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ORIGINAL ARTICLE

Disparities in health care utilization by smoking status in Canada

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Abstract
Objectives To examine the association between smoking status and the utilization of health care services in Canada.
Methods The study uses data from the 2007 Canadian Community Health Survey, which contains information on the number of visits to general practitioner (GP), specialists (SP) and the number of nights spent in a hospital. The finite mixture estimation method is used in order to account for heterogeneity among smokers.
Results Multivariate regression results indicate differential effects of smoking on health care utilization for at least two different groups of health care users: low and high users. In particular, we find that among the low-use group, smokers use less GP and SP services than never smokers. However, for the low-use and high-use groups, smokers have more hospitalizations than never smokers. The incidence of hospitalization is higher for the low-use group after controlling for need, socio-demographic characteristics and province fixed effects. Former smokers who recently quit use more health care services.
Conclusions Tobacco consumption elevates the use of health care services, especially among the high-use group.

Keywords Smoking · Health care utilization · Unobserved heterogeneity · Finite mixture model · Canada

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Introduction

It is well established that tobacco use leads to premature death, economic losses to society, and a significant burden on the health care system. Smoking is a major risk factor for many diseases such as heart attacks, strokes, chronic obstructive pulmonary disease and cancer (Centers for Disease Control and Prevention [CDC] 2008). The World Health Organization (WHO) (2011) links 6 million deaths each year to tobacco use and by 2030 tobacco-related deaths are expected to reach 8 million per year. The average life span of a smoker is reduced by 6–10 years (Doll et al. 2004). The cost per pack of cigarettes in terms of a shorter life span is estimated to be about $36 (Gruber and Koszegi 2004). Recently, Viscusi and Hersch (2008) suggest that the mortality costs of smoking could be as high as $222 for men and $94 for women. Viscussi and Herch project the mortality cost of smoking as the expected number of years of life lost due to smoking multiplied by the economic value of these years.

Smoking imposes a substantial burden on society. For example, in developed countries, smoking-attributable health care costs account for up to 15 % of all annual health care costs (World Bank 1999). Tobacco accounts for 42.7 % of the total ($39.8 billion) social cost of substance abuse in Canada (Rehm et al. 2006). The average annual smoking-attributable economic loss to the US economy is estimated to be $193 billion (with $96 billion in health care expenditures and $97 billion of productivity losses) and with an additional $10 billion in second-hand smoke-related healthcare costs (Centers for Disease Control and Prevention [CDC] (2008). Environmental tobacco smoke is estimated to cause about 600,000 deaths annually and represents 10–15 % of the disease burden caused by active smoking (Oberg et al. 2010).

Several studies show that health care utilization and medical expenses of both current smokers and former smokers are higher than those for never smokers (e.g., Kahende et al. 2009; Fishman et al. 2003, 2006; Martinson et al. 2003). The average per capita health care cost attributable to smoking documented in previous Canadian studies is about 80$ (Harrison et al. 2003). Hvidtfeldt et al. (2010), using the Copenhagen City Heart Survey, find that smoking status is strongly associated with an increased risk of hospital admission and duration of hospitalization. Baliunas et al. (2007) find that smoking accounts for about 10.3 % of all acute care hospital days, costing the Canadian taxpayers 2.5 billion dollars, far more than alcohol and illegal drug use consumption combined. Using the 1995 Newfoundland Adult Health Survey, Harrison et al. (2003) estimate that 12.4 % of hospital costs and 7 % of expenses in doctors' visits among the adult population of Newfoundland are due to smoking. Haapanen-Niemi et al. (1999) find that Finish male (female) smokers have 70 % (49 %) more hospital days than never smokers.

Although a sizeable number of studies have examined the effect of smoking on health care utilization, there is limited evidence at the individual level in Canada. Most previous studies have used aggregate data, such as smoking prevalence rates and epidemiological data on tobacco-related diseases, to extract smoking-attributable health care cost (e.g., Baliunas et al. 2007; Single et al. 1996; Collishaw and Myers 1984; Kaiserman 1997). In these studies, "the comparability of expenditure across smoking categories for condition-specific mortality or utilization" is assumed (Miller et al. 1999). Nonetheless, tobacco use may exacerbate some health conditions depending on individual-specific frailty, and consequently cause more health care use. While individual level evidence exists for other countries (mainly for US), the smoking population is likely to be heterogeneous across countries in addition to different health care systems, thus examining the relationship between smoking status and health care utilization can yield better information about intervention measures in Canada.

Standard count models of health care utilization restrict the effect of covariates (smoking status in our case) to be equal for all individuals. This may be less informative because commonly used measures of smoking status contained in health surveys (especially in cross-sectional data) mask considerable variability in smoker types. Therefore, heterogeneity may exist due to limited information on individual health status. For example, the use of self-rated health may not fully capture differences in individual health. The finite mixture model (FMM) has been shown to be more flexible in this respect (Gerdtham and Trivedi 2001; Deb and Trivedi 2002). Compared to one population estimate of health care utilization, FMM is able to account for unobserved heterogeneity that clusters around a finite set of subpopulations. Using individual level data from the Canadian Community Health Survey (CCHS) and a finite mixture estimation framework, this study examines the disparity in health care utilization by smoking status.

Methods

Data and variables

The data for this study come from the Statistics Canada 2007 CCHS cycle 4.1. CCHS is a nationally representative cross-sectional survey of the Canadian population aged 12 years and older. It collects vital information on health-related behavior, as well as corresponding economic and social-demographic variables. The survey excludes those living on Indian Reserves and Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions. CCHS is a large survey with 131,061 observations. We restrict the sample to those aged 18–74 years due to a potential contamination of the analysis. Frailty of health for those aged 75 years and above and other individual-unobserved health issues may further complicate our results.

The dependent variables of interest are: (1) The number of consultations to a family doctor or general practitioner (GP) during the year preceding the survey interview; (2) the number of consultations to a specialist (SP) excluding eye specialists during the year preceding the survey interview; and (3) the number of nights (Hospitalization) spent in a hospital as a patient 12 months prior the survey. Based on individual responses from multiple questions, smoking behavior is grouped into never smoker (reference category), current smoker, and former smoker. For further analysis, we categorize former smokers into three groups based on the number of years since they completely quit smoking: less than or equal to 2, 3–5, and 6 years or more.

A number of economic and socio-demographic factors are also included in the analysis. Gender is captured by a dummy variable (male = 1, female = 0). Age has four categories: 18–29, 30–44, 45–59, and 60–74 (reference category). Marital status is represented by three indicator variables: married, separated, and single (reference category). The presence of a regular family doctor is captured by a dummy variable (reg_doc = 1, no reg_doc = 0). Self-reported functional health status is represented by four categories: fair_poor (reference category), good, very good and excellent. The number of chronic diseases for each individual is included. An individual's physical activity level is represented by three categories: inactive (reference category), moderate and active. The last 12 months drinking status is captured by three categories: regular

drinker, occasional drinker with no drinking as the reference category. Four indicator variables represent individual educational status: less than secondary (reference category), secondary, some post-secondary, and post-secondary. Household income is represented by three dummy variables: low income (reference category), if household income is less than $40,000; middle income, from $40,000 to $80,000 and high income, more than $80,000. Employment status is captured by a dummy variable (employed = 1, unemployed = 0). Immigration status is captured in three categories: imm1, if years since immigration to Canada are 0–9 years; imm2 is 10 or more years since immigration with Canadian born as the reference category. To account for differences in health care utilization that may be due to cultural and regional factors, provincial fixed effects are included, with British Columbia as the reference category. Table 1 presents detailed variable descriptions and summary statistics.

Statistical analysis

The outcome measures (GP, SP and Hospitalization) are non-negative integer variables, therefore, count data models are more suitable (Winkelmann 2008; Cameron and Trivedi 1998; Jones 2000). The benchmark for count data models is a Poisson regression model, which has some restrictive assumptions which are often not satisfied in applied work. For example, a Poisson regression assumes equidispersion (mean is equal to the variance) and the outcome pairs are independent. A negative binomial is commonly used to correct for overdispersion. While the two-part model (also known as a hurdle model in the health literature) has been used extensively in health care utilization studies, recent studies show that the FMM has a more flexible form (e.g., Gerdtham and Trivedi 2001; Deb and Trivedi 1997, 2002). In the two-part estimation, the first part is binary information (visit vs. no visit) while in the second part, individuals are observed with positive counts conditional on making the first visit ("crossing the hurdle").

The FMM splits the population into subpopulations of different types—in this case, low or high users—rather than grouping individuals into users versus non-users. The FMM classification is even more justified in a cross-sectional model, where individuals are only observed for a short period of time and 'not over an episode of illness' (Deb and Trivedi 2002). The finite mixture framework is also appropriate for truncated/censored samples due to the unobservability of complete illness spells (Lourenço and Ferreira 2005). In health-related outcomes, the use of a finite mixture framework is even more appealing given that individuals self-rated health and other observed covariates may not fully reflect their health status (Deb and Trivedi

Table 1 Variable description and summary statistics: results from the Canadian community health survey, 2007

Variable	Variable description	Mean	S.D.
General practitioner	Annual number of consultations to family doctor/general practitioner	2.756	3.817
Specialist	Annual number of consultations to specialists	0.856	2.052
Hospitalization	Annual number of nights spent in a hospital as a patient	0.764	3.306
Current smoker	1 If currently a daily or occasional smoker, 0 otherwise	0.242	0.428
Former smoker	1 If previously a daily or occasional smoker, 0 otherwise	0.390	0.488
Quit ≤ 2 years	1 If former smoker post-quit years: ≤2 years	0.051	0.219
Quit 3–5 years	1 If former smoker post-quit years: 3–5 years	0.028	0.166
Quit ≥ 6 years	1 If former smoker post-quit years: 6 and more years	0.187	0.390
Never smoker	1 If never smoked, 0 otherwise	0.364	0.481
Male	1 If gender is male, 0 otherwise	0.497	0.500
Female	1 If gender is female, 0 otherwise	0.503	0.500
Age 18–29	1 If aged 18–29 years, 0 otherwise	0.223	0.416
Age 30–44	1 If aged 30–44 years, 0 otherwise	0.298	0.457
Age 45–59	1 If aged 45–59 years, 0 otherwise	0.306	0.461
Age 60–74	1 If aged 60–74 years, 0 otherwise	0.173	0.378
Married	1 If married/common-law, 0 otherwise	0.646	0.478
Separated	1 If divorced/widowed/separated, 0 otherwise	0.107	0.310
Single	1 If never married, 0 otherwise	0.245	0.430
Reg_doctor	1 If respondent has a regular doctor, 0 otherwise	0.836	0.370
Health_fair_poor	1 If self-perceived health is fair/poor, 0 otherwise	0.107	0.310
Health_good	1 If self-perceived health is good, 0 otherwise	0.291	0.454
Health_very good	1 If self-perceived health is very good, 0 otherwise	0.378	0.485
Health_excellent	1 If self-perceived health is excellent, 0 otherwise	0.222	0.416
Chronic	Number of chronic conditions	1.022	1.324
Inactive	1 If physical activity index is inactive, 0 otherwise	0.497	0.500
Moderate	1 If physical activity index is moderate, 0 otherwise	0.238	0.430
Active	1 If physical activity index is active, 0 otherwise	0.245	0.426
Regular drinker	1 If regular drinker, 0 otherwise	0.654	0.476
Occasional drinker	1 If occasional drinker, 0 otherwise	0.154	0.361
No drinking	1 If no drink in the past 12 months, 0 otherwise	0.178	0.382
Less secondary	1 If education is less than secondary, 0 otherwise	0.133	0.340

Table 1 continued

Variable	Variable description	Mean	S.D.
Secondary	1 If education is secondary, 0 otherwise	0.166	0.372
Some post-secondary	1 If education is some post-secondary, 0 otherwise	0.088	0.283
Post-secondary	1 If education is post-secondary, 0 otherwise	0.586	0.493
Low income	1 If household income (<$40,000)	0.214	0.410
Medium income	1 If household income ($40,000 to $80,000)	0.297	0.457
High income	1 If household income (>$80,000)	0.342	0.474
Employed	1 If worked in the past 12 months, 0 otherwise	0.776	0.417
Unemployed	1 If no work in the past 12 months, 0 otherwise	0.206	0.404
Canadian_born	1 If country of birth is Canada, 0 otherwise	0.747	0.435
Imm1	1 If years of immigration: 0–9 years, 0 otherwise	0.064	0.246
Imm2	1 If years of immigration: 10 or more years, 0 otherwise	0.162	0.368
Newfoundland	1 If province of residence is Newfoundland, 0 otherwise	0.016	0.125
Prince Edward	1 If province of residence is Prince Edward, 0 otherwise	0.004	0.064
Nova Scotia	1 If province of residence is Nova Scotia, 0 otherwise	0.028	0.166
New Brunswick	1 If province of residence is New Brunswick, 0 otherwise	0.023	0.149
Quebec	1 If province of residence is Quebec, 0 otherwise	0.236	0.425
Ontario	1 If province of residence is Ontario, 0 otherwise	0.390	0.488
Manitoba	1 If province of residence is Manitoba, 0 otherwise	0.003	0.179
Saskatchewan	1 If province of residence is Saskatchewan, 0 otherwise	0.027	0.163
Alberta	1 If province of residence is Alberta, 0 otherwise	0.105	0.306
British Columbia	1 If province of residence is BC, 0 otherwise	0.134	0.341

2002; Gupta and Greve 2011). Following previous studies, we hypothesize that an individual's unobserved health status is captured by a finite mixture which splits the population into different subpopulations of health care users.

The FMM assumes the dependent variable, y comes from a population that comprises C distinct sub-populations, with unknown mixing weights $\pi_1, \ldots, \pi_C$ where $0 \leq \pi_j \leq 1$ and $\sum_{j=1}^{C} \pi_j = 1$. The finite mixture density of y with ss-support points is given by

$$f(y_i|\Theta) = \sum_{j=1}^{C-1} \pi_j f_i(y_i|\theta_j) + \pi_C f_C(y_C|\theta_C) \quad (1)$$

where the mixing weights (probabilities) π_j are estimated along with the other parameters, denoted by Θ. The C-point finite mixture negative binomial distributions are specified as

$$f_i(y_i) = \frac{\Gamma(y_i + \psi_{j,i})}{\Gamma(\psi_{j,i})\Gamma(y_i + 1)} \left(\frac{\psi_{j,i}}{\lambda_{j,i} + \psi_{j,i}}\right)^{\psi_{j,i}} \left(\frac{\lambda_{j,i}}{\lambda_{j,i} + \psi_{j,i}}\right)^{y_i} \quad (2)$$

where $\lambda_{j,i} = \exp(\chi_i'\beta_j)$, $\Gamma(\cdot)$ is the gamma function and $\psi_{j,i} = (1/\alpha_j)\lambda_{j,i}^K$. In this study, we use the NB2 (i.e. $k = 2$) variant for the mixture component densities since NB2 has some advantages over NB1 (Winkelmann 2008). Deb and Trivedi (1997, 2002) list a number of advantages of using FMM over a continuous mixing distribution: (1) It enables unobserved heterogeneity to be captured in a simple and intuitive way; (2) It is semi-parametric since the mixing variable is not distribution specific; (3) It is valid even if the underlying mixing distribution is continuous (Heckman and Singer 1984); and (4) some continuous mixing models may not have a closed-form solution.

We estimate a two-component finite mixture negative binomial model for all measures of health care utilization (GP, SP and Hospitalization). We classify the two components into low-use group, on the basis of a low predicted mean, and high-use group, with high predicted mean. In addition to FMM estimation, a baseline specification, negative binomial regression is also estimated. The performance of both models is assessed using the Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC), where smaller values are preferred (Cameron and Trivedi 1998). The analysis is using Stata 11.2.

Results

The unconditional mean of health care utilization by smoking status is presented in Tables 2, 3. The results indicate that current and former smokers use more health care services than never smokers. Among former smokers, recent quitters (quit 2 years or below) use more health care than smokers with a longer time since quitting.

The model selection criteria between standard count model (negative binomial) and FMM are reported in Table 4. These results indicate that the FMM outperforms the negative binomial in all specifications. Nonetheless, the results from negative binomial regressions are shown in the appendix (Tables 8, 9, 10). Results from the finite mixture regression, reported in Tables 5, 6, 7, show substantial differences across the groups of low and high users. We

Table 2 Dependent variables by smoking status: results from the Canadian community health survey, 2007

	Never smokers		Current smokers		Former smokers	
	Mean	SD	Mean	SD	Mean	SD
General practitioner	2.698	3.689	2.798	3.640	2.782	4.250
Specialist	0.791	1.977	0.857	2.048	0.915	2.154
Hospitalization	0.565	2.654	0.886	3.604	0.869	3.620

Table 3 Dependent variables by former smokers (years since quitting): results from the Canadian community health survey, 2007

	Quit $\leq$ 2 years		Quit 3–5 years		Quit $\geq$ 6 years	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
General practitioner	3.096	4.161	2.911	3.905	2.905	3.644
Specialist	1.067	2.345	0.956	2.168	0.927	1.974
Hospitalization	1.440	4.787	1.104	4.200	0.873	3.658

Table 4 Model selection criteria between negative binomial and finite mixture specifications: results from the Canadian community health survey, 2007

Dependent variable	Estimation	AIC	BIC
Model 1			
General practitioner	Negative binomial	440926.4	441270.7
	Finite mixture	432054.3[a]	432752.5[b]
Specialist	Negative binomial	237960.9	238305.2
	Finite mixture	235099.3[a]	235797.6[b]
Hospitalization	Negative binomial	97038.9	97361.3
	Finite mixture	95629.7[a]	96283.3[b]
Model 2			
General practitioner	Negative binomial	440829.1	441192.5
	Finite mixture	431989.5[a]	432726.0[b]
Specialist	Negative binomial	237939.3	238302.8
	Finite mixture	235050.6[a]	235787.1[b]
Hospitalization	Negative binomial	96969.3	97309.5
	Finite mixture	95554.1[a]	96243.6[b]

[a] Preferred model based on Aikake information criteria (AIC); AIC $= -2\ln L + 2K$, where K = number of parameters

[b] Preferred model based on Bayesian information criteria (BIC); AIC $= -2\ln L + 2K \ln N$, where N = number of observations

find that being a current smoker is not associated with higher utilization of GP and specialist services for the low-use group. Current smokers have fewer GP and SP visits compared to never smokers; this is not surprising given that the low-use group has higher latent health. For this group, functional health and other socio-demographic factors may exert more influence on the consultations of GP and SP. For the high-use group, the coefficient for current smokers is significant and positive for GP and SP for both model 1 and 2. In particular, being a current smoker relative to a never smoker increases GP and SP visits by about 7 and 14 %, respectively. Former smokers have more GP (SP) visits by about 3 % (21 %) for the low-use group, 8 % (13 %) for the high-use group. These results are reasonable since the diseases associated with smoking may require more specialized care than visits to a general family doctor. Among former smokers in model 2, across all the dependent variables (GP, SP and Hospitalization), we find that recent quitters (quit for 2 years or less) are more likely to use more health care than never smokers. This association tends to decrease with the number of years since quitting smoking. For example, for the high-use group, recent quitters use more GP by about 21 and 5 % for former smokers with 6 or more years since quitting. Our results are somewhat consistent with recent studies (Kahende et al. 2009; Baumeister et al. 2007; Fishman et al. 2003, 2006).

We find that being a current or former smoker is associated with higher hospitalization for both the low-use and high-use groups. These results are reported in Table 7. Among the low-use group, hospitalization increases by a factor of 1.48 (1.79) for current (former) smokers compared with never smokers and by about 1.20 (1.24) for the high-use group. This result is different from Kahende et al.

Table 5 General practitioner visits: regression results from the Canadian community health survey, 2007

	Model 1		Model 2	
	Low-use group	High-use group	Low-use group	High-use group
Current smoker	−0.108***	0.067***	-0.109***	0.063***
	(0.015)	(0.017)	(0.014)	(0.016)
Former smoker	0.030***	0.075***	–	–
	(0.011)	(0.015)		
Quit ≤ 2 years	–	–	0.089***	0.191***
			(0.023)	(0.025)
Quit 3–5 years	–	–	0.026	0.144***
			(0.027)	(0.034)
Quit ≥ 6 years	–	–	0.035***	0.052***
			(0.012)	(0.017)
Male	−0.201***	−0.230***	−0.202***	−0.231***
	(0.012)	(0.013)	(0.012)	(0.013)
Age 18–29	−0.195***	0.551***	−0.198***	0.536***
	(0.030)	(0.024)	(0.031)	(0.024)
Age 30–44	−0.182***	0.323***	−0.183***	0.313***
	(0.019)	(0.021)	(0.020)	(0.021)
Age 45–59	−0.068***	0.090***	−0.070***	0.086***
	(0.014)	(0.018)	(0.014)	(0.018)
Married	0.002	0.066***	0.002	0.066***
	(0.016)	(0.017)	(0.016)	(0.017)
Separated	0.037**	0.097***	0.036**	0.094***
	(0.019)	(0.021)	(0.019)	(0.021)
Reg_ doctor	1.615***	0.489***	1.617***	0.491***
	(0.090)	(0.018)	(0.092)	(0.018)
Health_good	−0.206***	−0.383***	−0.205***	−0.380***
	(0.022)	(0.018)	(0.022)	(0.018)
Health_very good	−0.342***	−0.621***	−0.340***	−0.615***
	(0.023)	(0.019)	(0.023)	(0.019)
Health_excellent	−0.555***	−0.755***	−0.553***	−0.749***
	(0.024)	(0.024)	(0.024)	(0.024)
Chronic	0.186***	0.178***	0.185***	0.178***
	(0.006)	(0.006)	(0.006)	(0.006)
Active	−0.038***	−0.024	−0.039***	−0.023
	(0.012)	(0.016)	(0.012)	(0.016)
Moderate	0.005	0.005	0.005	0.005
	(0.011)	(0.015)	(0.011)	(0.015)
Regular drinker	0.037**	−0.230***	0.036**	−0.226***
	(0.015)	(0.016)	(0.015)	(0.016)
Occasional drinker	0.035**	−0.054***	0.035**	−0.053***
	(0.017)	(0.018)	(0.017)	(0.018)
Secondary	0.018	−0.025	0.018	−0.027
	(0.018)	(0.021)	(0.018)	(0.021)
Some post-secondary	0.107***	0.015	0.107***	0.016
	(0.023)	(0.025)	(0.023)	(0.025)
Post-secondary	0.107***	0.042**	0.108***	0.045**
	(0.016)	(0.018)	(0.016)	(0.018)
Medium income	0.068***	0.027*	0.067***	0.026*
	(0.012)	(0.015)	(0.012)	(0.015)
High income	0.079***	-0.006	0.080***	−0.005
	(0.014)	(0.018)	(0.014)	(0.018)
Employed	−0.013	−0.100***	−0.011	−0.101***
	(0.013)	(0.016)	(0.013)	(0.016)
Imm1	0.094**	0.031	0.093**	0.029
	(0.037)	(0.035)	(0.037)	(0.034)
Imm2	0.052***	0.043**	0.053***	0.044**
	(0.015)	(0.020)	(0.015)	(0.020)
Newfoundland	0.056**	−0.055	0.057**	−0.055
	(0.028)	(0.034)	(0.028)	(0.034)
Prince Edward	−0.071**	−0.291***	−0.070**	−0.290***
	(0.033)	(0.045)	(0.033)	(0.045)
Nova Scotia	0.001	−0.115***	0.002	−0.116***
	(0.027)	(0.031)	(0.027)	(0.031)
New Brunswick	−0.177***	−0.275***	−0.178***	−0.274***
	(0.026)	(0.032)	(0.026)	(0.032)
Quebec	−0.394***	−0.449***	−0.395***	−0.446***
	(0.017)	(0.022)	(0.017)	(0.022)
Ontario	−0.155***	−0.196***	−0.155***	−0.194***
	(0.015)	(0.018)	(0.015)	(0.018)
Manitoba	−0.066***	−0.169***	−0.065***	−0.166***
	(0.025)	(0.029)	(0.025)	(0.029)
Saskatchewan	−0.038	−0.068**	−0.036	−0.069**
	(0.024)	(0.027)	(0.024)	(0.027)
Alberta	−0.079***	−0.126***	−0.078***	−0.127***
	(0.020)	(0.024)	(0.020)	(0.024)
π_1	0.559	0.441	0.558	0.442
	(0.020)		(0.020)	
Observations	105.232			

Robust standard errors in parentheses; π_1 stands for the probability that an observation is in low-use group

* Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

(2009), in which no effect of smoking status on hospitalization intensity (number of nights) is found. Our results suggest that the relative association between smoking status and hospitalization is stronger for the low-use group than the high-use class. Being a recent quitter increases hospitalization by a factor of 3.81 for the low-use group and the high-use group by 1.47. Hospitalization increases for former smokers who quit 3–5 years ago (6 or more years) by a factor of 2.18 (1.35) for the low-use group and by a factor of 1.26 (1.16) for the high-use group. One explanation for the difference in the relative association

Table 6 Specialist visits: Regression results from the Canadian Community Health Survey, 2007

	Model 1		Model 2	
	Low-use group	High-use group	Low-use group	High-use group
Current smoker	−0.098***	0.131***	−0.105***	0.097***
	(0.029)	(0.027)	(0.027)	(0.025)
Former smoker	0.191***	0.120***	–	–
	(0.024)	(0.024)		
Quit ≤ 2 years	–	–	0.330***	0.201***
			(0.043)	(0.042)
Quit 3–5 years	–	–	0.220***	0.184***
			(0.055)	(0.057)
Quit ≥ 6 years	–	–	0.232***	0.015
			(0.026)	(0.030)
Male	−0.482***	−0.181***	−0.487***	−0.178***
	(0.022)	(0.022)	(0.022)	(0.022)
Age 18–29	0.070	0.653***	0.078*	0.625***
	(0.045)	(0.039)	(0.045)	(0.040)
Age 30–44	0.025	0.620***	0.033	0.598***
	(0.036)	(0.034)	(0.036)	(0.034)
Age 45–59	−0.016	0.293***	−0.015	0.279***
	(0.029)	(0.034)	(0.029)	(0.034)
Married	0.075**	0.001	0.069**	0.011
	(0.030)	(0.027)	(0.030)	(0.027)
Separated	0.005	0.049	−0.004	0.053
	(0.037)	(0.035)	(0.037)	(0.035)
Reg_ doctor	0.784***	0.176***	0.781***	0.175***
	(0.039)	(0.034)	(0.039)	(0.034)
Health_good	−0.650***	−0.264***	−0.644***	−0.261***
	(0.031)	(0.030)	(0.031)	(0.030)
Health_very good	−1.021***	−0.435***	−1.013***	−0.425***
	(0.036)	(0.033)	(0.036)	(0.033)
Health_excellent	−1.348***	−0.444***	−1.337***	−0.436***
	(0.044)	(0.041)	(0.043)	(0.040)
Chronic	0.287***	0.066***	0.285***	0.068***
	(0.007)	(0.009)	(0.007)	(0.009)
Active	−0.007	−0.050*	−0.010	−0.051**
	(0.025)	(0.025)	(0.025)	(0.025)
Moderate	0.016	−0.033	0.015	−0.032
	(0.024)	(0.024)	(0.024)	(0.024)
Regular drinker	−0.006	−0.223***	−0.005	−0.213***
	(0.027)	(0.025)	(0.027)	(0.025)
Occasional drinker	0.003	−0.024	0.005	−0.022
	(0.032)	(0.028)	(0.032)	(0.028)
Secondary	0.306***	−0.001	0.306***	−0.001
	(0.037)	(0.035)	(0.037)	(0.035)
Some post-secondary	0.560***	0.106**	0.561***	0.112***
	(0.045)	(0.043)	(0.045)	(0.043)
Post-secondary	0.666***	0.113***	0.672***	0.115***
	(0.032)	(0.029)	(0.032)	(0.029)
Medium income	0.164***	0.008	0.163***	0.005
	(0.025)	(0.025)	(0.025)	(0.025)
High income	0.246***	0.092***	0.248***	0.088***
	(0.029)	(0.028)	(0.029)	(0.028)
Employed	−0.159***	−0.172***	−0.159***	−0.170***
	(0.027)	(0.025)	(0.027)	(0.025)
Imm1	−0.236***	−0.093*	−0.238***	−0.100*
	(0.071)	(0.053)	(0.071)	(0.053)
Imm2	−0.020	−0.005	−0.019	−0.009
	(0.031)	(0.036)	(0.031)	(0.036)
Newfoundland	0.107*	−0.190***	0.106*	−0.191***
	(0.063)	(0.070)	(0.063)	(0.071)
Prince Edward	0.284***	0.051	0.287***	0.049
	(0.073)	(0.069)	(0.073)	(0.069)
Nova Scotia	0.247***	−0.003	0.253***	−0.004
	(0.054)	(0.056)	(0.054)	(0.056)
New Brunswick	0.090	−0.084	0.088	−0.090
	(0.056)	(0.056)	(0.056)	(0.055)
Quebec	0.497***	−0.052	0.496***	−0.053
	(0.037)	(0.038)	(0.037)	(0.038)
Ontario	0.363***	0.113***	0.367***	0.105***
	(0.033)	(0.030)	(0.033)	(0.030)
Manitoba	0.077	−0.058	0.082	−0.060
	(0.052)	(0.051)	(0.052)	(0.051)
Saskatchewan	−0.093*	−0.136***	−0.088*	−0.143***
	(0.053)	(0.050)	(0.053)	(0.050)
Alberta	−0.101**	0.003	−0.102**	0.000
	(0.047)	(0.040)	(0.047)	(0.040)
π_1	0.896	0.104	0.897	0.103
	(0.007)		(0.006)	
Observations	105.434			

Robust standard errors in parentheses; π_1 stands for the probability that an observation is in low-use group

* Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

between smoking status and hospitalization among low and high users could be health status disparity relative to never smokers within each sub group. For example, there may be a greater difference between current/former smokers with never smokers in the low-use than in the high-use category.

The parameter estimates of other control variables in Tables 5, 6, 7 are generally consistent with previous health care utilization studies. For example, having a regular family doctor is associated with higher health care utilization while additional chronic disease increases GP, SP and hospitalization, respectively, by a factor of 1.20, 1.33,

Table 7 Hospitalization: Regression results from the Canadian community health survey, 2007

	Model 1		Model 2	
	Low-use group	High-use group	Low-use group	High-use group
Current smoker	0.394***	0.180***	0.339***	0.162***
	(0.098)	(0.055)	(0.086)	(0.052)
Former smoker	0.582***	0.216***	–	–
	(0.087)	(0.047)		
Quit ≤ 2 years	–	–	1.337***	0.382***
			(0.120)	(0.074)
Quit 3–5 years	–	–	0.780***	0.228**
			(0.179)	(0.109)
Quit ≥ 6 years	–	–	0.300***	0.151***
			(0.099)	(0.051)
Male	−0.754***	0.095**	−0.711***	0.103**
	(0.091)	(0.044)	(0.086)	(0.045)
Age 18–29	2.567***	−0.178*	2.322***	−0.224***
	(0.198)	(0.102)	(0.182)	(0.083)
Age 30–44	1.366***	0.004	1.169***	−0.006
	(0.152)	(0.065)	(0.136)	(0.065)
Age 45–59	−0.135	−0.010**	−0.224*	−0.107**
	(0.125)	(0.049)	(0.116)	(0.050)
Married	1.152***	−0.159***	1.134***	−0.172***
	(0.118)	(0.061)	(0.116)	(0.058)
Separated	0.853***	0.036	0.822***	0.029
	(0.144)	(0.065)	(0.138)	(0.062)
Reg_ doctor	1.045***	0.252***	1.035***	0.246***
	(0.121)	(0.068)	(0.117)	(0.067)
Health_good	−1.866***	−0.383***	−1.752***	−0.360***
	(0.139)	(0.050)	(0.133)	(0.050)
Health_very good	−2.386***	−0.746***	−2.297***	−0.710***
	(0.136)	(0.063)	(0.125)	(0.061)
Health_excellent	−2.350***	−0.993***	−2.277***	−0.959***
	(0.153)	(0.080)	(0.134)	(0.078)
Chronic	0.375***	0.094***	0.367***	0.092***
	(0.026)	(0.014)	(0.023)	(0.014)
Active	−0.329***	−0.183***	−0.337***	−0.177***
	(0.102)	(0.053)	(0.092)	(0.052)
Moderate	−0.209**	−0.137***	−0.176**	−0.134***
	(0.091)	(0.049)	(0.085)	(0.048)
Regular drinker	−1.232***	−0.169***	−1.173***	−0.162***
	(0.103)	(0.047)	(0.100)	(0.047)
Occasional drinker	−0.231**	0.033	−0.200**	0.016
	(0.097)	(0.057)	(0.089)	(0.056)
Secondary	−0.079	0.007	−0.070	0.005
	(0.116)	(0.061)	(0.111)	(0.060)
Some post-secondary	−0.154	0.092	−0.141	0.097
	(0.146)	(0.086)	(0.141)	(0.084)
Post-secondary	0.247**	0.036	0.288***	0.042
	(0.102)	(0.048)	(0.097)	(0.049)
Medium income	−0.094	−0.169***	−0.092	−0.170***
	(0.087)	(0.047)	(0.083)	(0.047)
High income	−0.077	−0.094	0.002	−0.097*
	(0.113)	(0.058)	(0.102)	(0.058)
Employed	−0.755***	−0.396***	−0.764***	−0.393***
	(0.084)	(0.043)	(0.080)	(0.044)
Imm1	−0.296*	−0.417***	−0.320**	−0.399***
	(0.161)	(0.137)	(0.155)	(0.134)
Imm2	−0.406***	−0.185***	−0.396***	−0.161**
	(0.128)	(0.066)	(0.118)	(0.067)
Newfoundland	−0.272	0.275***	−0.259	0.281***
	(0.219)	(0.107)	(0.209)	(0.105)
Prince Edward	0.802***	0.173	0.774***	0.152
	(0.227)	(0.159)	(0.232)	(0.150)
Nova Scotia	−0.437**	−0.135	−0.427**	−0.120
	(0.192)	(0.109)	(0.177)	(0.109)
New Brunswick	−0.196	0.005	−0.156	0.024
	(0.194)	(0.093)	(0.188)	(0.096)
Quebec	0.103	0.018	0.096	0.027
	(0.119)	(0.065)	(0.114)	(0.065)
Ontario	−0.497***	−0.104*	−0.470***	−0.106*
	(0.114)	(0.057)	(0.107)	(0.057)
Manitoba	−0.124	0.055	−0.097	0.060
	(0.166)	(0.098)	(0.156)	(0.098)
Saskatchewan	0.125	−0.061	0.062	−0.047
	(0.144)	(0.094)	(0.140)	(0.094)
Alberta	−0.067	0.003	−0.075	−0.008
	(0.180)	(0.083)	(0.142)	(0.078)
π_1	0.877	0.123	0.883	0.117
	(0.009)		(0.009)	
Observations	57.178			

Robust standard errors in parentheses; π_1 stands for the probability that an observation is in low-use group

* Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

and 1.45 for low users and by 1.19, 1.07, and 1.10 for high users. Studies show that self-reported health status (SAH) is a vital determinant of health care utilization (e.g. Chern et al. 2002; Al-Windi et al. 2002). Our results are consistent with the literature that there exists a SAH gradient in health care utilization. Generally the education variables in our model are positive and significant for GP and SP visits. The empirical evidence about the influence of education on health care utilization is mixed and may depend on the choice of dependent variable. For example, Kahende et al. (2009) find the effect of education to be positive and

significant only for those with less than high school in both the contact and intensity of outpatient visits. They also find similar impact on the probability of being hospitalized for high school diploma and less than high school categories. Deb and Trivedi (2002) as well as Bago d'Uva (2006) find that education increases outpatient visits; Sari (2009) finds decreases in family doctor visits with higher education; and Gerdtham and Trivedi (2001) find the relationship between the intensity of physician visits and education to be insignificant and negative for frequent users and positive for infrequent users. Generally, we find positive and significant relationship between income and GP and SP visits. As expected, the income variables are in general negative for inpatient visits (hospitalization).

Discussion

Though there has been a decrease in smoking prevalence in Canada, about 17 % of the population aged 15 years and older currently smoke (Health Canada 2011). The negative health effects of smoking have been documented in countless situations (Centers for Disease Control and Prevention 2008; World Health Organization 2011).In this paper, we examine the association between smoking status and the demand for physician services (GP and SP visits) in Canada using individual level data from CCHS. Also, we assess if smoking status is associated with frequent hospitalization. The finite mixture estimation method is used since measures of smoking status contained in health surveys mask considerable variability in smoker types. In addition, observed covariates especially in cross-sectional data may not fully capture individual health status. The FMM has been shown to be appropriate in approximating population heterogeneity in a finite number of latent classes, whereby each of the classes can be interpreted as a group (Deb and Trivedi 1997).

Results from FMM indicate differential effects of smoking on health care utilization for at least two different groups of health care users: low and high users. We find that among the high-use group, smokers use more GP and SP services than never smokers while smokers have less GP and SP visits compared to never smokers for the low-use group. One possible explanation is that the health damage resulting from smoking may not have been revealed or diagnosed yet for the low-use group of smokers. For both the low-use and high-use groups, smokers have more hospitalizations than never smokers. This result is not surprising given that some of the negative health effects associated with tobacco use may require more hospitalizations in a hospital. Former smokers who recently quit use more health care services (GP, SP and Hospitalizations) than never smokers for both the low-use and high-use groups. This result is consistent with US studies, which find that recent quitters tend to have more health care costs (Fishman et al. 2003; Kahende et al. 2009).

Based on empirical evidence that smokers generally have higher healthcare costs, nonsmokers may subsidize the health care costs of smokers if the sources of financing the health care system are not differentially higher for smokers (World Bank 1999). However, assessing the relative healthcare costs of smokers and non-smokers is a complex exercise. The issue of pensions and the fact that smokers are more likely to die earlier than non-smokers along with other factors complicate this assessment. This paper does not attempt to estimate these costs; it is beyond the scope of this study.

The current study has some limitations. The cross-sectional nature of the CCHS does not enable us to infer a causal relationship between smoking status and health care utilization. The variables in CCHS are self-reported, which may be subject to recall bias. The frequency of health care use may be due to preventive purpose, however we cannot infer this due to the cross-sectional nature of the CCHS. In this regard, a prospective cohort design would be required.

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Appendix A: Negative binomial results

See Tables 8, 9, 10.

Table 8 General practitioner visits: regression results from the Canadian community health survey, 2007

	Model 1	Model 2
Current smoker	0.016	0.014
	(0.011)	(0.010)
Former smoker	0.068***	–
	(0.009)	
Quit $\leq$ 2 years	–	0.175***
		(0.017)
Quit 3–5 years	–	0.105***
		(0.022)
Quit $\geq$ 6 years	–	0.058***
		(0.010)
Male	−0.244***	–0.245***
	(0.008)	(0.008)
Age 18–29	0.323***	0.314***
	(0.0156	(0.016)

Table 8 continued

	Model 1	Model 2
Age 30–44	0.146***	0.141***
	(0.012)	(0.012)
Age 45–59	0.032***	0.029***
	(0.010)	(0.011)
Married	0.057***	0.056***
	(0.011)	(0.011)
Separated	0.082***	0.079***
	(0.014)	(0.014)
Reg_doctor	0.742***	0.743***
	(0.015)	(0.015)
Health_good	−0.352***	−0.349***
	(0.0123)	(0.012)
Health_very_good	−0.547***	−0.543***
	(0.013)	(0.013)
Health_excellent	−0.709***	−0.704***
	(0.016)	(0.016)
Chronic	0.192***	0.192***
	(0.003)	(0.003)
Active	−0.030***	−0.030***
	(0.010)	(0.010)
Moderate	0.005	0.005
	(0.009)	(0.009)
Regular drinker	−0.143***	−0.141***
	(0.010)	(0.010)
Occasional drinker	−0.030**	−0.029**
	(0.012)	(0.012)
Secondary	−0.005	−0.005
	(0.013)	(0.013)
Some post-secondary	0.060***	0.061***
	(0.016)	(0.016)
Post-secondary	0.075***	0.077***
	(0.011)	(0.011)
Medium income	0.044***	0.043***
	(0.010)	(0.010)
High income	0.027**	0.028***
	(0.011)	(0.011)
Employed	−0.068***	−0.069***
	(0.010)	(0.010)
Imm1	0.047**	0.046*
	(0.024)	(0.024)
Imm2	0.045***	0.046***
	(0.012)	(0.012)
Newfoundland	−0.024	−0.024
	(0.022)	(0.022)
Prince Edward	−0.221***	−0.220***
	(0.028)	(0.028)
Nova Scotia	−0.090***	−0.089***
	(0.019)	(0.019)
New Brunswick	−0.260***	−0.259***
	(0.020)	(0.020)
Quebec	−0.449***	−0.448***
	(0.014)	(0.014)
Ontario	−0.194***	−0.192***
	(0.012)	(0.012)
Manitoba	−0.137***	−0.135***
	(0.018)	(0.018)
Saskatchewan	−0.053***	−0.053***
	(0.018)	(0.018)
Alberta	−0.120***	−0.120***
	(0.016)	(0.016)
Observations	105.232	

Robust standard errors in parentheses * Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

Table 9 Specialist visits: Regression results from the Canadian community health survey, 2007

	Model 1	Model 2
Current smoker	0.048**	0.023
	(0.022)	(0.020)
Former smoker	0.176***	–
	(0.018)	
Quit ≤ 2 years	–	0.272***
		(0.033)
Quit 3–5 years	–	0.252***
		(0.04)
Quit ≥ 6 years	–	0.147***
		(0.019)
Male	−0.383***	−0.383***
	(0.016)	(0.016)
Age 18–29	0.419***	0.410***
	(0.031)	(0.031)
Age 30–44	0.367***	0.361***
	(0.024)	(0.025)
Age 45–59	0.138***	0.132***
	(0.021)	(0.021)
Married	0.054**	0.056**
	(0.022)	(0.022)
Separated	0.036	0.035
	(0.027)	(0.027)
Reg_doctor	0.474***	0.475***
	(0.027)	(0.027)
Health_good	−0.478***	−0.475***
	(0.022)	(0.022)
Health_very_good	−0.736***	−0.729***
	(0.024)	(0.024)

Table 9 continued

	Model 1	Model 2
Health_excellent	−0.876***	−0.869***
	(0.029)	(0.029)
Chronic	0.215***	0.215***
	(0.005)	(0.006)
Active	−0.027	−0.029
	(0.019)	(0.019)
Moderate	−0.016	−0.016
	(0.018)	(0.018)
Regular drinker	−0.164***	−0.157***
	(0.020)	(0.020)
Occasional drinker	−0.013	−0.011
	(0.025)	(0.025)
Secondary	0.122***	0.121***
	(0.028)	(0.028)
Some post-secondary	0.298***	0.302***
	(0.034)	(0.034)
Post-secondary	0.366***	0.370***
	(0.023)	(0.023)
Medium income	0.078***	0.076***
	(0.019)	(0.019)
High income	0.169***	0.171***
	(0.022)	(0.022)
Employed	−0.208***	−0.206***
	(0.020)	(0.020)
Imm1	−0.141***	−0.146***
	(0.050)	(0.050)
Imm2	−0.040*	−0.042*
	(0.024)	(0.024)
Newfoundland	−0.082*	−0.084*
	(0.047)	(0.047)
Prince Edward	0.207***	0.208***
	(0.058)	(0.058)
Nova Scotia	0.115***	0.115***
	(0.042)	(0.042)
New Brunswick	−0.005	−0.006
	(0.042)	(0.042)
Quebec	0.243***	0.244***
	(0.027)	(0.027)
Ontario	0.256***	0.255***
	(0.024)	(0.024)
Manitoba	0.001	0.004
	(0.040)	(0.040)
Saskatchewan	−0.116***	−0.116***
	(0.040)	(0.040)
Alberta	−0.024	−0.024
	(0.034)	(0.034)
Observations	105.434	

Robust standard errors in parentheses * Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

Table 10 Hospitalization: regression results from the Canadian Community Health Survey, 2007

	Model 1	Model 2
Current smoker	0.219***	0.196***
	(0.050)	(0.047)
Former smoker	0.310***	–
	(0.044)	
Quit $\leq$ 2 years	–	0.728***
		(0.065)
Quit 3–5 years	–	0.440***
		(0.099)
Quit $\geq$ 6 years	–	0.197***
		(0.050)
Male	−0.075*	−0.078**
	(0.039)	(0.040)
Age 18–29	0.434***	0.387***
	(0.066)	(0.066)
Age 30–44	0.213***	0.184***
	(0.060)	(0.060)
Age 45–59	−0.157***	−0.180***
	(0.052)	(0.052)
Married	0.165***	0.162***
	(0.053)	(0.053)
Separated	0.245***	0.239***
	(0.064)	(0.064)
Reg_doctor	0.445***	0.450***
	(0.062)	(0.062)
Health_good	−0.747***	−0.735***
	(0.046)	(0.046)
Health_very_good	−1.191***	−1.165***
	(0.053)	(0.053)
Health_excellent	−1.399***	−1.371***
	(0.065)	(0.066)
Chronic	0.199***	0.198***
	(0.012)	(0.012)
Active	−0.220***	−0.221***
	(0.047)	(0.048)
Moderate	−0.168***	−0.163***
	(0.044)	(0.044)
Regular drinker	−0.409***	−0.403***
	(0.044)	(0.043)
Occasional drinker	0.001	−0.007
	(0.050)	(0.050)
Secondary	−0.068	−0.077
	(0.060)	(0.060)
Some post-secondary	−0.003	−0.012
	(0.082)	(0.081)
Post-secondary	0.042	0.051
	(0.049)	(0.050)

Table 10 continued

	Model 1	Model 2
Medium income	−0.176***	−0.177***
	(0.045)	(0.045)
High income	−0.140***	−0.132**
	(0.053)	(0.053)
Employed	−0.510***	−0.512***
	(0.042)	(0.043)
Imm1	−0.370***	−0.362***
	(0.104)	(0.104)
Imm2	−0.258***	−0.240***
	(0.064)	(0.064)
Newfoundland	0.054	0.043
	(0.104)	(0.102)
Prince Edward	0.428***	0.408***
	(0.139)	(0.132)
Nova Scotia	−0.215**	−0.196*
	(0.107)	(0.107)
New Brunswick	−0.031	−0.013
	(0.089)	(0.092)
Quebec	0.060	0.073
	(0.062)	(0.061)
Ontario	−0.175***	−0.171***
	(0.055)	(0.054)
Manitoba	0.016	0.029
	(0.099)	(0.097)
Saskatchewan	−0.038	−0.033
	(0.081)	(0.081)
Alberta	−0.012	−0.015
	(0.070)	(0.070)
Observations	57.178	

Robust standard errors in parentheses * Statistical significance at 10 % level; ** Statistical significance at 5 % level; *** Statistical significance at 1 % level

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