massachusetts residents in 2004. SAMMEC includes an Adult and a Maternal and Child Health (MCH) program that provide the ability to estimate the health and health-related economic consequences of smoking (CDC, SAMMEC, 2006).

SAMMEC calculates annual state and national-level smoking-attributable deaths and years of potential life lost for adults and infants in the United States. The Adult application also calculates medical expenditures and productivity costs among adults. Likewise, Maternal and Child Health (MCH) SAMMEC estimates annual state and national-level smoking-attributable deaths and years of potential life lost for infants (CDC, SAMMEC, 2006).

Estimates of adult smoking prevalence are obtained from the annual Behavioral Risk Factor Surveillance System (BRFSS).

Major Findings

The 2004 Massachusetts SAMMEC data indicate significant smoking-related loss of life and economic costs despite the recent decline in smoking rates. Much of the smoking-related mortality and economic costs occurring in 2004 are the result of higher smoking prevalence in the past. The 2004 BRFSS data indicate that an average of 18.4% of Massachusetts adults are current smokers. The findings for 2004 may, in fact, underestimate the true impact of cigarette smoking because the SAMMEC application uses the current lower smoking rates in its calculations.

Analyses of SAMMEC data for 2004 indicate that there were 8,171 total deaths attributable to smoking. Overall, approximately 22 Massachusetts residents die each day from smoking-related causes. In terms of economic impact, smoking costs approximately $1.7 billion in lost productivity due to premature deaths of smokers. Additionally, in 2004 smoking costs were estimated at $3.9 billion in personal health care expenditures.

The 8,171 smoking-attributable deaths among residents age 35 and over can be classified by four major categories: cancer, heart disease, and respiratory disease. Table 1 presents the smoking-attributable deaths associated with each disease. Fire deaths are from the fact sheet, "Massachusetts Fires in 2004," Department of Fire Services Office of the State Fire Marshal. These data do not include any deaths from environmental exposure to tobacco smoke; the SAMMEC program does not calculate deaths or disease from second-hand smoke. Also, these data do not include deaths attributable to pipe, cigar, or smokeless tobacco use. The 8,171 deaths represent 15.4 % of all deaths of residents age 35 and over; 18.5% of male deaths, and 12.6% of female deaths.

The 8,171 smoking-attributable deaths is 9.6% lower than the figure estimated for 2003 when there were 9,040 estimated death attributable to smoking. Although the CDC attempts to

"discourage the use of SAMMEC as a surveillance system" for annual estimates, several factors seem to play a part in this difference. First of all, in-state deaths of Massachusetts residents dropped in 2004. In the previous 5 years (1999 – 2003), the total number of in-state deaths of Massachusetts residents ranged from 54,545 to 55,555 with an average of 55,144. In 2004, there were 2,002 fewer in-state deaths of Massachusetts residents which is a 3.6% reduction from the average of the previous five years. Furthermore, the reduction in the number of deaths occurred in categories that are most closely linked to smoking. For example, there was an 8% reduction in deaths from emphysema between 2003 and 2004, a 6% reduction in lung cancer deaths, and a 9% reduction in deaths from chronic airway obstruction.

A second consideration is that smoking prevalence dropped from 27.8% in 1986 to 18.1% in 2004. Because the SAMMEC model relies on smoking prevalence for its estimates, this statewide drop in smoking prevalence would translate into fewer smoking attributable deaths. In addition, the values computed for the adults who had never smoked were different for 2003 and 2004. In 2003, it was estimated that 49.9% Massachusetts adults had never smoked. In 2004, the figure was 54.6%. These estimates are utilized by the SAMMEC model and become a part of the calculations for computing smoking attributable deaths.
According to SAMMEC data, six Massachusetts infants died in 2004 from causes associated with maternal smoking. For 2004, the cause of death includes short gestation/low birth weight (Figure 2).

Table 1. Smoking-Attributable Mortality – 2004

Cause of Death	Males	Females	Total
Malignant Neoplasms			
Lip, Oral Cavity, Pharynx	86	28	114
Esophagus	184	46	230
Stomach	40	17	57
Pancreas	64	101	165
Larynx	60	15	75
Trachea, Lung, Bronchus	1,589	1,202	2,791
Cervix Uteri	0	8	8
Urinary Bladder	112	31	143
Kidney and Renal Pelvis	62	4	66
Acute Myeloid Leukemia	23	14	37
Total Malignant Neoplasms	**2,220**	**1,466**	**3,686**
Cardiovascular Diseases			
Ischemic Heart Disease	773	518	1,291
Other Heart Disease	308	228	536
Cerebrovascular Disease	112	134	246
Atherosclerosis	20	9	29
Aortic Aneurysm	88	59	147
Other Arterial Disease	10	19	29
Total Cardiovascular Diseases	**1,311**	**967**	**2,278**
Respiratory Diseases			
Pneumonia, Influenza	162	131	293
Bronchitis, Emphysema	128	131	259
Chronic Airways Obstruction	743	904	1,647
Total Respiratory Diseases	**1,033**	**1,166**	**2,199**
Fire Deaths*			
Smoking-caused fire deaths	**5**	**3**	**8**
All Cause Total	**4,569**	**3,602**	**8,171**

Smoking Prevalence	MDPH 2004 MA BRFSS
Relative Risk	CPS-II (82-88)
Mortality	MDPH 2004 MA Mortality

In 2004, Massachusetts' residents lost a total of 118,084 years of potential life lost due to smoking-related disease (Table 2). This figure represents, on average, a loss of almost 13 years of life for every smoker in the state. Table 2 shows a list of the smoking-attributable years of potential life lost associated with each disease. These figures do not include the 459 years of potential life lost due to infant mortality related to maternal smoking presented in Figure 2.

Table 2. Smoking-Attributable Years of Potential Life Lost (YPLL) by Disease, Massachusetts 2004

Cause of Death	Males	Females	Total
Malignant Neoplasms			
Lip, Oral Cavity, Pharynx	1,438	466	1,904
Esophagus	2,647	723	3,370
Stomach	523	224	747
Pancreas	989	1,507	2,496
Larynx	953	260	1,213
Trachea, Lung, Bronchus	21,079	19,150	40,229
Cervix Uteri	0	216	216
Urinary Bladder	1,315	362	1,677
Kidney and Renal Pelvis	855	40	895
Acute Myeloid Leukemia	336	223	559
Total Malignant Neoplasms	**30,135**	**23,171**	**53,306**
Cardiovascular Diseases			
Ischemic Heart Disease	12,215	6,357	18,572
Other Heart Disease	3,643	2,387	6,030
Cerebrovascular Disease	1,558	2,052	3,610
Atherosclerosis	169	82	251
Aortic Aneurysm	947	634	1,581
Other Arterial Disease	101	181	282
Total Cardiovascular Diseases	**18,633**	**11,693**	**30,326**
Respiratory Diseases			
Pneumonia, Influenza	1,362	1,185	2,547
Bronchitis, Emphysema	1,400	1,527	2,927
Chronic Airways Obstruction	7,414	9,989	17,403
Total Respiratory Diseases	**10,176**	**12,701**	**22,877**
All Cause Total	**58,944**	**47,565**	**106,509**

Smoking Prevalence	MDPH 2004 MA BRFSS
Mortality	MDPH 2004 MA Mortality
Relative Risk	CPS-II(82-88)
Life Expectancy*	US 2001 Life Expectancy

* Note that , since US life tables are used to calculate YPLL, the MA YPLL may be UNDERESTIMATED because MA, in general, had a longer life expectancy that the US for 5-year age groups.

Smoking-attributable lost productivity costs were calculated to be over $1.7 billion dollars in 2004 (Figure 3). A total of $955 million dollars was lost to premature death from smoking-related cancers. An additional $537 million dollars were due to premature deaths from smoking-

attributable heart disease, and $250 million dollars per year were lost due to premature deaths from smoking-related respiratory diseases. However, these figures do not include any lost productivity costs from deaths related to exposure to second-hand smoke.

Smoking-attributable health care expenditures are the excess personal health care costs of smokers and former smokers. For those residents over 18 years of age, $3.909 billion dollars were spent on smoking-related illnesses in 2004 in Massachusetts (Figure 4). This figure represents 10% of all health care expenditures in the Commonwealth. There were an additional $7.3 million dollars of smoking-attributable neonatal expenditures in Massachusetts in 1999 as estimated by the SAMMEC program. This figure represents 2% of all neonatal expenditures in the Commonwealth.

Data Collection and Analyses

Data on smoking prevalence are from the 2004 Massachusetts Behavioral Risk Factor Surveillance System (BRFSS). For each year since 1986, the Commonwealth of Massachusetts has collected data on smoking through the BRFSS. This system includes a random-digit-dialed telephone survey of non-institutionalized adults years 18 or older. BRFSS is a cooperative effort between the Centers for Disease Control and Prevention (CDC) and state health departments. In 2004, 8,203 adults completed interviews conducted through the Massachusetts BRFSS. Data on maternal smoking prevalence were obtained from certificates of live birth from Massachusetts Registry of Vital Records and Statistics for mothers who gave birth in Massachusetts in 2004.

Data on outcomes were provided from several sources. The American Cancer Society's Cancer Prevention Study provided estimates of the relative risks of mortality for smoking related diseases. Massachusetts mortality data were obtained from death certificates from the Registry of Vital Records and Statistics for the year 2004. Smoking prevalence data and relative risk estimates were used to calculate the smoking-attributable fraction (SAF) for each smoking related disease for adult current and former smokers aged 35 years and older. The SAFs were then combined with Massachusetts mortality data to estimate the number of deaths attributable to smoking.

Smoking-attributable years of potential life lost (YPLL) is defined as the sum of the years of life lost from premature deaths caused by smoking. This figure was obtained by multiplying the midpoint estimate of remaining life expectancy (RLE), which was obtained from 2001 National Centers for Health Statistics life tables, for each smoking-related disease, sex, and five-year age by the number of smoking-attributable deaths. Since Massachusetts, in general, had a longer life expectancy than US estimates, the life expectancy data from the 2001 US Life Expectancy tables may underestimate YPLL for Massachusetts residents. Table A. Expectation of Life by Age, Race, and Sex: United States, 2003, in 2003 National Centers for Health Statistics life tables was used for figure 2.

Smoking-attributable productivity costs are calculated as the estimated costs of lost future earnings from paid market and unpaid household labor resulting from premature death due to smoking-related disease. This measure is considered to be an economic parallel to YPLL and is based on the present value of future earnings with an annual 1% increase in labor productivity. SAMMEC uses updated age-specific present value of lifetime future earnings estimates from "Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation" by A.C.

Haddix et al. 1996. These cost data were combined with smoking-attributable mortality estimates of the year 2004 in Massachusetts to calculate total smoking-attributable productivity costs.

Smoking-attributable health care expenditures are defined as the excess personal health care costs of smokers and former smokers compared to those residents who have never smoked. Figures are obtained by applying the smoking-attributable fraction (SAF) to total health care expenditures for the state of Massachusetts. The SAF of medical expenditures reflects the proportion of annual personal health care expenditures that could be avoided if smoking were eliminated from the population. SAMMEC uses expenditures that could be avoided if smoking were eliminated from the population. SAMMEC uses expenditures SAFs from B.P. Miller et al. "Smoking Attributable Medical Care Costs in the United States" Social Science and Medicine, 1999. The health care expenditure data are for 1998 for the state of Massachusetts as published on CDC's SAMMEC website: http://apps.nccd.cdc.gov/sammec/show_same_data.asp.

The smoking-attributable fraction (SAF) is a critical calculation for the SAMMEC application. The SAF is used to calculate Smoking-Attributable Mortality (SAM) for 19 smoking-related diseases. The SAF is calculated using sex-specific smoking prevalence and relative risk (RR) of death data for adult current and former smokers age 35 and over. Infant mortality SAFs are calculated using maternal smoking prevalence and RR of death estimates for four perinatal conditions caused by smoking. The SAFs for each disease and sex are derived using the following formula:

$$SAF=[(p0 + p1(RR1) + p2(RR2))-1]/[p0 + p1(RR1) + p2(RR2)]$$

Where p0 is the percentage of adult never smokers in the study group (in this case, Massachusetts residents), or with the maternal and child health calculations, the percentage of maternal nonsmokers in the study group.

p1 is the percentage of adult current smokers in the study group, or with the maternal child health calculations, the percentage of maternal smokers in the study

p2 is the percentage of adult former smokers in the study group. This figure does not apply to maternal child health calculations.

RR1 is the relative risk of death for adult current smokers relative to adult never smokers, or with the maternal and child health calculations, the relative risk of death for infants of maternal smokers relative to infants of maternal nonsmokers.

RR2 is the relative risk of death for adult former smokers relative to adult never smokers. This figure does not apply to maternal child health calculations.

Relative Risk estimates for persons 35 and older were obtained from the second wave of the American Cancer Society's Cancer Prevention Study (CPS-II), and six-year follow-up (Thun et al. 1997. ACS published). Relative risk estimates for short-gestation/low birth weight, Sudden Infant Death Syndrome (SIDS), Respiratory Distress Syndrome (RDS) and other infant conditions

were obtained from a meta-analysis of the epidemiological literature conducted by Gavin et al. (2001).

All relative risk data are pre-set by the SAMMEC computer software package; death data and smoking prevalence data are Massachusetts-specific data and are input into the computer software programs to generate data for the above analyses.

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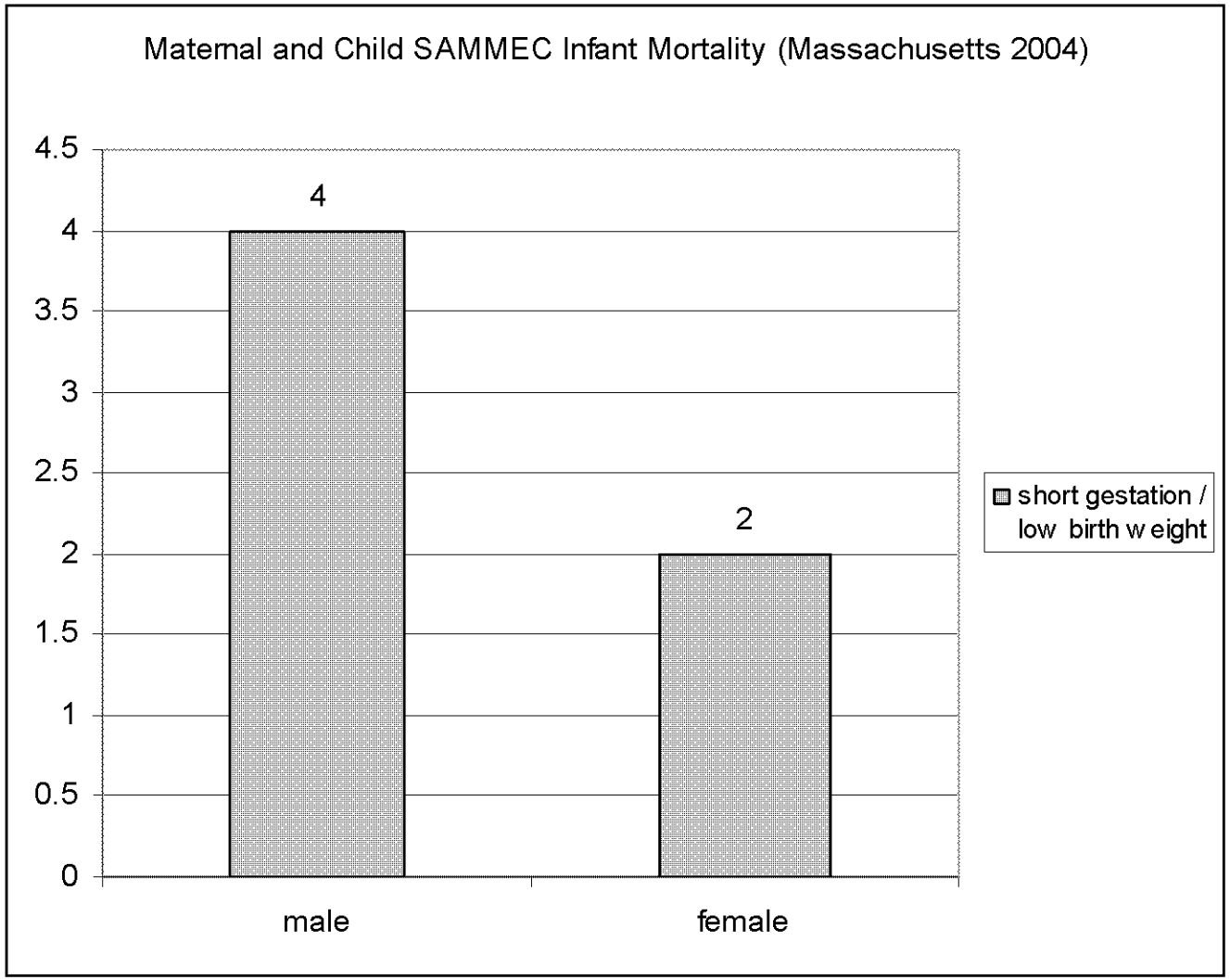
Maternal and Child SAMMEC Infant Mortality (Massachusetts 2004)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4
2
male
female
short gestation / low birth weight

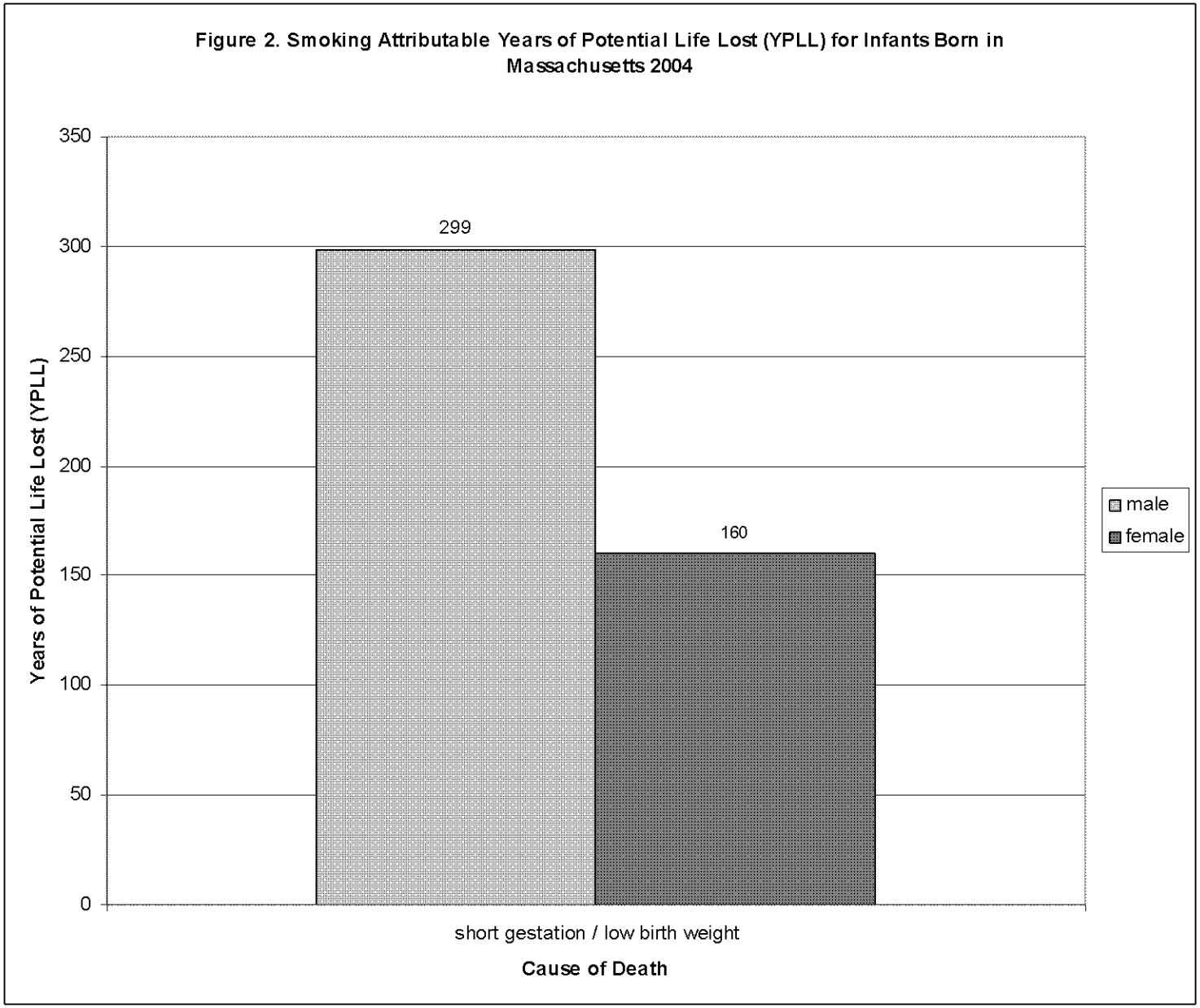
Figure 2. Smoking Attributable Years of Potential Life Lost (YPLL) for Infants Born in Massachusetts 2004
350
300
250
200
150
100
50
0
Years of Potential Life Lost (YPLL)
299
160
male
female
short gestation / low birth weight
Cause of Death

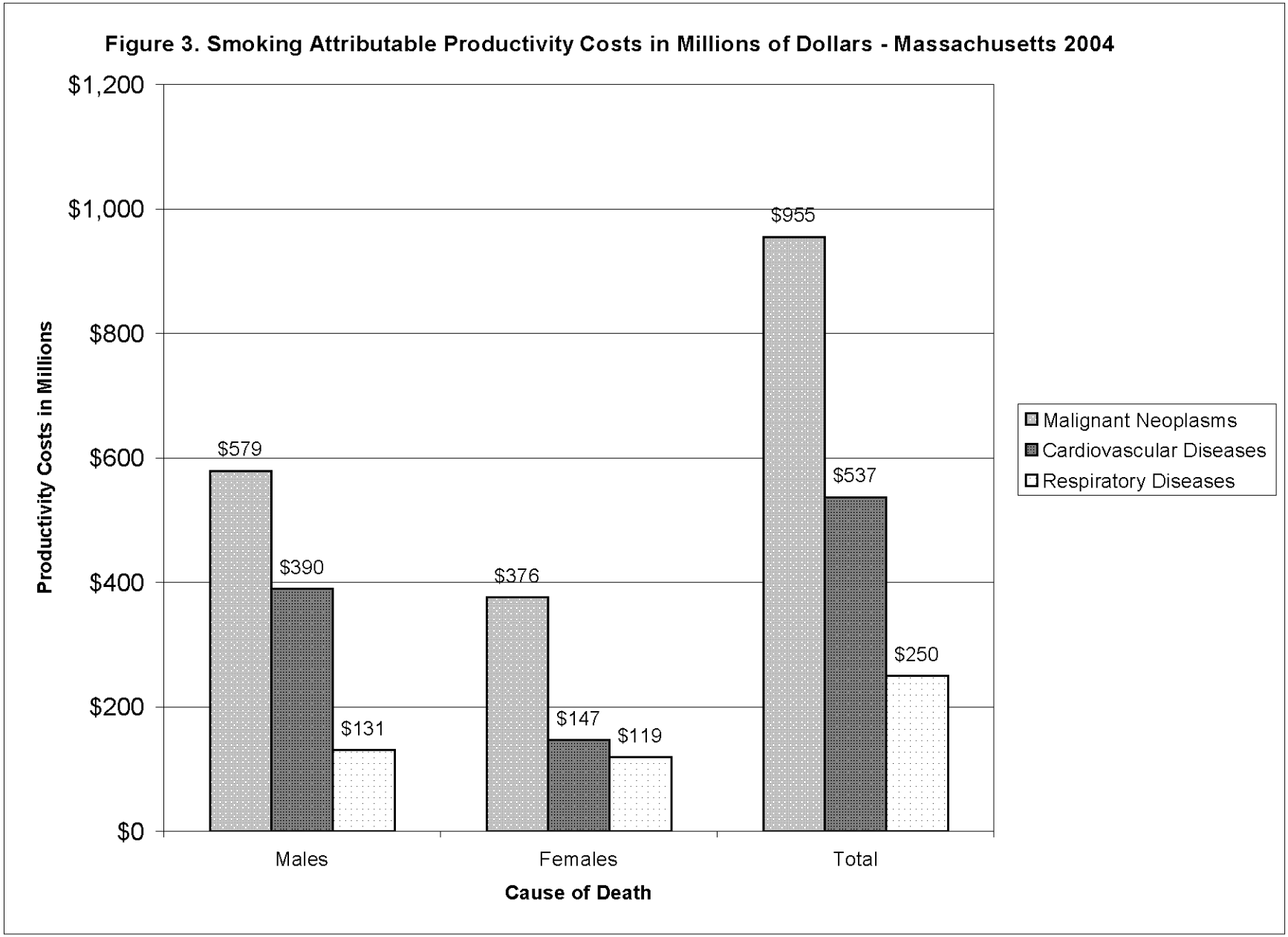
Figure 3. Smoking Attributable Productivity Costs in Millions of Dollars - Massachusetts 2004
$1,200
$1,000
$800
$600
$400
$200
$0
Productivity Costs in Millions
$579
$390
$131
$376
$147
$119
$955
$537
$250
Males
Females
Total
Cause of Death
Malignant Neoplasms
Cardiovascular Diseases
Respiratory Diseases
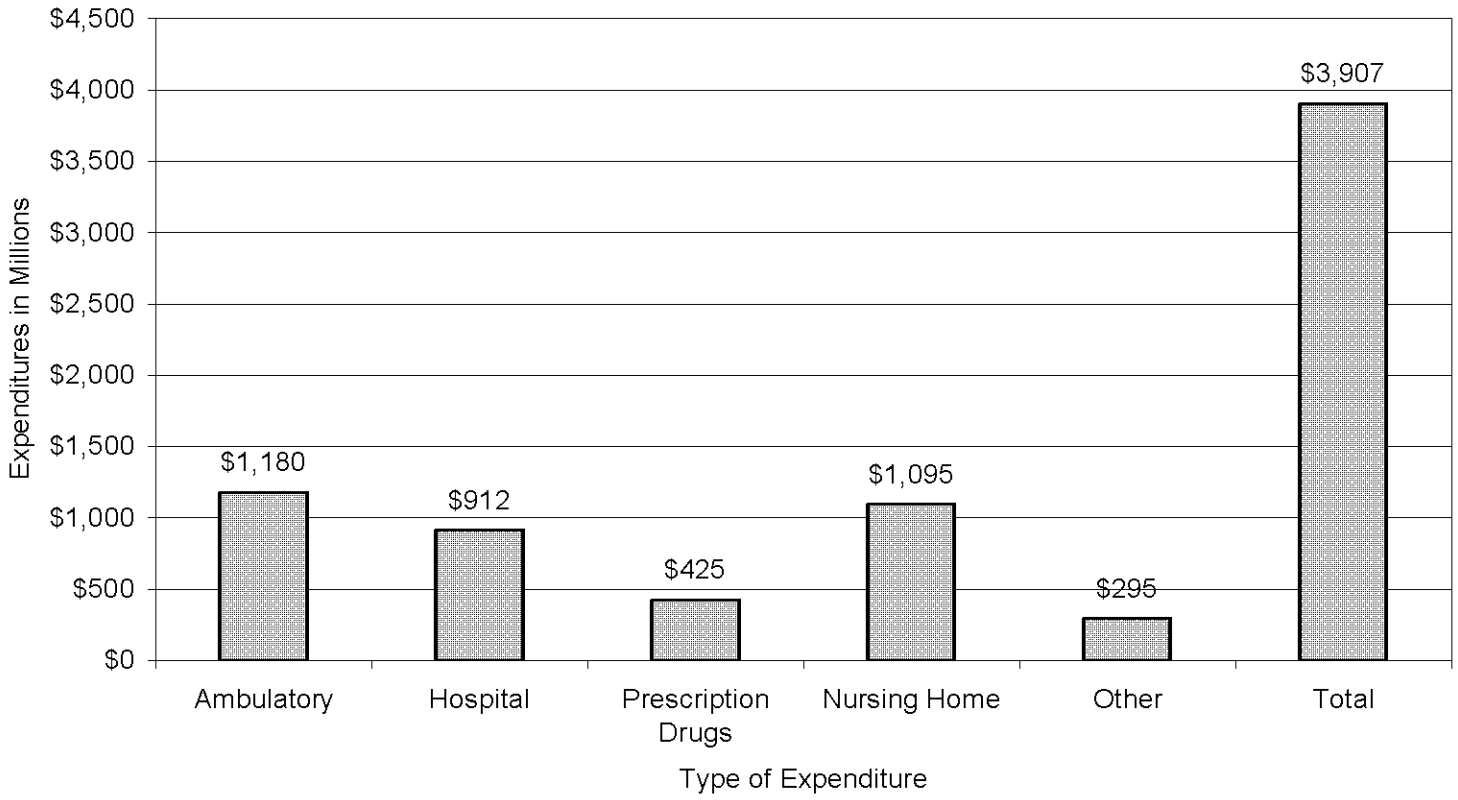
Figure 4. Smoking-Attributable Health Care Expenditures in Millions of Dollars - Massachusetts 2004 (age 18+)