

ABSTRACT

Background: This report uses population-based individual-level data to compute direct estimates of the costs of physicians' services in Ontario in relation to Body Mass Index (BMI) and smoking.

Methods: Subjects were 2,170 respondents to the National Population Health Survey who approved linkage to the Ontario Health Insurance Plan.

Results: The mean per capita cost of physicians' services in Ontario increased by \$8.90 (95% CI: \$1.90 - \$15.60) for each unit increase in BMI and by \$1.75 (95% CI: \$0.11 - \$3.40) for every year of daily smoking. The annual attributable cost of smoking and overweight among residents of Ontario, aged 40-79, was estimated at \$275,000,000.

Conclusions: Overweight and smoking are responsible for large costs to the health care system. The cost of public health initiatives could be easily recovered if they were successful in making only moderate changes to the levels of smoking and body weight in the population.

ABRÉGÉ

Contexte : au moyen de données représentatives individuelles, nous avons obtenu des estimations directes des coûts des services médicaux en Ontario liés à l'indice de masse corporelle (IMC) et au tabagisme.

Méthode : nous avons sondé 2 170 répondants de l'Enquête nationale sur la santé de la population ayant accepté le jumelage de leurs données personnelles avec celles du Régime d'assurance-maladie de l'Ontario.

Résultats : le coût moyen par personne des services médicaux en Ontario a augmenté de 8,90 \$ (95 % IC : 1,90 \$ - 15,60 \$) pour chaque accroissement unitaire de l'IMC et de 1,75 \$ (95 % IC : 0,11 \$ - 3,40 \$) pour chaque année de tabagisme quotidien. Le coût annuel attribuable au tabagisme et à l'embonpoint des résidents ontariens de 40 à 79 ans était d'environ 275 millions de dollars.

Conclusion : l'embonpoint et le tabagisme entraînent des coûts importants pour le système de soins de santé. Le coût des initiatives de santé publique serait facilement récupéré si ces initiatives réussissaient à réduire, même de façon modeste, le tabagisme et l'embonpoint dans la population.

Obesity, Cigarette Smoking and the Cost of Physicians' Services in Ontario

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Obesity and tobacco use are related to a variety of adverse long-term health outcomes. Over a lifetime they may produce significant costs to society as well as to the individual. The association of excess weight with health problems such as heart disease, diabetes, hypertension, and stroke has been extensively documented.¹ Smoking causes morbidity and mortality from heart and lung diseases and cancer.² Obesity and cigarette smoking are both common in Canada. In 1996/97, 34% of Canadians were overweight (Body Mass Index (BMI) 25.0 - 29.9) and 12%, approximately 2.1 million, were obese (BMI \geq 30.0).³ In 1996/97, 5.5 million Canadians aged 20 to 64 were current smokers, 5.0 million were former smokers, and 7.1 million had never smoked.³

Apart from their impact on the quality of life of individuals,⁴ obesity and smoking have substantial implications for the costs of health care. In the United States, investigators have used financial records of Health Maintenance Organizations (HMO) to investigate health care costs associated with obesity. BMI (1.9% higher charges per BMI unit), current smoking status (18% higher charges), and history of tobacco use (25.8% higher charges) were prospectively related to health care charges in Minnesota.⁵ In another large HMO, relative to BMI of 20 - 24.9, mean annual costs were 25% greater among those with BMI 30 - 34.9 and 44% greater among those with BMI \geq 35.⁶ The association

between BMI and coronary heart disease, hypertension, and diabetes largely explained these elevated costs.

Although Canadian Medicare covers all medically necessary services provided by hospitals and physicians, there has not been any method for linking personal characteristics of individuals to the costs of their care. Canadian researchers have thus been obliged to use indirect methods to estimate the costs to the health care system of smoking and excess BMI. Birmingham and collaborators identified 10 comorbidities of obesity and calculated a population attributable fraction (PAF) for each comorbidity.⁷ The costs attributable to obesity were calculated by multiplying estimates of the direct costs of each comorbidity by the PAF. They estimated that the total direct cost of obesity in Canada in 1997 was over \$1.8 billion. Similarly, Kaiserman⁸ reported that, in 1991, smoking-attributable health care costs in Canada were \$2.5 billion.

These Canadian estimates depend upon many assumptions about the proportion of health care costs attributable to smoking and obesity. I have used individual-level data from the linkage of the National Population Health Survey (NPHS) to the Ontario Health Insurance Plan to compute direct estimates of the costs of physicians' services in Ontario in relation to BMI and smoking simultaneously.

METHODS

Sources of data

The National Population Health Survey

The NPHS was designed to collect information related to the health of the Canadian population.⁹ Body Mass Index was computed from the questions "How tall are you?" and "How much do you

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weigh?" Respondents were asked whether they currently, or formerly, smoked cigarettes daily, and the ages they started and quit. The number of years respondents smoked was computed from these answers for current and former daily smokers.

The subjects of the present analysis are respondents, aged 40 to 79 years, residing in the Province of Ontario who responded to the NPHS of 1995/96. Approval for the linkage of their NPHS responses to administrative databases was granted by 2,170 (89%) of the Ontario respondents in this age range, independent of age, sex, and income. I obtained a copy of the data file from the Ontario Ministry of Health. The Health Insurance Numbers had been scrambled to protect privacy.

Statistical analysis

Utilization of physicians' services was measured by the fee submitted to OHIP by physicians in the year prior to the NPHS interview of each subject. The expenditure data for subjects in the NPHS survey were highly skewed. Eight percent of respondents did not visit a physician, the median and mean expenditures were \$293 and \$580. The expenditures of the 2.5% of individuals incurring expenses in excess of \$3000 were trimmed to \$3000 to limit the effect of outlying data on the estimates of the means.

Generalized additive¹⁰ and fractional polynomial¹¹ models were used to explore the shapes of the relations between BMI, smoking and expenditures while controlling for age, sex, and household income. Mean expenditures, in relation to BMI and smoking, were analyzed with multiple linear regression modelling. The survey weight for each subject was used in all calculations. In skewed data, such as these, regression analysis provides an unbiased estimate of the mean, but the residuals are not normally distributed.¹² Bootstrap resampling¹³ was thus used to compute 95% confidence limits. Analyses were performed with the Stata software package.¹⁴

RESULTS

Study subjects

The majority (86%) of subjects were urban dwellers and most (94%) were

TABLE I
Distribution of Subjects in the Study Population

Characteristic	Male	Female	Total
Age (years)			
40-49	345	384	729
50-59	253	295	548
60-69	230	279	509
70-79	143	276	419
Body Mass Index			
<20	24	77	101
20-24.9	294	516	810
25-29.9	483	406	889
30-34.9	135	156	291
35 or more (Mean 39.5; Maximum 62)	35	79	114
Smoking			
Never	238	559	797
Former	465	366	831
Current	268	309	577
Years Daily Cigarette Smoking			
0	320	645	965
>0-19.9 (Mean 11.1)	162	150	312
20-39.9 (Mean 28.9)	355	305	660
40 or more (Mean 47.3)	131	132	263

TABLE II
Results of a Regression Model for Expenditures on Physicians' Services in the Year Prior to the NPHS Interview

Explanatory Factor	Increase in Mean Expenditures Per One Unit Change in Explanatory Factors. Units are \$	95% Confidence Interval
Age (years)	16.8	10.3 - 23.3
Female vs Male	348	127 - 577
Decrease with Age (if Female)	-3.91	-8.17 to + 0.01
BMI	8.9	1.90 - 15.60
Years of Daily Smoking	1.75	0.11 - 3.40

TABLE III
Estimates of Annual Costs of Physicians' Services Attributable to Obesity and Smoking

1) Estimate of Mean Annual Incremental Cost Due to Obesity and Smoking

BMI	Years of Daily Cigarette Smoking			
	0	>0 to 19	20 to 39	40 or More
20-24	\$0	\$18	\$53	\$79
25-29	\$45	\$62	\$97	\$123
30-34	\$89	\$151	\$186	\$212
35+	\$160	\$311	\$346	\$372

2) Estimates of Size of Ontario Population Aged 40 to 79 Years in 1994/95

BMI	Years of Daily Cigarette Smoking				Total
	>0 to 19	20 to 39	40 or More		
20-24	700,000	212,000	392,000	166,000	1,470,000
25-29	740,000	286,000	508,000	145,000	1,679,000
30-34	233,000	70,000	168,000	34,000	505,000
35+	74,000	43,000	66,000	6,900	189,900
Total	1,747,000	611,000	1,134,000	351,900	3,843,900

3) Annual Costs of Physicians' Services Among Ontarians Aged 40 to 79 Attributable to Obesity and Smoking

BMI	Years of Daily Cigarette Smoking				Total
	>0 to 19	20 to 39	40 or More		
20-24	\$0	\$3,710,000	\$20,580,000	\$13,072,500	\$37,362,500
25-29	\$32,930,000	\$17,732,000	\$49,276,000	\$17,871,250	\$117,809,250
30-34	\$20,737,000	\$10,570,000	\$31,248,000	\$7,216,500	\$69,771,500
35+	\$11,854,800	\$13,381,600	\$22,849,200	\$2,569,905	\$50,655,505
Total	\$65,521,800	\$45,393,600	\$123,953,200	\$40,730,155	\$275,598,755

white. Table I shows the numbers of subjects by age, sex, BMI, and smoking habit (missing for 5 subjects). The majority

had smoked at one time but only a minority were smoking at the time of the interview.

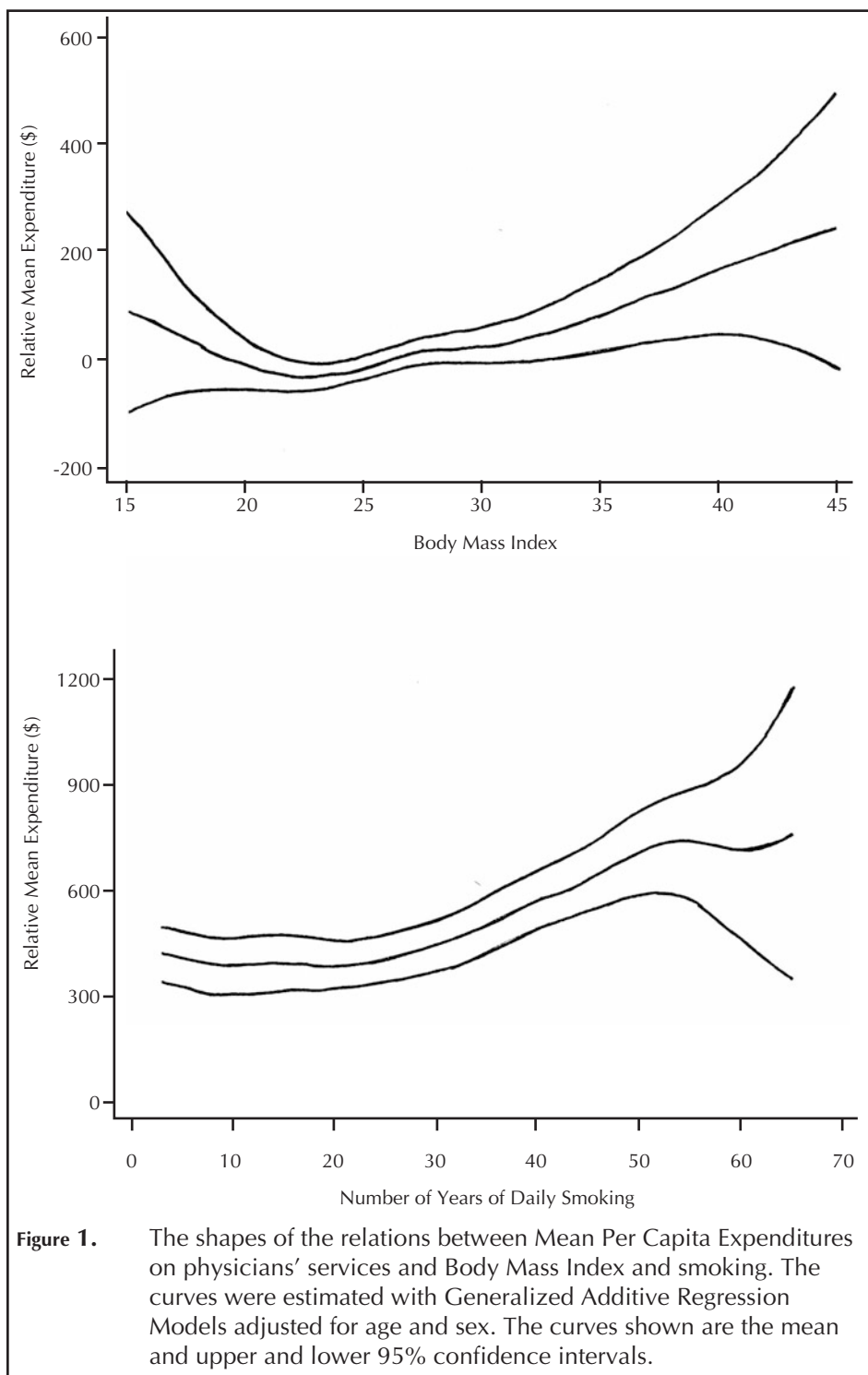


Figure 1. The shapes of the relations between Mean Per Capita Expenditures on physicians' services and Body Mass Index and smoking. The curves were estimated with Generalized Additive Regression Models adjusted for age and sex. The curves shown are the mean and upper and lower 95% confidence intervals.

Shapes of the relations between BMI, smoking and expenditures on physicians' services

The results of generalized additive models exploring the relations between BMI, smoking and expenditures are presented in Figure 1. Estimates of the mean expenditures, and 95% confidence intervals on the

means, are shown. The BMI – expenditure relation was J-shaped, with a minimum mean cost at BMI around 22. The group of subjects with BMI less than 20 includes a mixture of individuals; those who have chosen to maintain a low BMI and those who have low BMI because they are ill. It was not possible to distinguish between

these subjects with the data recorded by the NPHS. Subjects with BMI < 20 were thus excluded from subsequent cost analyses because of difficulties with interpretation. The hypothesis that the relation between mean expenditures and BMI was linear in the range above BMI = 20 was not rejected ($p=0.38$).

The lower portion of Figure 1 shows the relation between years of daily smoking and mean expenditures on physicians' services. "Years of daily smoking" was significantly related to mean expenditures ($p=0.03$). Looking at the graph, one can envision a non-linear threshold-type relationship in which expenditures do not begin to increase unless 20 or more years of smoking have been accumulated. The hypothesis that the relation was linear was not, however, rejected ($p=0.32$) and a linear non-threshold model was adopted for the purposes of analysis.

Regression modelling of the relations between BMI, smoking and expenditures on physicians' services

Survey-weighted linear regression models were used to examine the relations between BMI, years of daily smoking and expenditures on physicians' services. All models included adjustment for age, sex, and income in four categories as derived by Statistics Canada. The income terms were not significant and had only minor effects on the estimates of the coefficients for BMI and smoking. They were thus dropped from the final model. An interaction between age and sex was of borderline statistical significance ($p=0.069$) and was retained. A smoking-BMI interaction term made no significant contribution ($p=0.14$).

The results of the regression model for mean expenditures in relation to age, sex, BMI, and years of daily smoking, for residents of Ontario aged 40 to 79, are presented in Table II. Mean expenditures increased by \$16.80 for every 1-year increase in age. After controlling for BMI and smoking, women had higher average expenditures than men, but the difference diminished with age (\$192 at age 40; \$39 at age 79). Average expenditures were estimated to increase by \$8.90 for every unit of BMI above BMI = 20, and by \$1.75 for every year of daily cigarette smoking.

Taking never smokers with BMI between 20 and 24 as the baseline, the incremental costs attributable to smoking and increased BMI were computed from the regression coefficients and are presented at the top of Table III.

Estimates of annual costs of physicians' services attributable to obesity and smoking

The weighted data from the NPHS survey were used to estimate the numbers of Ontario residents, aged 40 to 79, with various combinations of BMI and years of daily cigarette smoking. These estimates are shown in Table III. Estimates of the annual costs of physicians' services attributable to obesity and smoking were computed by multiplying the mean per capita costs by the population sizes. The results are shown in Table III. The annual cost attributable to smoking among individuals with optimal BMI was estimated to be \$37,000,000. The annual cost attributable to increased BMI among never-smokers was \$65,000,000. Overall, the annual cost of physicians' services attributable both to smoking and increased BMI was \$275,000,000 as measured in 1994 dollars.

DISCUSSION

Forty-five percent of Canadians have a BMI exceeding 25 and are overweight or obese.³ In 1996/97, 29% (6,764,000) of Canadians aged 15 and over smoked.¹⁵ Current smokers in 1996/97 consisted of 25% (5,829,000) who smoked daily and 4% (935,000) who smoked occasionally. Obesity and smoking have effects on an individual's quality of life. There are also increased public costs for medical care, hospitalization, and medications. This is the first Canadian study to use individual level information on personal factors and health services utilization to directly investigate one aspect of these public costs, the cost of physicians' services. It is also the first to examine obesity and smoking together. The regression models were not adjusted for health conditions such as hypertension, diabetes, and chronic obstructive lung dis-

eases which led the subjects to consult with physicians. These conditions are steps on the causal pathway between smoking, obesity and health care costs. Any adjustment would serve to dilute the apparent effects of the underlying causes.¹⁶

A strength of this study is the usage of administrative data on health care utilization. Some 89% of Ontario respondents agreed to the linkage of their health numbers. Because there was no association between agreement and age, sex, or income, bias due to the less than 100% approval rate is unlikely. A weakness of this study is that the physician utilization data were for the one-year interval preceding the health survey. This forces respondents to be a "survivor population"; deaths, and their associated costs, attributable to overweight or smoking in the year prior to the survey would not be captured by the NPHS interview process. This will result in an underestimate of attributable costs in the population.

The average per capita cost of physicians' services in 1994 increased by \$8.90 for every unit increase in BMI beyond the optimal range of 20-25, and by \$1.75 for every year of daily smoking. Graphical analysis suggested the possibility of a threshold in the relation between costs and the number of years of smoking, but the hypothesis of a non-threshold linear relationship was not rejected. It is plausible that short periods of daily smoking will have negligible effect on the use of health services several decades later, and that there is effectively a threshold duration below which health care costs are not affected. The use of a non-threshold model might thus have led to overestimation of the costs attributable to short durations of smoking.

Annual expenditure on physicians' services attributable to overweight and smoking, among Ontario residents 40-79 years of age, was \$275 million dollars in 1994. Total attributable costs will also include the costs of hospitalization, medication and other factors such as loss of productivity. This is a cross-sectional survey and it has not been demonstrated here that reductions in BMI and smoking in the

population will lead to reduced costs, but it is reasonable to assume that they will. The large costs attributable to overweight and smoking are important considerations for the planning and maintenance of public health initiatives to reduce the average BMI and consumption of cigarettes in the community. The cost of these initiatives could be easily recovered if they were successful in making only moderate changes to the levels of smoking and body weight in the population.

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