Cost of Smoking to the Medicare Program, 1993

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Medicare expenditures attributable to smoking in 1993 were estimated using a multivariate model that related expenditures to smoking history, health status, and the propensity to have had a smoking-related disease, controlling for sociodemographics, economic variables, and other risk factors. Smoking-attributable Medicare expenditures are presented separately for each State and by type of expenditure. Nationally, smoking accounted for 9.4 percent of Medicare expenditures—$14.2 billion, with considerable variation among States. Smoking accounted for 11.4 percent of Medicare expenditures for hospital care, 11.3 percent of nursing home care, 5.9 percent of home health care, and 5.6 percent of ambulatory care.

INTRODUCTION

Interest in the costs related to smoking has never been higher. Previous research has looked at the cost borne by taxpayers to treat people with smoking-related diseases under Medicaid. For the first time, we use these methods to look at the costs to Medicare, which covers the medical expenses of 34 million Americans age 65 or over and 5.5 million persons with disabilities. The numbers are significant: 16 percent of Medicare enrollees in 1994 reported themselves as current smokers, and another 44 percent reported themselves as former smokers (Olin and Liu, 1998).

The published literature during the past three decades abounds with estimates of the annual costs of smoking in the United States (Hedrick, 1971; Luce and Schweitzer, 1978; Kristein, 1977; Rice et al., 1986; Office of Technology Assessment, 1985 and 1993; Bartlett et al., 1994). Several studies include only the direct medical care costs; others include the indirect costs, the value of unpurchased resources lost attributable to smoking. These studies yield national cost estimates. Recently, two articles were published that presented State-level estimates of Medicaid smoking-attributable expenditures (SAEs) (Miller et al., 1998a) and total SAEs (Miller et al., 1998b).

In this article, we present State estimates of Medicare expenditures attributable to smoking for the Medicare population, including those with disabilities. Estimates are reported by type of expenditure. Also presented are the Medicaid, residual public and private, and total SAEs for each State. Presentation of these State estimates enables each State to quantify its financial burden of smoking by source of payment.

METHODS

The estimation of Medicare SAEs involved four steps: (1) a national model of Medicare SAEs was estimated; (2) the national model was applied to the States; (3) a national estimate was derived from the sum of the State estimates; and (4) interval estimates from the national model were applied to the State estimates.

National Model

We estimated the Medicare expenditure models with data from respondents who were age 65 or over in the National Medical Expenditure Survey (NMES) (Agency for Health Care Policy and Research, 1991). The model has three parts: a sample-bias correction equation; two morbidity equations estimating the effect of smoking history on smoking-related diseases and poor health status; and six expenditure equations estimating the effect of health status and smoking history on the likelihood of three different types of expenditures and on their positive magnitudes. Although there are separate models by sex, we shall refer to these models in the singular. We discuss these three parts in turn. A more detailed description of the national model and its estimation is contained in the Technical Note.

Sample Bias

There may be sample-selection bias introduced by the fact that the NMES obtained data on smoking history through its supplemental survey, which was conducted approximately $4^1/_2$ months into its annual study. Not every NMES respondent completed the survey. For example, participants who died in the first quarter did not participate. Any bias in participating would reflect two countervailing tendencies. First, the likelihood that people who were more concerned about health issues, and hence were more likely to participate in the supplemental survey, were likely to have a higher demand for medical services. Second, participants who were sicker and needed more medical services were less likely to participate. Bias is likely to occur in the estimation of ambulatory care, which is more likely a function of demand (i.e., discretionary) than for hospital or home health care, where services are more determined by supply than demand.

Morbidity

The morbidity portion of the model estimates the effect of smoking history (current, never smokers, or former/unknown smoking status) on previous disease and the effect of smoking history and the propensity for previous disease on self-reported poor health status. The first morbidity equation explains the propensity of a NMES participant (in the supplemental survey) ". . . to have previously been told by a doctor" that he or she had any of five diseases (cancer, emphysema, heart conditions, arteriosclerosis, and stroke) that proxy for the broad class of smoking-related diseases discussed in the Surgeon General's Reports (Centers for Disease Control, 1989). The second equation estimates the propensity for poor health as a function of the propensity to have previously had a smoking-related disease. Health is self-reported as excellent, good, fair, or poor. There is a measurement error associated with the previous smoking-related disease measure and the self-reported health measure, because smoking is not known to be related to all cancers. For example, skin cancer, the most prevalent form of cancer, is not known to be influenced by smoking.

Expenditures

Two Medicare expenditure equations were estimated for each of three types of medical expenditures: ambulatory, hospital, and home health expenditures. For each type, the first equation is a probit

equation estimating the propensity for positive Medicare expenditures. The second equation is a log expenditure equation estimating the logarithm of the magnitude of expenditures, given expenditures were positive. Each equation was specified as a function of a participant's expected propensity for self-reported poor health status, conditional on their reported poor health status, and smoking history, controlling for sociodemographics, economic variables, and other risk factors.

SAEs and Smoking Attributable Fractions

SAEs are the difference between predicted expenditures for smokers and predicted expenditures for a hypothetical group of non-smoking smokers, i.e., nonsmokers who are similar to the smokers in every way except smoking status. The Medicare smoking-attributable fraction (SAF) is the ratio of smoking-attributable Medicare expenditures to total Medicare expenditures. The change in smoking status affects the expected propensity to have a smoking-related disease and expected health status, both of which in turn affect expected expenditures. Although health status and prior treatment are known for smokers, an adjustment was made to the SAFs to take into account the fact that these variables cannot be known for hypothetical non-smoking smokers. This adjustment is described in previous work (Miller et al., 1998a,b).

Because the NMES did not include expenditures for nursing home care, SAEs for nursing home care were estimated by applying the SAFs for hospital expenditures for people age 65 or over to total nursing home expenditures, as in our previous studies about State Medicaid SAEs (Miller et al., 1998a) and State total SAEs (Miller et al., 1998b).

Estimation of State Medicare SAEs

Smoking-attributable Medicare expenditures for each State were estimated by substituting into the national model's equations values for people age 65 or over from each State. The individuals in each State's 1993 Behavioral Risk Factor Surveillance System (BRFSS) survey (Centers for Disease Control and Prevention, 1993) who were age 65 or over were used to represent the Medicare recipients in the State. Additionally, we assumed that BRFSS was a random sample and set the inverse Mill's terms in the morbidity and ambulatory expenditure equations to zero. The State SAFs were then calculated based on these expected expenditures. Because there were no 1993 BRFSS data for Wyoming, the SAFs for Wyoming are the means of the corresponding SAFs for its contiguous States: Colorado, Idaho, Montana, Nebraska, South Dakota, and Utah.

The resulting State Medicare SAFs were applied to State total Medicare expenditures (Table 1), obtained from the Health Care Financing Administration (Levit et al., 1995). At the State level, Medicare expenditures are not available by age group. Although a small portion of Medicare expenditures are for disability payments for persons under age 65, we assumed that Medicare SAFs would not differ substantially by age. Therefore, we applied the SAF estimated for Medicare recipients age 65 or over to total Medicare expenditures for each State.

Interval Estimates

Interval estimates of Medicare SAEs were estimated by type of care for the Nation using a "jackknife" estimation (Rao, Wu, and Yue, 1992; Miller et al., 1998a), and the relative errors from this analysis were applied to each State's estimates.

Table 1

Total Medicare Expenditures in Millions, by State and Type of Expenditure: United States, Calendar Year 1993

State	All Types	Ambulatory Care[1]	Hospital Care	Home Health Services	Nursing Home
United States	$150,373	$43,812	$94,228	$8,022	$4,311
Alabama	2,625	676	1,613	272	64
Alaska	101	22	76	2	1
Arizona	2,277	807	1,298	94	78
Arkansas	1,422	374	962	64	22
California	17,347	6,026	9,895	735	691
Colorado	1,555	418	1,013	63	61
Connecticut	2,134	594	1,258	167	115
Delaware	377	113	240	16	8
District of Columbia	603	134	445	15	9
Florida	12,484	4,763	6,438	801	482
Georgia	3,549	935	2,187	348	79
Hawaii	497	173	306	12	6
Idaho	384	91	257	17	19
Illinois	6,404	1,770	4,219	284	131
Indiana	3,126	712	2,105	147	162
Iowa	1,447	363	1,043	33	8
Kansas	1,325	374	887	43	21
Kentucky	2,144	603	1,376	115	50
Louisiana	2,730	665	1,749	303	13
Maine	606	150	391	58	7
Maryland	2,692	779	1,778	79	56
Massachusetts	4,712	1,102	3,017	378	215
Michigan	5,406	1,573	3,449	257	127
Minnesota	2,163	590	1,430	53	90
Mississippi	1,367	348	839	166	14
Missouri	3,439	860	2,395	113	71
Montana	390	95	271	13	11
Nebraska	746	195	527	13	11
Nevada	732	255	411	44	22
New Hampshire	473	114	309	39	11
New Jersey	4,838	1,696	2,944	118	80
New Mexico	565	166	354	29	16
New York	11,873	3,351	7,907	375	240
North Carolina	3,552	1,001	2,252	210	89
North Dakota	375	95	269	5	6
Ohio	6,176	1,677	4,066	223	210
Oklahoma	1,666	396	1,108	146	16
Oregon	1,521	469	932	50	70
Pennsylvania	10,055	2,812	6,619	353	271
Rhode Island	665	171	425	47	22
South Carolina	1,541	417	978	110	36
South Dakota	364	90	264	2	8
Tennessee	3,548	831	2,107	528	82
Texas	8,765	2,368	5,558	681	158
Utah	625	145	399	55	26
Vermont	242	51	160	28	3
Virginia	2,735	762	1,817	101	55
Washington	2,360	704	1,425	97	134
West Virginia	1,105	297	756	37	15
Wisconsin	2,396	605	1,603	74	114
Wyoming	149	34	101	9	5

[1] Includes physician and other professional services and medical durables.

SOURCE: (Levit et al., 1995).

RESULTS

Estimated SAFs

Table 2 presents estimated Medicare SAFs for State expenditures by type of medical expenditure for calendar year 1993. Nationally, the SAF for all States and Washington, DC, was 9.43 percent. The highest SAF, 11.44 percent, was for hospital care. The lowest SAF (5.58 percent) was for ambulatory care services.

SAFs varied across States as a function of sociodemographic characteristics, smoking prevalence and history, and self-reported health status. Utah had the lowest total Medicare SAF (5.84 percent) and Nevada had the highest (15.67 percent). For each type of expenditure, there was considerable variation among the States. For ambulatory care, the total SAF for the United States was 5.58 percent. The highest ranking State, Oregon at 7.85 percent, had an SAF that was three times that of Iowa, at 2.6 percent. The State SAFs for hospital care ranged from 5.02 percent in Alabama to 21.57 percent in Nevada. The State SAFs for home health services were generally lower than for other expenditure categories, ranging from 3.09 percent in Utah to 8.3 percent in Nevada. SAFs for nursing home care ranged from 5.02 percent in Alabama to 21.59 percent in Nevada. Nevada had the highest State prevalence of smoking among adults, 30.3 percent, in 1992-93 (Centers for Disease Control and Prevention, 1996).

Estimated SAEs

Table 3 presents the estimated national and State Medicare SAEs by type of expenditure for calendar year 1993. The total estimated Medicare SAEs for the United States amounted to $14.2 billion. Of this total, $10.8 billion was for hospital care,

$2.4 billion for ambulatory care (including amounts spent for physician and other professional services, and medical durables), $488 million for nursing home care, and $473 million for home health services.

Differences in SAEs across States reflect differences in the size of the Medicare population, SAFs, and amounts spent by type of expenditure. California had the highest overall Medicare SAEs, $1.5 billion, followed by New York with $1.4 billion. Alaska had the lowest SAEs, $8 million.

Interval Estimates

We applied the national interval estimates to each State to derive interval estimates of the State SAEs; we then aggregated these into estimated SAEs for each State. The 95-percent confidence interval ranges from $309 million to $28.0 billion. The relative error is 49.9 percent, which can be applied to the State point estimates.

Other SAEs

Table 4 shows the SAEs for Medicare, Medicaid, other public and private expenditures, and the total. In 1993, total SAEs for the Nation amounted to $72.7 billion. Of this total, SAEs for the Medicare program amounted to $14.2 billion, 19.5 percent of the total, while Medicaid SAEs amounted to $12.9 billion, 17.7 percent of the total. The remaining other public and private SAEs totaled $45.7 billion, 62.8 percent of the total. Other public programs include military and veterans' health programs, as well as State and local public programs. Private SAEs include private health insurance and out-of-pocket expenditures.

There is considerable variation among the States in the source of payment for SAEs, as shown in Table 4. Medicare SAEs in Alaska comprise only 5.4 percent of the total, while SAEs for Medicaid are 15.4 percent of the

Table 2

Smoking-Attributable Fractions[1] (SAFs) of Medicare Expenditures, by State and Type of Expenditure: United States, 1993

State	All Types	Ambulatory Care[2]	Hospital Care	Home Health Services	Nursing Home
United States	9.43	5.58	11.44	5.90	11.32
Alabama	4.60	3.78	5.02	4.06	5.02
Alaska	8.23	6.32	8.84	5.50	9.00
Arizona	7.43	5.28	8.85	5.06	8.85
Arkansas	6.98	5.19	7.75	5.67	7.77
California	8.70	6.63	10.04	6.26	10.04
Colorado	8.41	5.75	9.59	5.87	9.59
Connecticut	7.14	6.01	7.65	6.91	7.65
Delaware	8.59	5.63	10.06	6.81	10.00
District of Columbia	5.86	4.22	6.37	5.07	6.33
Florida	9.10	7.70	10.23	7.63	10.23
Georgia	6.12	4.05	7.22	4.52	7.22
Hawaii	8.20	6.85	9.01	6.67	9.00
Idaho	6.43	5.43	6.86	4.76	6.84
Illinois	6.27	3.00	7.71	4.63	7.71
Indiana	7.06	3.25	8.38	5.17	8.38
Iowa	5.19	2.60	6.13	3.85	6.13
Kansas	7.14	5.15	8.05	5.14	8.05
Kentucky	6.87	4.06	8.17	5.50	8.18
Louisiana	7.12	4.28	8.51	5.26	8.54
Maine	7.24	6.27	7.73	6.38	7.71
Maryland	8.38	6.58	9.23	6.23	9.23
Massachusetts	7.61	7.04	7.86	7.13	7.86
Michigan	7.70	4.44	9.26	5.91	9.26
Minnesota	6.86	4.92	7.68	4.98	7.68
Mississippi	6.73	4.21	8.07	5.09	8.07
Missouri	6.01	3.57	6.91	4.98	6.92
Montana	14.55	7.07	17.43	6.85	17.45
Nebraska	10.13	5.46	11.94	5.08	11.91
Nevada	15.67	6.92	21.57	8.30	21.59
New Hampshire	15.05	7.56	18.60	7.77	18.64
New Jersey	15.26	7.46	19.90	8.28	19.90
New Mexico	11.85	6.18	14.86	5.90	14.88
New York	11.68	5.37	14.51	6.48	14.51
North Carolina	8.85	4.93	10.88	4.83	10.88
North Dakota	9.91	4.51	11.87	4.80	11.83
Ohio	12.95	5.93	16.03	6.62	16.03
Oklahoma	7.14	2.77	9.10	3.90	9.13
Oregon	14.41	7.85	17.86	6.84	17.86
Pennsylvania	12.18	5.34	15.27	6.37	15.27
Rhode Island	13.09	6.66	16.18	7.13	16.18
South Carolina	8.09	4.56	9.91	4.68	9.92
South Dakota	10.81	5.30	12.67	5.50	12.63
Tennessee	7.68	2.74	10.36	4.37	10.37
Texas	11.91	5.23	15.35	6.32	15.35
Utah	5.84	2.78	7.24	3.09	7.23
Vermont	13.82	5.78	17.49	7.07	17.33
Virginia	9.39	3.72	11.93	5.17	11.93
Washington	11.92	4.73	15.54	5.98	15.54
West Virginia	11.01	4.30	13.84	5.92	13.87
Wisconsin	14.51	7.69	17.22	7.27	17.22
Wyoming[3]	8.77	5.32	10.17	5.22	10.20

[1] SAFs are expressed as percentages of total Medicare expenditures, including amounts spent for persons with disabilities.

[2] Includes physician and other professional services and medical durables.

[3] No data from the Behavioral Risk Factor Surveillance System were available for Wyoming. The Wyoming SAFs were computed as the mean of the SAFs of its contiguous States: Montana, Idaho, Utah, Colorado, South Dakota, and Nebraska.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table 3

Medicare Smoking-Attributable Expenditures (SAEs) in Millions, by State and Type of Expenditure: United States, 1993

State	All Types	Ambulatory Care[2]	Hospital Care	Home Health Services	Nursing Home
United States	$14,182	$2,445	$10,776	$473	$488
Alabama	121	26	81	11	3
Alaska	8	1	7	0	0
Arizona	169	43	115	5	7
Arkansas	99	19	75	4	2
California	1,508	400	993	46	69
Colorado	131	24	97	4	6
Connecticut	152	36	96	12	9
Delaware	32	6	24	1	1
District of Columbia	35	6	28	1	1
Florida	1,136	367	659	61	49
Georgia	217	38	158	16	6
Hawaii	41	12	28	1	1
Idaho	25	5	18	1	1
Illinois	402	53	325	13	10
Indiana	221	23	176	8	14
Iowa	75	9	64	1	0
Kansas	95	19	71	2	2
Kentucky	147	24	112	6	4
Louisiana	194	28	149	16	1
Maine	44	9	30	4	1
Maryland	225	51	164	5	5
Massachusetts	359	78	237	27	17
Michigan	416	70	319	15	12
Minnesota	148	29	110	3	7
Mississippi	92	15	68	8	1
Missouri	207	31	165	6	5
Montana	57	7	47	1	2
Nebraska	76	11	63	1	1
Nevada	115	18	89	4	5
New Hampshire	71	9	57	3	2
New Jersey	738	127	586	10	16
New Mexico	67	10	53	2	2
New York	1,386	180	1,147	24	35
North Carolina	314	49	245	10	10
North Dakota	37	4	32	0	1
Ohio	800	99	652	15	34
Oklahoma	119	11	101	6	1
Oregon	219	37	166	3	13
Pennsylvania	1,225	150	1,011	22	41
Rhode Island	87	11	69	3	4
South Carolina	125	19	97	5	4
South Dakota	39	5	33	0	1
Tennessee	273	23	218	23	9
Texas	1,044	124	853	43	24
Utah	37	4	28	2	2
Vermont	33	3	28	2	1
Virginia	257	28	217	5	7
Washington	281	33	221	6	21
West Virginia	122	13	105	2	2
Wisconsin	348	47	276	5	20
Wyoming	13	2	10	0	1

[1] Includes physician and other professional services and medical durables.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table 4

Amount and Percent Distribution of Smoking-Attributable Expenditures (SAEs), by State and Source of Payment: United States, 1993

| State | Amount in Millions | | | | Percent | | |
	Total	Medicare	Medicaid[1]	Other Public and Private	Medicare	Medicaid	Other Public and Private
United States	$72,732	$14,182	$12,893	$45,657	19.5	17.7	62.8
Alabama	803	121	107	575	15.0	13.4	71.6
Alaska	154	8	24	122	5.4	15.4	79.2
Arizona	877	169	122	586	19.3	13.9	66.8
Arkansas	604	99	78	427	16.4	13.0	70.7
California	8,716	1,508	1,733	5,475	17.3	19.9	62.8
Colorado	939	131	152	656	13.9	16.1	69.9
Connecticut	1,200	152	182	866	12.7	15.2	72.2
Delaware	224	32	23	169	14.4	10.2	75.5
District of Columbia	316	35	36	245	11.2	11.4	77.5
Florida	4,627	1,136	517	2,974	24.6	11.2	64.3
Georgia	1,706	217	252	1,237	12.7	14.8	72.5
Hawaii	328	41	44	243	12.4	13.4	74.1
Idaho	179	25	25	129	13.8	14.1	72.1
Illinois	2,968	402	561	2,005	13.5	18.9	67.6
Indiana	1,560	221	255	1,084	14.2	16.3	69.5
Iowa	617	75	79	463	12.2	12.9	75.0
Kansas	634	95	72	467	14.9	11.4	73.7
Kentucky	1,023	147	201	675	14.4	19.6	66.0
Louisiana	1,147	194	417	536	17.0	36.4	46.7
Maine	338	44	96	198	13.0	28.4	58.6
Maryland	1,379	225	212	942	16.4	15.4	68.3
Massachusetts	2,457	359	406	1,692	14.6	16.5	68.9
Michigan	2,580	416	533	1,631	16.1	20.6	63.2
Minnesota	1,214	148	187	879	12.2	15.4	72.4
Mississippi	549	92	111	346	16.8	20.3	63.0
Missouri	1,502	207	207	1,088	13.8	13.8	72.4
Montana	205	57	28	120	27.6	13.7	58.5
Nebraska	396	76	43	277	19.1	11.0	70.0
Nevada	418	115	50	253	27.4	12.0	60.5
New Hampshire	348	71	95	182	20.5	27.2	52.3
New Jersey	2,583	738	545	1,300	28.6	21.1	50.3
New Mexico	365	67	48	250	18.3	13.2	68.5
New York	6,648	1,386	1,851	3,411	20.9	27.8	51.3
North Carolina	1,669	314	206	1,149	18.8	12.3	68.8
North Dakota	180	37	19	124	20.6	10.6	68.9
Ohio	3,370	800	597	1,973	23.7	17.7	58.6
Oklahoma	694	119	80	495	17.2	11.6	71.3
Oregon	726	219	89	418	30.2	12.3	57.6
Pennsylvania	4,008	1,225	606	2,177	30.6	15.1	54.3
Rhode Island	348	87	97	164	25.0	27.8	47.1
South Carolina	768	125	142	501	16.2	18.5	65.2
South Dakota	174	39	21	114	22.6	11.9	65.5
Tennessee	1,389	273	300	816	19.6	21.6	58.8
Texas	4,822	1,044	654	3,124	21.7	13.6	64.8
Utah	209	37	34	138	17.4	16.3	66.0
Vermont	146	33	29	84	23.0	19.9	57.5
Virginia	1,341	257	163	921	19.2	12.1	68.7
Washington	1,333	281	237	815	21.1	17.8	61.1
West Virginia	493	122	119	252	24.7	24.2	51.1
Wisconsin	1,376	348	198	830	25.3	14.4	60.3
Wyoming	80	13	11	56	16.4	14.4	70.0

[1] Excludes amounts spent for people under age 19, psychiatric hospital care, and mental retardation nursing homes.

SOURCE: (Miller et al., 1998a,b); Zhang et al., San Francisco, California, 1999.

Table 5

Smoking-Attributable Fractions and Expenditures, by Source of Payment:
United States, 1993 and 1997

Source of Payment	1993 Total Medical Expenditures in Millions	Smoking-Attributable Fraction	Smoking-Attributable Expenditures in Millions	
			1993	1997
Total	$614,561	11.83	$72,732	$89,169
Medicare	150,373	9.43	14,182	20,479
Medicaid	106,156	12.14	12,893	16,954
Other Public and Private	358,032	12.75	45,657	51,736

SOURCES: (Miller et al., 1998a, b; Levit et al., 1998); Zhang et al., San Francisco, California, 1999.

total, leaving almost four-fifths of the total, 79.2 percent, paid by other public and private sources. Louisiana, with its relatively high proportion of the total SAEs paid by Medicaid, 36.4 percent, leaves 17.0 percent paid by Medicare and less than one-half (46.7 percent) paid by other public and private programs.

The 1993 SAFs and SAEs for the Nation are shown in Table 5 by source of payment. The SAF for total medical expenditures was 11.83 percent, but it varied by source of payment. The Medicare SAF was the lowest, at 9.43 percent, followed by Medicaid, at 12.14 percent, and the implicit SAF for other public and private sources, at 12.75 percent.

Estimates of SAEs were updated to 1997 based on the increases in total personal health care, Medicare, and Medicaid expenditures (Levit et al., 1998). Total expenditures are projected to $89.2 billion in 1997, with Medicare increasing to $20.5 billion, Medicaid to $17.0 billion, and other public and private sources to $51.7 billion. The proportions of care paid by Medicare and Medicaid are projected to increase slightly from 1993 to 1997, from 19.5 percent to 23.0 percent for Medicare and from 17.7 percent to 19.0 percent for Medicaid, while the proportion of care paid by other sources is projected to decrease slightly (from 62.8 to 58.0 percent).

CONCLUSIONS

This study presents State-level estimates of Medicare expenditures attributable to smoking and compares them with SAEs by other payers. The SAF for Medicare is the lowest of the three payer groups for several reasons. Prescription drugs are not covered by Medicare but were found to have a relatively high SAF in previous work. Similarly, nursing homes, which were found to have the highest SAF for total medical expenditures, are covered under Medicare only in limited circumstances. Furthermore, the sickest smokers may die before they are eligible for Medicare, and hence their costs are included in other payer groups. It is for this reason that smoking prevalence for older people in the Medicare program is lower than it is for younger adults.

The SAFs and SAEs reported here clearly show that cigarette smoking accounts for a substantial portion of annual State and national medical expenditures. There is considerable variation among the States in the proportions of Medicare, Medicaid, and other public and private medical payments attributable to smoking. The range in SAEs across States is attributable to differences in smoking prevalence, health status, and other socioeconomic variables used in the model as well as in the magnitude and patterns of medical expenditures in each State.

TECHNICAL NOTE

This Technical Note contains a detailed description of the estimation of the national model. Table A lists the variables included. The national model is based on an analysis of the NMES sample age 65 or over. Descriptive statistics for this sample are presented in Table B.

In order to address the issue of sample bias in the national model, we made the standard Heckman-Lee adjustments (Heckman, 1979; Lee, 1976). We estimated a probit equation predicting the propensity for supplemental survey participation. We incorporated the selection-bias correction term (inverse Mill's ratios) into the morbidity equations and into the ambulatory expenditure equations of the models. Table C presents the probit results for the propensity-to-participate equations, by sex. Note that the results presented in this article are for the models that incorporate sample-bias corrections. We explored the sensitivity of the results to the omission of consideration about sample-bias correction. The results with and without the sample-bias correction were similar.

Morbidity

The morbidity portions of the model estimate the effect of smoking history on previous disease and the effect of smoking history and the propensity for previous disease on self-reported poor health status.

The propensity to have a smoking-related disease as a function of smoking history was specified, controlling for sociodemographic, economic variables, other risk factors, and an inverse Mill's ratio. We estimated a probit model of smoking-related disease propensity (Table D). Most importantly, for both sexes, current and former

smoking status (and those missing smoking information) was significantly related to an increase in the likelihood of a smoking-related disease.

Poor health is a four-category, self-reported health-status measure: excellent, good, fair, and poor. We used an ordered probit model (McKelvey and Zavoina, 1975) and estimated the propensity for poor health as a function of the participant's expected propensity to previously have had a smoking-related disease, conditional on whether they did or did not have any smoking-related disease, an individual's smoking history, and the control variables previously discussed. Table E presents the point estimates for this poor health propensity equation. In both sex groups, both current-smoker status and a higher propensity to have had a previous smoking-related disease increase the propensity for poor health status. For males, current smoker status reduces the variance in the propensity measure. Although being a male former smoker increased the poor health propensity, being a female former smoker had no effect on the health propensity.

Expenditures

Two Medicare expenditure equations were estimated for each of three types of medical expenditures: ambulatory, hospital, and home health care. The first equation is a probit equation estimating the propensity for positive Medicare expenditures. The second is a log expenditure equation estimating the logarithm of the magnitude of expenditures, given expenditures were positive.

Table F presents point estimates for the ambulatory, hospital, and home health care propensities for positive expenditures, and

Table G presents point estimates for the logarithm of positive expenditure levels for these same types of medical expenditures.

The propensity-for-poor-health variable captures the health and disease effect on expenditures caused by smoking. The smoking-history variables, controlling for poor health, capture an associative effect of smoking on expenditures. This associative effect is the resolution of some health effects not captured by the propensity for poor health and some demand effects associated with smoking. An example of a health effect not captured by the poor-health-status model is illustrated by pregnancy. Pregnant women do not usually think of themselves as having poorer health status. Pregnancy has been found to increase the likelihood or magnitude of positive expenditures (Adams, Solanki, and Miller, 1997). Consequently, the poor-health measure misses increments to expenditure attributable to the effect of smoking on pregnancy. An example of a demand effect is as follows: If individuals with a smoking history do not look after their health as regularly as individuals without a smoking history, the demand of the former group for medical care and medical expenditures is lower. The direct effect of smoking history, controlling for poor health, reflects both of these behaviors and others as well.

The causal effect of smoking on expenditures, reflected by the coefficient on the health propensity in both the likelihood and the magnitude of expenditure equations is always positive and statistically significant. This is true for both the propensity and magnitude of every type of medical expenditure covered by Medicare. The associative effects vary by type of medical expenditure and by sex. For example, former male smokers have a higher likelihood of positive ambulatory expenditures, and former female smokers have a higher likelihood of positive hospital and home health care expenditures. Former male smokers have a lower magnitude of hospital expenditures, and former female smokers have a lower magnitude of home health care expenditures.

The direct-smoking-history variables also influence the variance in the magnitude of medical expenditures. When the effect is significant, it always increases the variance in expenditures. The estimated effects include the following: Every male history of smoking increases the variance in male ambulatory expenditures; for females, being a current smoker increases the variance in ambulatory and hospital expenditures; being a former smoker increases the variance in home health expenditures.

Table A

Variable Names and Definitions

Variable	Definition
Lastage	Age
Black	Black
Hispaoth	Hispanic or Other Race
Midwest	Middle West
Nrtheast	Northeast
South	South
Misseduc	Missing Education Information
Hsgrad	High School Graduate
Collsome	Some College
Collgrad	College Graduate
Lowinc	Low Income
Midinc	Middle Income
Highinc	High Income
Sepnvrr	Separated, Divorced, or Never Married
Widowed	Widowed
Mcaidfx	Medicaid Insured
Privx	Private Insured
Insuroth	Other Insurance
Disbed	Disability Days
Discd	Bed Days
Currsmok	Current Smoker
Missform	Former Smoker or Missing Smoking Information
Prevstar	Propensity of Smoking-Related Disease
Hlthstar	Propensity of Poor Health Status
IMR	Inverse Mill's Ratio

SOURCE: Zhang et al., San Francisco, California, 1999.

Table B

Descriptive Statistics of National Medical Expenditure Survey Sample of Persons Age 65 or Over, by Sex: United States, 1993

Variable	Males		Females	
	Mean	Standard Deviation	Mean	Standard Deviation
Lastage	73.41	6.41	74.00	6.82
Black	0.11	0.31	0.13	0.33
Hispaoth	0.05	0.22	0.05	0.21
Midwest	0.26	0.44	0.26	0.44
Nrtheast	0.19	0.39	0.20	0.40
South	0.37	0.48	0.37	0.48
Misseduc	0.02	0.14	0.02	0.12
Hsgrad	0.28	0.45	0.30	0.46
Collsome	0.11	0.31	0.11	0.32
Collgrad	0.12	0.32	0.08	0.27
Lowinc	0.17	0.38	0.21	0.41
Midinc	0.36	0.48	0.30	0.46
Highinc	0.35	0.48	0.25	0.43
Sepnvrr	0.08	0.27	0.12	0.32
Widowed	0.14	0.34	0.48	0.50
Mcaidfx	0.05	0.20	0.12	0.32
Privx	0.80	0.39	0.77	0.41
Insuroth	0.01	0.07	0.01	0.08
Disbed	6.79	31.66	11.29	39.82
Discd	12.50	35.44	16.79	41.67
Overwght	0.17	0.37	0.22	0.42
Sevwght	0.06	0.24	0.09	0.28
Miswght	0.04	0.21	0.05	0.23
Msblt	0.05	0.22	0.06	0.23
Sbltrare	0.23	0.42	0.22	0.41
Sbltsome	0.18	0.38	0.17	0.37
Prevstar	-0.01	0.84	-0.18	0.83
Hlthstar	1.49	1.05	1.60	1.07
IMR	0.18	0.09	0.20	0.11

NOTE: The sample included 1,997 males and 2,970 females.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table C

Probit Model of Sample Participation, by Sex: United States, 1993

Variable	Males		Females	
	Estimate	Standard Error	Estimate	Standard Error
Constant	**1.86	0.47	**3.18	0.35
Lastage	**-0.01	0.01	**-0.03	0.00
Black	-0.01	0.14	-0.16	0.11
Hispaoth	0.15	0.19	-0.04	0.15
Midwest	-0.01	0.13	-0.04	0.10
Nrtheast	-0.18	0.12	-0.23	0.10
South	0.02	0.12	0.00	0.09
Misseduc	**-0.46	0.20	**-0.69	0.16
Hsgrad	-0.08	0.09	0.05	0.07
Collsome	0.18	0.15	0.10	0.11
Collgrad	*0.27	0.16	0.00	0.12
Lowinc	0.09	0.12	-0.03	0.09
Midinc	**0.41	0.12	-0.12	0.09
Highinc	**0.33	0.13	-0.02	0.10
Sepnvrr	0.02	0.13	0.18	0.12
Widowed	*-0.20	0.10	-0.06	0.07
Mcaidfx	0.22	0.19	**0.35	0.12
Privx	**0.22	0.10	**0.31	0.09
Insuroth	0.32	0.55	**-0.67	0.29
Disbed	**0.00	0.00	**0.00	0.00
Discd	0.00	0.00	0.00	0.00
IMR	**1.54	0.47	**1.00	0.43

* Significant at the 0.10 level.

** Significant at the 0.05 level.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table D

Probit Model of Smoking-Related Diseases, by Sex: United States, 1993

Variable	Males		Females	
	Estimate	Standard Error	Estimate	Standard Error
Constant	**-2.09	0.38	**-2.45	0.36
Currsmok	**0.19	0.09	*0.14	0.07
Missform	**0.19	0.07	**0.20	0.06
Lastage	**0.02	0.01	**0.03	0.01
Black	**-0.45	0.11	**-0.22	0.09
Hispaoth	*-0.26	0.13	**-0.26	0.12
Midwest	-0.06	0.09	-0.11	0.07
Nrtheast	*-0.16	0.10	**-0.20	0.08
South	0.11	0.09	0.02	0.07
Misseduc	-0.33	0.23	**-0.67	0.26
Hsgrad	0.08	0.07	0.01	0.06
Collsome	0.11	0.10	*0.14	0.08
Collgrad	0.07	0.11	**-0.20	0.09
Sepnvrr	-0.01	0.10	**0.18	0.08
Widowed	*-0.18	0.09	0.08	0.05
Overwght	*0.13	0.08	0.09	0.06
Sevwght	*-0.20	0.12	0.12	0.09
Miswght	-0.06	0.15	0.09	0.11
Msblt	*-0.25	0.14	-0.14	0.11
Sbltrare	0.04	0.07	-0.02	0.06
Sbltsome	**-0.17	0.08	0.01	0.07
IMR	**1.54	0.47	**1.00	0.43

* Significant at the 0.10 level.

** Significant at the 0.05 level.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table E

Ordered Probit Model of Poor Health, by Sex: United States, 1993

Variable	Males		Females	
	Estimate	Standard Error	Estimate	Standard Error
Constant	**1.01	0.32	**1.84	0.30
Currsmok	**0.20	0.08	**0.16	0.06
Missform	*0.12	0.06	-0.02	0.05
Lastage	0.00	0.00	-0.01	0.00
Black	**0.30	0.08	0.07	0.07
Hispaoth	0.02	0.11	0.07	0.09
Midwest	**0.16	0.08	-0.07	0.06
Nrtheast	*0.16	0.08	**-0.19	0.07
South	**0.22	0.07	**0.20	0.06
Misseduc	**-0.55	0.16	**-0.69	0.19
Hsgrad	**-0.21	0.06	**-0.28	0.05
Collsome	**-0.19	0.09	**-0.42	0.07
Collgrad	**-0.39	0.09	**-0.54	0.08
Sepnvrr	*-0.17	0.09	**0.19	0.07
Widowed	**-0.28	0.08	**-0.21	0.05
Overwght	-0.01	0.07	*0.08	0.05
Sevwght	**0.32	0.11	**0.23	0.08
Miswght	-0.05	0.11	0.07	0.09
Msblt	**0.21	0.10	**0.23	0.10
Sbltrare	**0.13	0.06	**0.24	0.05
Sbltsome	*0.12	0.07	0.04	0.06
Prevstar	**0.53	0.04	**0.47	0.03
IMR	**2.48	0.37	**2.07	0.35
Variance				
Currsmok	*-0.12	0.07	-0.06	0.05
Missform	-0.04	0.05	0.04	0.04
Threshold				
MU(1)	**1.5348	0.06761	**1.6052	0.04378
MU(2)	**2.853	0.11768	**2.9204	0.06126

* Significant at the 0.10 level.

** Significant at the 0.05 level.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table F

Estimates of Probit Model of Having Positive Expenditures, by Type of Expenditure and Sex: United States, 1993

Variable	Ambulatory Care		Hospital Care		Home Health Care	
	Males	Females	Males	Females	Males	Females
Constant	-0.41	-0.13	**-1.84	**-2.58	**-1.96	**-1.30
Lastage	0.01	0.01	0.01	**0.01	**0.01	**0.01
Black	**-0.26	0.12	-0.04	-0.05	-0.19	-0.04
Hispaoth	*-0.28	-0.07	-0.01	*-0.26	0.02	0.00
Midwest	-0.15	-0.02	-0.04	0.02	0.02	*-0.14
Nrtheast	-0.16	0.12	0.04	-0.07	*-0.18	**-0.22
South	-0.12	-0.07	-0.06	-0.08	-0.06	**-0.24
Lowinc	*0.22	-0.08	0.01	-0.07	0.08	0.04
Midinc	0.21	0.17	0.11	-0.06	0.13	0.08
Highinc	**0.40	0.09	-0.01	0.03	0.17	0.12
Misseduc	-0.36	-0.13	0.09	-0.21	0.30	**-0.56
Hsgrad	**0.20	0.04	*0.16	*0.12	0.08	0.06
Collsome	**0.29	**0.32	*0.21	0.12	**0.23	**0.21
Collgrad	**0.56	0.20	**0.32	-0.08	**0.31	**0.25
Sepnvrr	*-0.21	0.03	0.02	0.08	*0.19	0.09
Widowed	**-0.27	*0.16	-0.15	**0.13	0.12	**0.24
Overwght	0.16	-0.04	**-0.18	-0.01	-0.06	-0.08
Sevwght	0.27	0.11	**-0.29	0.03	**0.26	-0.07
Miswght	-0.18	-0.04	-0.13	-0.10	-0.01	0.08
Msblt	*-0.28	**-0.45	-0.04	-0.18	**-0.29	**-0.23
Sbltrare	-0.06	**-0.39	*0.16	**-0.18	-0.02	-0.06
Sbltsome	0.06	**-0.22	0.02	0.06	-0.01	0.06
Mcaidfx	0.30	**0.40	0.18	**0.22	0.10	**0.25
Privx	**0.28	**0.46	0.04	0.12	**0.20	0.03
Hlthstar	**0.29	**0.30	**0.28	**0.37	**0.30	**0.24
Currsmok	-0.06	**-0.25	-0.15	-0.09	0.03	-0.11
Missform	**0.19	0.13	-0.03	**0.16	0.10	**0.21
IMR[1]	1.10	-1.04	—	—	—	—

* Significant at the 0.10 level.

** Significant at the 0.05 level.

[1]IMR (inverse Mill's ratio) only included in ambulatory model.

SOURCE: Zhang et al., San Francisco, California, 1999.

Table G

Estimates of Regression Model of Logarithm of Positive Expenditures, by Type of Expenditure and Sex

Variable	Ambulatory Care		Hospital Care		Home Health Care	
	Males	Females	Males	Females	Males	Females
Constant	**5.62	**6.21	**8.71	**7.66	**3.61	**2.43
Lastage	**-0.03	*-0.01	0.00	0.01	**0.02	**0.03
Black	-0.09	0.01	0.06	**0.33	-0.03	-0.18
Hispaoth[1]	0.09	-0.13	—	—	0.27	**-0.57
Midwest	**-0.23	**-0.36	*-0.31	-0.05	-0.15	-0.01
Nrtheast	**-0.36	**-0.28	-0.09	-0.04	-0.12	-0.14
South	**-0.30	**-0.47	-0.21	**-0.29	*-0.24	-0.18
Lowinc	0.09	-0.09	-0.15	0.08	0.27	0.13
Midinc	**0.78	-0.03	-0.22	0.13	0.09	*0.19
Highinc	**0.72	0.07	-0.22	-0.10	-0.03	0.20
Misseduc[2]	-0.30	*-0.48	—	—	—	—
Hsgrad	0.04	**0.16	*0.25	**0.23	0.04	0.01
Collsome	**0.31	**0.19	0.26	-0.19	0.11	0.07
Collgrad	**0.78	**0.22	*0.31	-0.13	0.01	0.15
Sepnvrr	**0.27	**0.25	-0.09	0.08	-0.14	0.14
Widowed	**-0.34	*0.11	0.06	0.16	0.12	0.14
Overwght	-0.11	*0.12	-0.09	-0.06	*-0.33	-0.03
Sevwght	-0.03	-0.09	**-0.73	*-0.29	-0.14	0.04
Miswght	-0.15	0.10	0.03	-0.27	-0.10	-0.03
Msblt[3]	-0.17	**-0.26	—	—	0.31	-0.08
Sbltrare	-0.14	**-0.23	-0.13	-0.01	-0.04	0.11
Sbltsome	**-0.19	-0.09	0.04	-0.11	-0.18	-0.04
Mcaidfx	**0.43	**0.42	0.16	-0.02	0.40	**0.96
Privx	**0.50	**0.32	*0.26	0.06	0.01	0.02
Hlthstar	**0.35	**0.32	**0.18	**0.26	**0.21	**0.21
Currsmok	-0.07	**-0.26	0.05	0.00	-0.05	0.13
Missform	0.07	**0.23	**-0.27	0.02	-0.03	*0.17
IMR[4]	**4.62	0.22	—	—	—	—
Sigma	**1.28	**1.29	**1.09	**1.07	**1.43	**1.39
Variance						
Currsmok	*0.18	**0.17	-0.12	**0.45	-0.22	-0.13
Missform	**0.21	-0.05	0.05	0.14	-0.16	**0.23

* Significant at the 0.10 level.

** Significant at the 0.05 level.

[1]Too few observations, combined with black persons in the hospital model.

[2]Too few observations, combined with less than high school in hospital and home health model.

[3]Too few observations, combined with seatbelt always in hospital model.

[4]IMR (inverse Mill's ratio) included only in ambulatory model.

SOURCE: Zhang et al., San Francisco, California, 1999.

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