A Cross-Sectional Study of Smoking during Pregnancy: Comparisons between Atlantic Canada and the Rest of Canada

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Abstract: Prenatal smoking is harmful to fetal development, with long-term implications for health and economic well-being. The objective of this study is to compare prenatal smoking in Atlantic Canada (i.e., Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick) and the rest of Canada – to support research and policy aimed at reducing disparities. We pool three cycles of the Canadian Community Health Survey with similar design and content – Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). These are the only cycles that coincide with our objective; health regions in Atlantic Canada did not select 'optional content' related to prenatal smoking between 2007 and 2017, and public use microdata from 2017 (released in 2020) do not have a sufficient sample of new mothers in the region. We examine the prevalence and correlates of prenatal smoking using descriptive statistics and multivariate regressions, separately for Atlantic Canada and the rest of Canada.

We find that the proportion of women who smoked during pregnancy is higher in Atlantic Canada (30.6 percent versus 26.2 percent in the rest of Canada). However, there is no difference in the number of cigarettes per day among those who smoked. In terms of correlates, we find that the probability of prenatal smoking is higher for single women (versus married or common law) and is inversely related to household income – regardless of whether women reside in Atlantic Canada or the rest of Canada. There are, however, important differences in the effects of age, visible minority status, education, labour market status, and the provincial/territorial unemployment rate.

Based on these differences, we conclude that data from the rest of Canada should not be extrapolated to Atlantic Canada. Given the importance of prenatal smoking for subsequent health and economic well-being, we argue that health regions in Atlantic Canada should select the relevant 'optional content' on an ongoing basis to collect a sufficient sample of new mothers, to better understand this issue and policy options for the region.

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1. Introduction

Prenatal smoking is a preventable cause of death and illness in infants, with implications for health and economic well-being throughout the lifecycle. A recent Surgeon General's report concludes 'the evidence is sufficient to infer a causal relationship' between prenatal smoking and ectopic pregnancy, miscarriage, sudden infant death syndrome, reduced lung function in infants, congenital malformations (orofacial cleft), fetal growth restriction, and low birthweight (Centers for Disease Control and Prevention 2014). Indeed, infants born to women who smoked during pregnancy are more than twice as likely to have low birthweight, which has become a 'surrogate measure' of the harmful effects on fetal development (Almond, Chay, and Lee 2005; Lien and Evans 2005; Lumley et al. 2009). Low birthweight is associated with morbidity, as well as behavioural and cognitive impairment in children (Matte et al. 2001; McCormick et al. 1992; Oreopoulos et al. 2008; Taylor et al. 2000). There is also evidence that it negatively affects education, employment, and health in later life (Behrman and Rosenzweig 2004; Case, Fertig, and Paxson 2005; Currie and Hyson 1999; Gluckman et al. 2008; Oreopoulos et al. 2008). Of course, the consequences of prenatal smoking depend on the amount and timing of exposure. For example, risks increase with the number of cigarettes, and smoking in the third trimester has been shown to be most harmful to fetal development (Bernstein et al. 2005; Jaddoe et al. 2008; Lieberman et al. 1994).

The economic costs of prenatal smoking are substantial, but they are hard to measure because of the far-reaching consequences (Adams et al. 2011; Centers for Disease Control and Prevention 2002; Miller et al. 2001). During the first year of life, the majority of costs pertain to healthcare for low birthweight infants (Miller et al. 2001). In Canada, the average cost of inpatient delivery care is more than 11 times higher for low birthweight infants than for those in the normal range – $12,354 compared to $1,084 in 2005-2006 (Canadian Institute for Health Information 2009). This estimate pertains to 'typical' low birthweight infants; it does not include those who were transferred between hospitals, died, or had long-term hospital stays, nor does it include the cost of follow-up care. Indeed, the costs of prenatal smoking continue to accrue given the long-term healthcare needs and productivity losses of the affected children (Centers for Disease Control and Prevention 2002). There are also long-term implications for the health and productivity of mothers. While not specific to prenatal smoking, there is evidence that having a child with a long-term disability or chronic condition is associated with poor maternal health (Burton, Lethbridge, and Phipps 2008a, 2008b). Such mothers are also less likely to engage in paid work and/or work fewer hours per week (Burton and Phipps 2009; Burton et al. 2017).

The prevalence of prenatal smoking in developed countries (such as Canada, Australia, and the United States) has been declining in recent decades. However, the decline has been concentrated among women with high socio-economic status (Chamberlain et al. 2013; Lumley et al. 2009). For example, the prevalence of prenatal smoking remains relatively high among those who are young or single, as well as women with low income or education (Al-Sahab et al. 2010; Cui et al. 2014; Ebert and Fahy 2007; Heaman and Chalmers 2005; Lange et al. 2015; Schneider and Schütz 2008). Likewise, prenatal smoking is more prevalent among women who have low self-assessed health, as well as those who smoke or drink regularly (Cui et al. 2014; Lange et al. 2015).

In Canada, past studies have also noted regional differences in prenatal smoking. For example, Lange et al. (2015) find that prevalence of prenatal smoking is higher in Atlantic Canada (i.e., Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick) compared to the national average. This is consistent with disparities in many of the correlates discussed above. For example, in 2016, the proportion of lone-parent households was highest in Nova Scotia and New Brunswick, while Newfoundland and Labrador and Prince Edward Island were also above the national average (Statistics Canada 2017a). Moreover, the proportion of the population with 'less than high school' education is higher in Atlantic Canada compared to the national average, while the proportion with post-secondary education is lower (Statistics Canada 2017b). Finally, excluding the Northern territories (i.e., Yukon, Northwest Territories, and Nunavut), self-assessed health is marginally lower in Atlantic Canada compared to the rest of the country, while smoking and heavy drinking are more common (Statistics Canada n.d.a).

In this study, we compare prenatal smoking in Atlantic Canada and the rest of Canada – both the probability of smoking and number of cigarettes per day because consequences depend on the amount of smoking (Bernstein et al. 2005; Jaddoe et al. 2008; Lieberman et al. 1994). Based on disparities in the correlates of prenatal smoking (i.e., lone-parent households, educational attainment, self-assessed health, smoking, and heavy drinking), we expect that women in Atlantic Canada are at higher risk. This has been noted in past studies, such as Lange et al. (2015), but they do not focus on Atlantic Canada, perhaps due to data limitations. Specifically, the Canadian Community Health Survey (CCHS) is the primary data source for studying prenatal smoking. However, questions about prenatal smoking became 'optional content' in Cycle 4.1 (2007) of the survey, and they were not selected by health regions in Atlantic Canada between 2007 and 2017. The 2017 public use microdata only became available in 2020. Moreover, since new mothers are a small subset of the population, the 2017 data are insufficient for studying prenatal smoking in Atlantic Canada. We also note that they should not be pooled with data prior to Cycle 4.1 (2007) because of a major redesign in the CCHS which affected data collection as of 2015.

Thus, our goal is to compare the prevalence and correlates of prenatal smoking in Atlantic Canada and the rest of Canada to inform future data collection, research, and policy. Specifically, our analysis is based on data prior to Cycle 4.1 (2007). If we find similarities in the prevalence and correlates of prenatal smoking across groups, then researchers and policy makers in Atlantic Canada may rely on 'optional content' from the rest of Canada. However, if we do not find similarities across groups, then we would argue that health regions in Atlantic Canada should select the 'optional content' related to prenatal smoking on an ongoing basis to collect a sufficient sample of new mothers, to better understand this issue and policy options for the region.

2. Methods

2.1 Data and Sample

We use public use microdata from the CCHS, which is a cross-sectional survey of the Canadian population aged 12 and older – excluding full-time members of the military, institutional residents, those in very remote areas, and First Nations Peoples who live on reserve. These exclusions represent less than three percent of the population (Statistics Canada n.d.b). An objective of the CCHS is to enable 'health research on small populations and rare characteristics' through large samples (Statistics Canada n.d.b). This is important for studying Atlantic Canada, which contains only 6.4 percent of the Canadian population – 1.4 percent in Newfoundland and Labrador, 0.4 percent in Prince Edward Island, 2.6 percent in Nova Scotia, and 2.1 percent in New Brunswick (Statistics Canada n.d.c). To our knowledge, the CCHS is the only recurrent survey that includes detailed information about maternal experiences in Canada. It has been used in past Canadian studies on prenatal smoking (Cui et al. 2014; Lange et al. 2015), as has the Maternity Experiences Survey (Al-Sahab et al. 2010). However, the latter was a one-time survey with a relatively small sample of Canadian women who gave birth in 2006.

The CCHS was conducted every two years from 2000-2001 to 2007, after which it became an annual survey. The majority of households are sampled using area and list frames, plus about one percent from random digit dialing. Approximately three-quarters of interviews are completed in person, while the rest are completed via telephone (Statistics Canada n.d.b). First, a household representative provides basic socio-demographic information, then one individual is selected for a more in-depth interview. Combined response rates (i.e., household-level and person-level) are approximately 80 percent, although the exact percentages vary by survey cycle (Statistics Canada n.d.b).

We pool Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005) of the CCHS. These are the only cycles in which questions about prenatal smoking are part of the 'core content' and thus are asked to all eligible women (i.e., those aged 15 to 55 who gave birth within five years of the survey). As of Cycle 4.1 (2007), questions about prenatal smoking became part of the 'optional content,' which is selected by health regions and varies across survey cycles (Statistics Canada n.d.b). Notably, questions about prenatal smoking were not selected by health regions in Atlantic Canada until 2017 (these public use data only became available in 2020). We argue, however, that our study is relevant despite the relatively old data. If we find similarities in prenatal smoking across groups, then researchers and policy makers in Atlantic Canada may rely on 'optional content' from the rest of Canada. However, if we do not find similarities across groups, then health regions in Atlantic Canada should continue to select the 'optional content' related to prenatal smoking going forward.

Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. We drop proxy interviews (completed by another household member if the woman was unable due to poor physical or mental health) and those who did not answer questions on key variables. The remaining sample includes 1,740 women in Atlantic Canada and 11,540 women in the rest of Canada.

2.2 Key Variables

We use two variables to measure prenatal smoking. First, women who gave birth within five years of the survey are asked, 'During your last pregnancy, did you smoke daily, occasionally or not at all?' From this, we define a binary dependent variable to indicate whether the woman smoked during pregnancy. It takes a value of one if she smoked 'daily' or 'occasionally' and zero if 'not at all.' This is consistent with the approach used in past studies (Cui et al. 2014; Lange et al. 2015). Then, women who smoked are asked about the number of cigarettes they smoked per day. From this, we define a count dependent variable, which is greater than zero. This is important because risks increase with the amount of prenatal smoking (Bernstein et al. 2005; Jaddoe et al. 2008; Lieberman et al. 1994).

Other key variables include socio-demographic characteristics that have been shown to affect prenatal smoking (Al-Sahab et al. 2010; Cui al. 2014; Ebert and Fahy 2007; Finch, Thomas, and Beck 2019; Heaman and Chalmers 2005; Lange et al. 2015; Schneider and Schütz 2008; Uphoff, Small, and Pickett 2019). These include the woman's age (a set of categorical variables versus 25 to 29 years), visible minority status (visible minority versus white), immigrant status (immigrant versus non-immigrant), marital status (single versus married or common law), education (less than high school or post-secondary versus high school) and the natural logarithm of real household income in 2006 dollars (Statistics Canada n.d.d). Income is categorical in the public use microdata file, so we construct a quasi-continuous variable using the midpoint of each category (as a robustness check, we estimate regressions using nominal income categories). In addition to adjusting for inflation, we divide income by the square root of household size to account for economies of scale in consumption (Buhmann et al. 1988). Moreover, for women in the Northern territories (i.e., Yukon, Northwest Territories, Nunavut), we further divide income by 1.46 to account for lower purchasing power in the region (Daley, Burton, and Phipps 2015). Other socio-demographic characteristics include the woman's labour market status (did not have a job versus had a job) and the average annual provincial/territorial unemployment rate (Statistics Canada n.d.e). We also control for province/territory and survey cycle in the regressions. New Brunswick is the base group in the regressions for Atlantic Canada, and Ontario is the base group in the regressions for the rest of Canada.

2.3 Empirical Approach

We examine the prevalence and correlates of prenatal smoking using descriptive statistics and multivariate regressions. For each dependent variable, we compare means/proportions between Atlantic Canada and the rest of Canada, testing for differences using two-sample t-tests (in the Appendix, we also compare provinces/territories in Atlantic Canada and the rest of Canada, respectively). The same thing is done for socio-demographic characteristics. We then estimate the effect of these characteristics on prenatal smoking as outlined in Equation 1:

$$Y_{ipt} = \beta_0 + \boldsymbol{\beta} \boldsymbol{X}_{ipt} + \mu_{ipt} \quad (1).$$

Y_{ipt} denotes the dependent variable for woman i in province/territory p and survey cycle t. $\boldsymbol{X}_{ipt}$ is a vector of socio-demographic characteristics, as well as dummy variables for province/territory and survey cycle. β_0 and $\boldsymbol{\beta}$ are parameters to be estimated. μ_{ipt} is the error term.

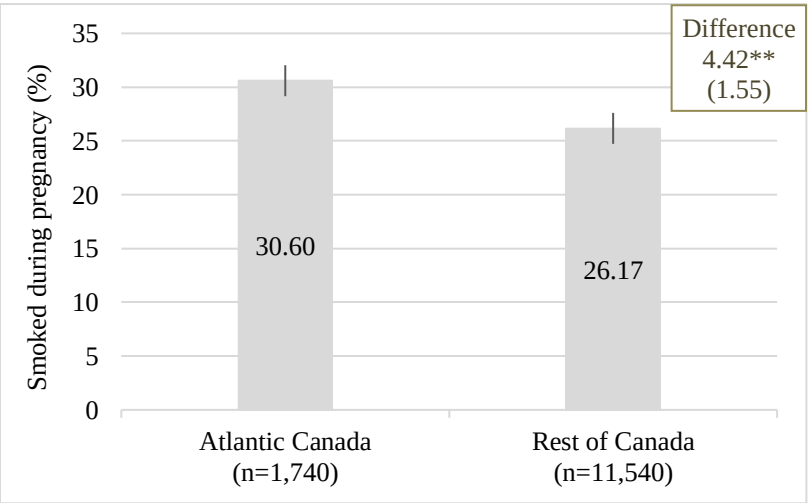
We estimate Equation 1 separately for women in Atlantic Canada and the rest of Canada. For the binary indicator of whether a woman smoked, we use probit regressions and report marginal effects, which can be interpreted as a change in the probability of the dependent variable being equal to one, all else constant. For number of cigarettes per day, conditional on smoking, we use zero-truncated negative binomial regressions and report incidence rate ratios. They can be interpreted as a change in the rate of cigarettes smoked, all else constant. For example, an incidence rate ratio of 1.2 on a binary correlate would imply that the rate of cigarettes smoked is 1.2 times greater than the base group. In all cases, our estimates are correlations and should not be interpreted as causal. We use robust standard errors in all regressions. Moreover, in all analyses, we use the sampling weights provided in the CCHS; bootstrap weights are not available in the public use microdata file. Statistical significance is considered at the five percent level.

3. Results

3.1 Descriptive Statistics

Figure 1 depicts the proportion of women who smoked during pregnancy, separately for Atlantic Canada and the rest of Canada. It indicates that 30.6 percent of women in Atlantic Canada smoked during pregnancy, compared to 26.2 percent in the rest of Canada. The difference is statistically significant.

FIGURE 1. Proportion of women who smoked during pregnancy, separately for Atlantic Canada and the rest of Canada

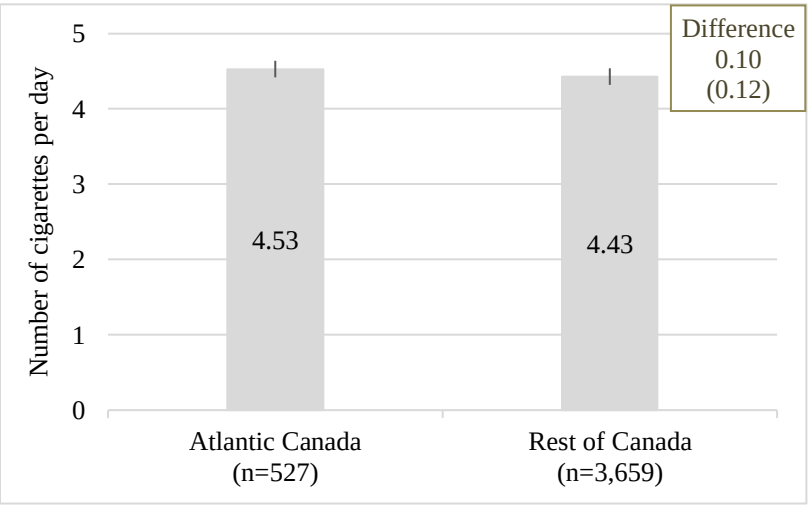


*NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the proportion of women who smoked during pregnancy. Standard error bars are indicated. The difference is tested using a two-sample t-test. The standard error is in parentheses. Sampling weights are used in all analyses. **p<0.05.*

In the Appendix, we compare provinces/territories in Atlantic Canada and the rest of Canada, respectively. Figure A1a indicates that, in Atlantic Canada, the proportion of women who smoked during pregnancy is higher in Newfoundland and Labrador (32.4 percent), New Brunswick (31.8 percent), and Nova Scotia (29.3 percent) compared to Prince Edward Island (26.5 percent). Figure A1b indicates that, in the rest of Canada, prenatal smoking is more prevalent in the Northern territories (49.9 percent) and Saskatchewan (35.3 percent). It is less prevalent in British Columbia (20.3 percent) and Ontario (22.2 percent).

As a second measure of prenatal smoking, Figure 2 depicts the mean number of cigarettes per day. Conditional on smoking, there is a negligible difference between women in Atlantic Canada (4.5 cigarettes per day) and the rest of Canada (4.4 cigarettes per day). The difference is not statistically significant. Likewise, Figures A2a and A2b indicate similarities across provinces/territories; the mean number of cigarettes per day ranges from 4.3 to 4.7 in Atlantic Canada, and from 4.2 to 4.7 in the rest of Canada.

FIGURE 2. Mean number of cigarettes per day among women who smoked during pregnancy, separately for Atlantic Canada and the rest of Canada



*NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the mean number of cigarettes per day among women who smoked during pregnancy. Standard error bars are indicated. The difference is tested using a two-sample t-test. The standard error is in parentheses. Sampling weights are used in all analyses. **p<0.05.*

In Table 1, we compare means/proportions of socio-demographic characteristics in Atlantic Canada and the rest of Canada. We find that new mothers in Atlantic Canada are younger; larger proportions are 15 to 29 years old, while smaller proportions are 35 years and older. They are also more likely to be single (almost 23 percent versus 16 percent in the rest of Canada). Table 1 also indicates that, while new mothers in Atlantic Canada have lower levels of education, differences are not statistically significant at the five percent level. However, real household

income is lower in Atlantic Canada, by about $5,310 per year. This is consistent with the larger proportion of women who did not have a job (37 percent versus 34 percent in the rest of Canada), as well as the higher provincial/territorial unemployment rate (11.1 percent versus 6.9 percent in the rest of Canada).

TABLE 1. Means/proportions of socio-demographic characteristics, separately for Atlantic Canada and the rest of Canada

Sample	Atlantic Canada	Rest of Canada	Difference
Age (%)			
15 to 24 years	16.417	13.337	3.080**
	(1.091)	(0.432)	(1.173)
25 to 29 years	29.096	23.094	6.002**
	(1.398)	(0.531)	(1.495)
30 to 34 years	28.631	30.527	-1.896
	(1.411)	(0.602)	(1.533)
35 to 39 years	19.529	24.064	-4.535**
	(1.247)	(0.613)	(1.389)
40 years and older	6.328	8.978	-2.650**
	(0.725)	(0.436)	(0.846)
Visible minority (%)	4.455	10.843	-6.388**
	(0.731)	(0.454)	(0.861)
Immigrant (%)	1.891	11.482	-9.591**
	(0.438)	(0.499)	(0.664)
Single (%)	22.898	16.165	6.732**
	(1.211)	(0.447)	(1.291)
Education (%)			
Less than high school	13.403	11.330	2.073
	(1.057)	(0.391)	(1.127)
High school	28.726	28.238	0.488
	(1.341)	(0.604)	(1.470)
Post-secondary	57.871	60.431	-2.560
	(1.504)	(0.650)	(1.639)
Real household income ($2006)	26,051.96	31,362.21	-5,310.25**
	(445.43)	(17426)	(478.20)
Did not have a job (%)	37.221	34.005	3.217**
	(1.498)	(0.637)	(1.627)
Unemployment rate (%)	11.068	6.885	4.183**
	(0.084)	(0.019)	(0.086)
Observations	1,740	11,540	–

NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged

*15 to 55 who gave birth within five years of the survey. This table contains means (continuous variables)/proportions (binary variables) of socio-demographic characteristics. Differences are tested using two-sample t-tests. Real household income ($2006) is adjusted for household size and lower purchasing power in the Northern territories. Standard errors are in parentheses. Sampling weights are used in all analyses. **p<0.05.*

3.2 Multivariate Regressions

Table 2 contains regression estimates for Atlantic Canada and the rest of Canada, respectively. The first two columns are marginal effects from probit regressions for the binary dependent variable 'smoked during pregnancy.' We find that marital status and household income are significant correlates, regardless of whether women reside in Atlantic Canada or the rest of Canada. Specifically, compared to being married or common law, the probability of prenatal smoking is approximately 8 percentage points higher for single women. Moreover, there is an inverse relationship between household income and the probability of smoking, and the size of the effect is similar across groups. As a robustness check, we estimate regressions using nominal income categories instead of the quasi-continuous variable. Results are robust such that the probability of prenatal smoking declines monotonically for women in higher income categories. Moreover, the size and statistical significance of estimates are similar for Atlantic Canada and the rest of Canada. These results are available from the corresponding author upon request.

TABLE 2. Correlates of prenatal smoking, separately for Atlantic Canada and the rest of Canada

Dependent variable	Smoked during pregnancy		Number of cigarettes per day	
Sample	Atlantic Canada	Rest of Canada	Atlantic Canada	Rest of Canada
Baseline probability	0.284	0.236	–	–
Age (versus 25 to 29 years)				
15 to 24 years	0.026	-0.022	0.944	0.945**
	(0.044)	(0.017)	(0.054)	(0.026)
30 to 34 years	-0.009	-0.057**	1.009	1.035
	(0.038)	(0.014)	(0.064)	(0.029)
35 to 39 years	-0.092**	-0.044**	1.021	1.078**
	(0.043)	(0.017)	(0.090)	(0.038)
40 years and older	-0.065	-0.072**	1.141**	1.099**
	(0.049)	(0.020)	(0.076)	(0.047)
Visible minority (versus white)	0.047	-0.013	1.059	0.899**
	(0.073)	(0.021)	(0.087)	(0.039)
Immigrant (versus non-immigrant)	-0.125	-0.142**	0.856	0.784**
	(0.077)	(0.017)	(0.122)	(0.070)
Single (versus married or common law)	0.081**	0.084**	1.003	1.001
	(0.039)	(0.017)	(0.049)	(0.024)

TABLE 2. Continued

Dependent variable	Smoked during pregnancy		Number of cigarettes per day	
Sample	Atlantic Canada	Rest of Canada	Atlantic Canada	Rest of Canada
Education (versus high school)				
Less than high school	0.247**	0.151**	1.103	1.125**
	(0.052)	(0.022)	(0.064)	(0.028)
Post-secondary	-0.058	-0.122**	1.033	0.952
	(0.034)	(0.014)	(0.065)	(0.025)
Log of real household income	-0.096**	-0.090**	0.986	0.965
	(0.024)	(0.010)	(0.034)	(0.019)
Did not have a job (versus had a job)	0.090**	0.020	1.092	1.035
	(0.036)	(0.013)	(0.063)	(0.022)
Unemployment rate	-0.192	-0.007	0.848	0.918**
	(0.109)	(0.017)	(0.174)	(0.028)
Province/territory (versus New Brunswick)				
Newfoundland and Labrador	0.882**	–	2.282	–
	(0.161)		(2.748)	
Prince Edward Island	0.263	–	1.166	–
	(0.175)		(0.324)	
Nova Scotia	-0.178	–	0.819	–
	(0.098)		(0.160)	
Province/territory (versus Ontario)				
Quebec	–	0.094**	–	1.257**
		(0.039)		(0.084)
Manitoba	–	0.013	–	0.847**
		(0.040)		(0.059)
Saskatchewan	–	0.058	–	0.898**
		(0.033)		(0.046)
Alberta	–	0.023	–	0.814**
		(0.041)		(0.061)
British Columbia	–	-0.033	–	1.057
		(0.018)		(0.041)
Northern territories	–	0.109**	–	1.155**
		(0.041)		(0.074)
Observations	1,740	11,540	527	3,659

NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. 'Smoked during pregnancy' is binary. Marginal effects from probit regressions are reported. 'Number of cigarettes per day' is a count variable greater than zero, conditional on smoking. Incidence rate ratios from zero-truncated

*negative binomial regressions are reported. We control for survey cycle in all regressions. Robust standard errors are in parentheses. Sampling weights are used in all analyses. **p<0.05.*

In addition to marital status and household income, we find that age and education are significant correlates for both groups, but there are differences in the size and statistical significance of estimates. Specifically, in the rest of Canada, the probability of prenatal smoking is lower among women aged 30 to 34 years (5.7 percentage points), 35 to 39 years (4.4 percentage points), and 40 years and older (7.2 percentage points) compared to the base group of women aged 25 to 29 years. A similar pattern exists for women in Atlantic Canada, but the estimates differ in size, and only one age category is statistically significant (the probability of prenatal smoking is 9.2 percentage points lower among women aged 35 to 39 years). In terms of education, 'less than high school' (versus high school) is associated with a higher probability of prenatal smoking by 24.7 percentage points in Atlantic Canada and 15.1 percentage points in the rest of Canada. Likewise, post-secondary education is associated with a lower probability of prenatal smoking by 12.2 percentage points in the rest of Canada. The effect is smaller and not statistically significant in Atlantic Canada.

Also shown in Table 2, there are other notable differences across groups. Specifically, in Atlantic Canada, the probability of prenatal smoking is 9 percentage points higher among women who did not have a job (versus those who had a job). The effect is small and not statistically significant in the rest of Canada. Moreover, the probability of smoking is 14.2 percentage points lower among immigrants (versus non-immigrants) in the rest of Canada. The effect is not statistically significant in Atlantic Canada, although the number of observations is very small. Finally, we find that women in Newfoundland and Labrador are more likely to smoke during pregnancy (versus New Brunswick), as are women in Quebec and the Northern territories (versus Ontario).

The last two columns of Table 2 pertain to the 'number of cigarettes per day' conditional on smoking during pregnancy. We find that the rate of cigarettes smoked is approximately 1.1 times greater among women aged 40 years and older (versus 25 to 29 years), in both Atlantic Canada and the rest of Canada. Notably, marital status and household income are not significant correlates for either group. Indeed, there are no other significant correlates for women in Atlantic Canada, nor are there differences across provinces/territories in the region. There are, however, additional correlates for women in the rest of Canada. Specifically, the rate of cigarettes smoked is lower among those aged 15 to 24 and greater among those aged 35 to 39 (versus 25 to 29 years). It is also associated with visible minority status and immigrant status; the rate of cigarettes smoked is 0.9 times lower among women who identify as a visible minority (versus white) and 0.8 times lower among immigrant women (versus non-immigrant women). Moreover, the rate of cigarettes smoked is 1.1 times greater among women with 'less than high school' education (versus high school), and it is inversely related to the provincial/territorial unemployment rate. Finally, compared to Ontario, the rate of cigarettes smoked is greater in Quebec and the Northern territories, while it is lower in Manitoba, Saskatchewan, and Alberta.

4. Discussion

4.1 Findings

In this study, we compare the prevalence and correlates of prenatal smoking in Atlantic Canada and the rest of Canada. Our analysis is based on relatively old data since 'optional content' related to prenatal smoking was not selected by health regions in Atlantic Canada between 2007 and 2017, and public use microdata from 2017 (released in 2020) do not contain a sufficient sample of new mothers to enable a separate analysis of Atlantic Canada. Thus, our goal is to understand the extent to which researchers and policy makers in Atlantic Canada should use data from the rest of Canada, or whether region-specific data on prenatal smoking are needed (on a continuing basis) going forward.

Our descriptive statistics indicate that prenatal smoking is more prevalent in Atlantic Canada (30.6 percent versus 26.2 percent in the rest of Canada). Prevalence is especially high in Newfoundland and Labrador, New Brunswick, and Nova Scotia. In the rest of Canada, it is highest in the Northern territories, followed by Saskatchewan. These findings are consistent with past studies on prenatal smoking (Cui et al. 2014; Lange et al. 2015). Extending the literature, we also examine the number of cigarettes per day, conditional on smoking. Despite differences in prevalence, the amount of smoking is similar among women in Atlantic Canada and the rest of Canada. Taken together, these findings suggest the importance of policy that targets both the decision to smoke during pregnancy (especially in Atlantic Canada, the Northern territories, and Saskatchewan) and the amount of smoking. The latter is relevant across the country. Of particular concern, our multivariate regressions suggest that women in the Northern territories are more likely to smoke during pregnancy and have a higher rate of cigarettes smoked.

There are some similarities in the correlates of prenatal smoking between Atlantic Canada and the rest of Canada. Consistent with past studies (Al-Sahab et al. 2010; Cui al. 2014; Heaman and Chalmers 2005), the probability of prenatal smoking is higher for single women (versus married or common law), and it is inversely related to household income. However, there is no association between these characteristics and the rate of cigarettes smoked. In terms of policy, there is evidence that interventions are not as effective for women of low socio-economic status but instead can be judgemental and alienating (Chamberlain et al. 2013). When addressing the decision to smoke by single women and those with low income, a 'mutually respectful dialogue' on prenatal smoking should reflect the woman's socio-economic status and perspectives (Ebert and Fahy 2007).

In addition to marital status and household income, we find that age and education are associated with prenatal smoking in Atlantic Canada and the rest of Canada, but there are group differences in the size and statistical significance of estimates. In terms of age, we find that older women (versus those aged 25 to 29 years) are less likely to smoke during pregnancy but have a higher rate of cigarettes smoked. While this is important for policy, readers should note the differences in estimates across groups, as well as the small sample of women aged 40 years and older when considering the amount of smoking in Atlantic Canada. In terms of education, we find that 'less than high school' (versus high school) is associated with a higher probability of prenatal smoking, and the effect is larger in Atlantic Canada (24.7 percentage points versus 15.1

percentage points in the rest of Canada). 'Less than high school' education is also associated with a higher rate of cigarettes smoked in the rest of Canada. This warrants consideration by policy makers in the rest of Canada (i.e., the higher probability of smoking and higher rate of cigarettes smoked), but we reiterate the earlier point that interventions should be respectful of differences in socio-economic status and perspectives (Chamberlain et al. 2013; Ebert and Fahy 2007). We also recognize that, while 'less than high school' education is not associated with the amount of smoking in Atlantic Canada, the relevant sample is quite small.

It is interesting to note that some correlates of prenatal smoking are specific to Atlantic Canada while others are specific to the rest of Canada. For example, in Atlantic Canada, the probability of prenatal smoking is higher among women who did not have a job (versus those who had a job). This is consistent with past studies (Cui et al. 2014; Lange et al. 2015) and important in Atlantic Canada, where a relatively large proportion of women did not have a job. Conversely, in the rest of Canada, the amount of smoking is negatively associated with the provincial/territorial unemployment rate. This is consistent with evidence from the United States (Finch, Thomas, and Beck 2019), as well as past findings that poor health is procyclical such that economic downturns are associated with a reduction in smoking (Ruhm 2005). In addition to the provincial/territorial unemployment rate, visible minority status and immigrant status are significant correlates in the rest of Canada. Specifically, the rate of cigarettes smoked is lower among women who identify as a visible minority (versus white). Past studies have found mixed results regarding the importance of visible minority status (Cui et al. 2014; Lange et al. 2015). This is consistent with our study such that visible minority status is important for women in the rest of Canada but not Atlantic Canada (although this may reflect the small sample size), and it is associated with the amount of smoking but not the probability. On the other hand, immigrant status is a significant correlate of both measures in the rest of Canada. The effects are reinforcing such that immigrant women (versus non-immigrant women) have a lower probability of prenatal smoking and lower rate of cigarettes smoked.

As noted earlier, data on prenatal smoking in Atlantic Canada are insufficient. Thus, our goal is to compare the prevalence and correlates of prenatal smoking in Atlantic Canada and the rest of Canada – if they are similar, it may be possible to use data from the rest of Canada to inform research and policy in Atlantic Canada. However, our findings suggest otherwise. For example, the proportion of women who smoked during pregnancy is higher in Atlantic Canada (although the amount of smoking is similar across groups). Moreover, while some correlates are similar across groups (e.g., marital status, household income), there are differences in the importance of age, visible minority status, immigrant status, education, labour market status, and the provincial/territorial unemployment rate. Taken together, our findings suggest that region-specific data are needed. We recommend that health regions in Atlantic Canada continue to select 'optional content' related to prenatal smoking going forward to collect data of sufficient size and regional specificity to better understand this issue and policy options.

4.2 Limitations

An objective of the CCHS is to facilitate 'health research on small populations and rare characteristics' (Statistics Canada n.d.b). Nevertheless, our sample is relatively small, especially when considering the amount of prenatal smoking among women in Atlantic Canada. New

mothers are a small subset of the population, so it is necessary to pool several cycles of data to facilitate regional analysis. This is not possible for Atlantic Canada in recent years. Given the importance of the prenatal period for subsequent health and economic well-being (Behrman and Rosenzweig 2004; Case, Fertig, and Paxson 2005; Currie and Hyson 1999; Gluckman et al. 2008; Oreopoulos et al. 2008), we argue that data on maternal experiences should be collected in Atlantic Canada on an ongoing basis to support research and policy in the region.

Another limitation is that questions about prenatal smoking pertain to the woman's last pregnancy, up to five years before the survey. Therefore, there may be discrepancies between the timing of the dependent variables and socio-demographic characteristics, which pertain to the survey period. Moreover, there may be recall bias in the dependent variables, especially for women who are further removed from their last pregnancy. We note, however, that these limitations are not unique to our work; they have also been encountered in past Canadian studies that use the same data and dependent variables (Cui et al. 2014; Lange et al. 2015).

Finally, we do not observe important contextual information about prenatal smoking, such as the timing of exposure or whether women use alternative tobacco and nicotine products (e.g., smokeless tobacco, electronic cigarettes, cigars, water pipes). This is left for future work, data permitting. For example, the timing of exposure is observed in 2017, which could eventually be pooled with subsequent cycles of the CCHS.

5. Conclusion

Prenatal smoking is harmful to fetal development, with long-term implications for health and economic well-being. Yet, there is limited evidence regarding prenatal smoking in Atlantic Canada, perhaps due to data limitations in recent years. In this study, we compare the prevalence and correlates of prenatal smoking in Atlantic Canada and the rest of Canada. We find that the proportion of women who smoked during pregnancy is higher in Atlantic Canada, and there are important differences in correlates (i.e., age, visible minority status, immigrant status, education, labour market status, provincial/territorial unemployment rate). Taken together, our findings suggest that data from the rest of Canada should not be extrapolated to Atlantic Canada; region-specific data are needed. In other words, we recommend that health regions in Atlantic Canada continue to select 'optional content' related to prenatal smoking in the CCHS to collect a sufficient sample of new mothers and thus better support research and policy in the region.

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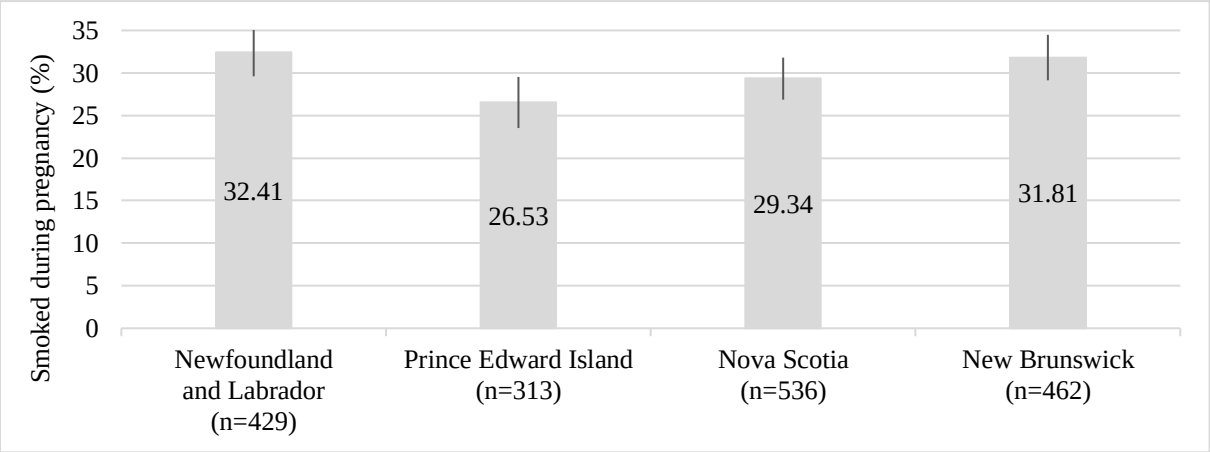
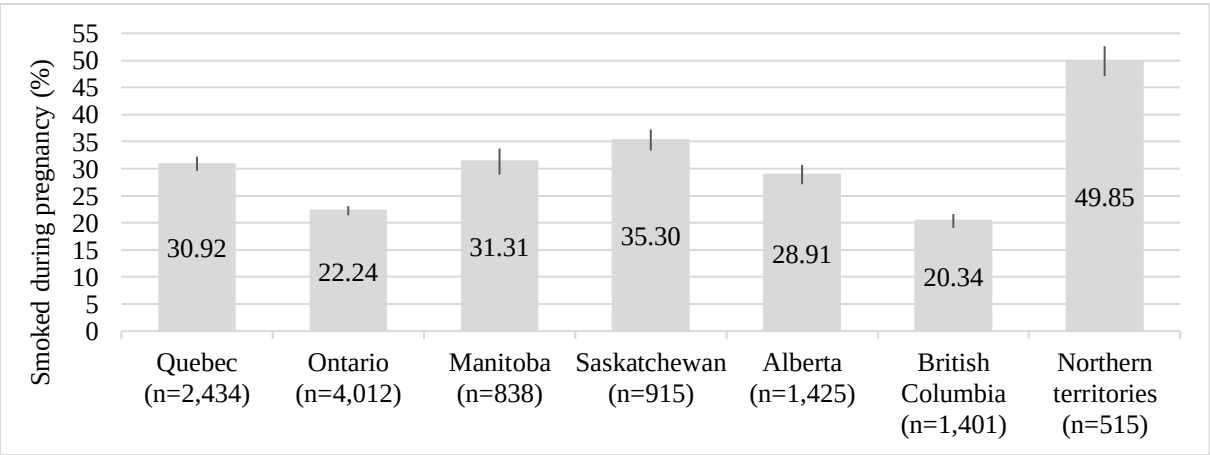
Appendix

FIGURE A1a. Proportion of women who smoked during pregnancy, separately by province/territory in Atlantic Canada



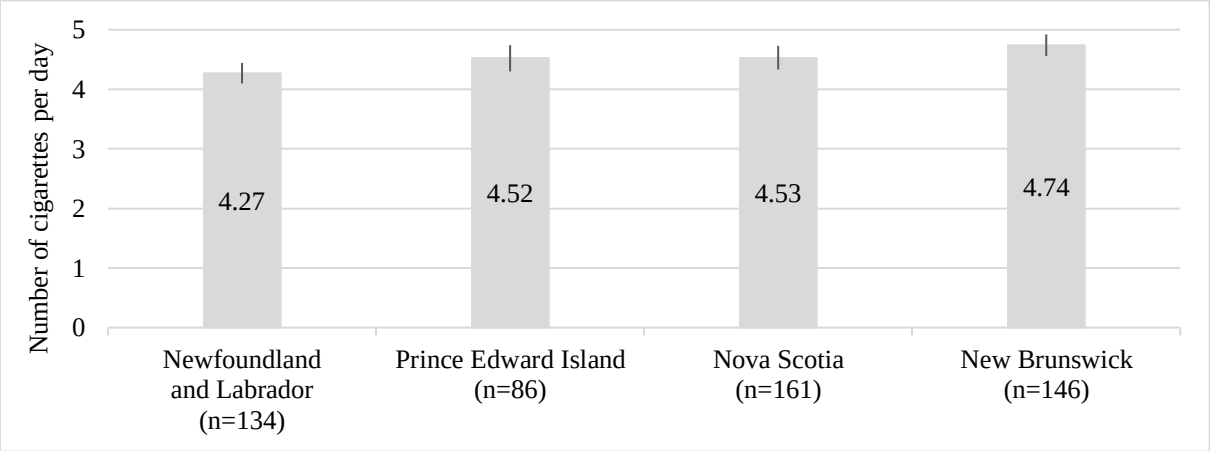
NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the proportion of women who smoked during pregnancy. Standard error bars are indicated. Sampling weights are used in all analyses.

FIGURE A1b. Proportion of women who smoked during pregnancy, separately by province/territory in the rest of Canada



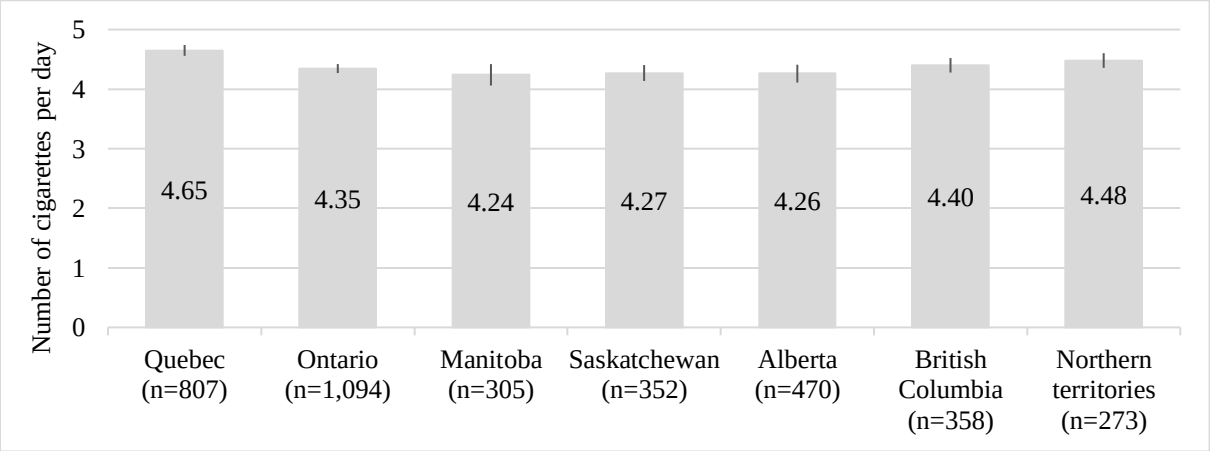
NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the proportion of women who smoked during pregnancy. Standard error bars are indicated. Sampling weights are used in all analyses.

FIGURE A2a. Mean number of cigarettes per day among women who smoked during pregnancy, separately by province/territory in Atlantic Canada



NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the mean number of cigarettes per day among women who smoked during pregnancy. Standard error bars are indicated. Sampling weights are used in all analyses.

FIGURE A2b. Mean number of cigarettes per day among women who smoked during pregnancy, separately by province/territory in the rest of Canada



NOTES: Our study is based on public use microdata from the Canadian Community Health Survey, Cycles 1.1 (2000-2001), 2.1 (2003), and 3.1 (2005). Our sample consists of women aged 15 to 55 who gave birth within five years of the survey. This figure depicts the mean number of cigarettes per day among women who smoked during pregnancy. Standard error bars are indicated. Sampling weights are used in all analyses.