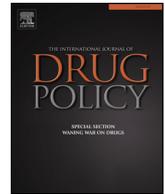




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International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Research Paper

Contraband Cigarette Purchasing from First Nation reserves in Ontario and Quebec: Findings from the 2002–2014 ITC Canada Survey

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ARTICLE INFO

Keywords:

Longitudinal
Tobacco
Taxation
Contraband
Purchasing
Economics
Proximity

ABSTRACT

Background: The availability of contraband cigarettes provides incentives for price-sensitive smokers to reduce their monetary costs of smoking. The objectives of this study were to examine whether Canadian smokers' geographic proximity to First Nations reserves and attempts to quit smoking influenced the likelihood of purchasing lower-cost cigarettes from reserves. **Methods:** Data were from the International Tobacco Control (ITC) Canada Survey, a prospective survey of Canadian adult smokers conducted from 2002 to 2014 using telephone and online interviewing methods. Analysis was restricted to smokers from Ontario (n = 2105) and Quebec (n = 1427) participating in at least one survey wave. Smokers' postal codes were used to calculate distance to the nearest reserve. Weighted logistic generalised estimating equations (GEE) regression examined the linear relationship between distance and the log odds of last purchasing cigarettes on reserve in each province. GEE models also examined the relationship between past-year quit attempts and the log odds of on-reserve purchasing. **Results:** Controlling for other factors, from 2002–2014, smokers from Ontario who lived 10 km closer to reserves than otherwise similar smokers had significantly higher odds of last purchasing on reserve (OR ranged from 1.16 to 1.65). Distance had little effect on smokers' purchasing behaviours in Quebec. Moreover, in Ontario, for every 10 km increase in distance, smokers who did not try to quit had significantly greater odds of purchasing from a reserve than smokers who tried to quit (p = 0.002). **Conclusion:** In order for tobacco taxation policies to achieve their maximal benefit, governments must limit potential sources of lower-cost cigarettes. Collaborative governance arrangements can ensure tobacco products sold on reserve to non-Indigenous people are appropriately taxed while allowing First Nations communities to keep the revenue generated by such taxes.

Introduction

Tobacco taxes reduce consumption by increasing the price of tobacco products (Chaloupka et al., 2011; 2012; International Agency for Research on Cancer, 2011). In the face of tax increases, price-sensitive smokers may actively search for lower-priced alternatives to reduce their financial burden of continuing to smoke. Price-sensitive smokers lower their costs using a variety of tactics, including cross-border shopping, internet orders, and duty-free shops (U.S. National Cancer Institute and World Health Organization, 2016). In North America, it is also possible for smokers to purchase cigarettes from Indigenous people on tribal lands, which are usually known as First Nations reserves in

Canada and Indian reservations in the United States. Cigarettes sold on tribal lands cost significantly less than those sold off tribal lands (Luk et al., 2009; Mecredy et al., 2013; Soulakova et al., 2018). While non-Indigenous people buying cigarettes from First Nations reserves in Canada must pay all applicable federal and provincial taxes, this is not strictly enforced (Luk et al., 2009; Mecredy et al., 2013).

The manufacture and distribution of contraband tobacco has been especially problematic in the Canadian provinces of Ontario and Quebec, despite these provinces having the lowest tobacco taxes in Canada. In these provinces, some First Nations communities legally manufacture cigarettes. For example, Grand River Enterprises (GRE), located on the Six Nations reserve near Brantford, Ontario, is the fourth

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<https://doi.org/10.1016/j.drugpo.2019.102612>

largest tobacco company in Canada (Non-Smokers' Rights Association, 2012). While GRE cigarettes can be sold legally to Indigenous people on reserve, GRE has been suspected of shipping a larger supply of cigarettes to reserves than could be smoked by the populations living on those reserves (Non-Smokers' Rights Association, 2012; 2015; Sarson, 2019). The Royal Canadian Mounted Police (RCMP) has documented that cigarettes produced on reserve for purchase by Indigenous people are instead sold illegally to non-Indigenous people (Royal Canadian Mounted Police, 2008; 2011). In addition, the Akwesasne reserve near Cornwall, Ontario, straddles both provincial and international borders, making it difficult for provincial and federal agencies to police the illegal distribution of contraband tobacco by organised criminal networks (Leuprecht, 2016). These factors increase the availability of untaxed and under-taxed cigarettes for smokers living in Ontario and Quebec.

Data from the 2005–2006 Ontario Tobacco Survey indicate that almost 26% of adult smokers in Ontario purchased cigarettes from First Nations reserves in the previous six months while 12% of smokers reported that they usually bought cigarettes on reserve (Luk et al., 2009). Using data from nine waves of the International Tobacco Control (ITC) Canada Survey, Guindon et al. (2017) showed that on-reserve purchases were more prevalent in Ontario than Quebec from 2004 to 2014 (Guindon et al., 2017). During that time period, the percentage of smokers from Ontario whose last purchase of cigarettes was from a reserve increased from 5% in 2005 to 23% in 2013/2014. Less than 10% of smokers from Quebec made such purchases over the entire study period (Guindon et al., 2017).

Measures have been introduced to address the Canadian contraband tobacco problem. In 2001, the Government of Quebec introduced ACCES Tabac, a partnership between provincial and federal agencies designed to reduce the supply of contraband tobacco through concerted enforcement (Leuprecht, 2016; 2018). In 2008, the RCMP launched the Contraband Tobacco Enforcement Strategy to further limit the supply of illegal tobacco (Stanbrook, 2013). Each of these programs may have had some effect in reducing the availability of contraband tobacco (Sen, 2017).

In spite of increased enforcement, the continued availability of low- and untaxed cigarettes enables price-sensitive smokers to minimise their financial costs of continuing to smoke (DeCicca et al., 2015; Xu et al., 2014). Previous research has found that proximity to tribal lands in the United States was associated with the purchase of low- and untaxed cigarettes from those lands (DeCicca et al., 2015; Hyland et al., 2005). In turn, price minimisation behaviours disincentive smoking cessation efforts. (McCreedy et al., 2013) found that smokers who usually smoked a contraband cigarette brand were significantly less likely to attempt to quit smoking than smokers of premium or discount brands (McCreedy et al., 2013).

Building on these findings, the current study examined whether smokers' potential access to contraband cigarettes, defined as geographic proximity to First Nations reserves, increased the likelihood of purchasing cigarettes from reserves. Because the Canadian contraband tobacco problem is concentrated in Ontario and Quebec, this study also examined whether on-reserve purchases differed by province and whether the likelihood of on-reserve purchases changed over time as a function of geographic proximity. Finally, this study examined whether past-year quit attempt attempts were associated with on-reserve purchases over and above the effect of geographic proximity.

Methods

Data sources

This study used data from the first nine waves of the International Tobacco Control Canada Survey. The ITC Canada Survey was part of a larger prospective cohort survey of nationally representative samples of smokers from Canada, the United States, the United Kingdom, and

Australia, conducted from 2002 (Wave 1) to 2014 (Wave 9). In Wave 1 of the ITC Canada Survey, 2214 adult smokers aged 18 and older were randomly sampled from 14 geographic strata defined by each of the 10 Canadian provinces. The largest urban centres in British Columbia (Vancouver), Ontario (Toronto and the Greater Toronto Area), and Quebec (Montreal) comprised additional sampling strata in those provinces (Thompson et al., 2006).

In the first six waves, respondents were interviewed by computer assisted telephone interviewing (CATI). In the remaining waves, both CATI and computer assisted web interviewing were used. In all follow-up waves, respondents lost to attrition were replaced with new respondents using the original sampling design. Respondents who quit smoking were also followed over time. Approximately 2000 respondents were interviewed in each of the first six waves; the sample size was reduced to approximately 1750 respondents in Wave 7 and 1500 respondents in each of Waves 8 and 9 (ITC Project, 2011; Thompson et al., 2006). In the first three waves, data were collected during a single calendar year, while in all remaining waves, data collection spanned two calendar years. All respondents provided informed consent to participate in the ITC Canada Survey; ethical approval was provided by the Office of Research Ethics, University of Waterloo (ORE #10556, #12978, #17469).

Overall, 3611 current smokers from Ontario and Quebec participated in at least one wave of the ITC Canada Survey. Of these, five respondents moved from Ontario to Quebec over the course of the study and were excluded from the analysis. Of the remaining respondents, 3562 (98.8%) provided sufficient postal code information to identify approximate residential locations. The statistical analysis was based on 3532 smokers who provided complete data for all covariates used in the generalised estimating equation (GEE) regression models specified below. These smokers contributed 9063 observations to the analysis. Location information for almost all of these observations (9042 or 99.8%) was based on postal code. Geographic coordinates for these postal codes were obtained from geospatial data files supplied by DMTI Spatial through Scholars GeoPortal (DMTI Spatial Inc., 2014; Ontario Council of University Libraries, 2013). Approximate locations for the remaining 21 observations were based on the geographic centroid of the forward sortation area (FSA) in which respondents lived using data from Statistics Canada (Statistics Canada, 2011). These data were also obtained through Scholars GeoPortal.

Measures

Purchasing cigarettes from a First Nations reserve

The primary outcome measure for this study was whether respondents made their last purchase of cigarettes from a First Nations reserve. Purchase locations were assessed using responses to the question "Where did you last buy cigarettes/roll-your-own tobacco for yourself?" One of the possible responses was "from a First Nations reserve". Additional open-ended responses to a second question identified other respondents who reported they last purchased cigarettes on reserve (e.g., "Native smoke shop", "the reserve", "Six Nations reserve").

Distance to First Nations reserves

The main explanatory variable was geographic distance between respondents' residential locations and the closest First Nations reserve. The geographic coordinates of residential locations were identified using the postal code of each respondent's home address, as outlined above. Separate geospatial data identifying the locations of First Nations reserves in Ontario and Quebec were obtained from Natural Resources Canada (Natural Resources Canada, 2017). These data files identified the administrative boundaries of all First Nations reserves in those provinces (one file per province). These separate files were merged into a single geospatial layer prior to extracting geographic centroids from the polygons identifying administrative boundaries using QGIS Version 2.18. In order to compute the Euclidean distance from

respondent locations to the nearest First Nations reserve, it was necessary to re-project each geospatial data layer to the North American Equidistant Conic projection (EPSG:102010) to minimise distance distortions. The distance from residential locations to the nearest First Nations reserve was then computed using QGIS.

Self-reported cigarette prices

Smokers also reported the price they paid for their last purchase of cigarettes. For smokers who last purchased from a reserve, the reported purchase price corresponds to an on-reserve purchase. Smokers reported the amount of cigarettes purchased for carton, pack, or loose (single cigarette) purchases. Smokers then reported the total price paid for their entire purchase. In Waves 3 through 6 and in Wave 9, smokers purchasing on reserve could also report the number of cigarettes purchased on reserve, often by a “bag” of 200 cigarettes. Price per cigarette (total purchase price divided by total cigarettes purchased) was computed for each smoker and then converted to a standardized price per “pack” of 25 cigarettes. Nominal prices were adjusted for inflation to 2014 Canadian dollars (last quarter of 2014, where \$1 CAD = \$0.862 USD (Organization for Economic Co-operation and Development, 2015; 2016)). Inflation-adjusted pack prices below \$1/pack or greater than \$20/pack were considered outliers and treated as missing for the analysis. Overall, 73 prices were treated as outliers across all waves (0 to 8 observations per wave, with the exception of Wave 2 where 39 observations were considered outliers).

Covariates

Both sociodemographic measures and smoking behaviours were included as covariates in regression models. Sociodemographic measures were sex, age group (18–24, 25–39, 40–54, 55+), ethnicity (First Nations, other, white), annual household income (low: < \$30,000; moderate: \$30,000–\$59,999; high: ≥ \$60,000; income not reported), and highest level of education (low: completed high school or less, moderate: trade school/community college/some university, high: completed university/post-graduate degree).

Measures of smoking behaviors were smoking status (daily, non-daily smoker), amount smoked per day (≤ 10 , 11–20, 21–30, \geq cigarettes/day), exclusive use of roll-your-own (RYO) cigarettes (exclusive use, smokes factory-made cigarettes alone or in combination with RYO cigarettes), intentions to quit smoking in the next 6 months (no plans, any plans), and attempts to quit in the previous year. Attempts to quit was computed from responses to questions identifying whether a respondent had ever tried to quit, when their last quit attempt started, or when their last quit attempt ended. Respondents who ever tried to quit and whose last attempt either started or ended in the previous 365 days were classified as having made an attempt to quit smoking in the previous year. Finally, since some respondents were surveyed multiple times over the course of the study, and because previous participation in the survey is known to influence respondent's answers to important outcomes, an additional covariate measuring each respondent's time-in-sample was also included in all regression models (Driezen and Thompson, 2011; Thompson et al., 2005).

Statistical analysis

Unweighted descriptive statistics were used to characterise the sample of smokers participating in the ITC Canada Survey. The average distance to First Nations reserves was then estimated for two groups of smokers: those who last purchased cigarettes from a reserve and those who did not. Mean distances were estimated within each province for each survey wave using the sampling weights; variances were estimated using Taylor series linearisation methods. Mean self-reported cigarette prices per standardized “pack” of 25 cigarettes were estimated in a similar fashion.

Weighted logistic regression was then used to estimate the adjusted prevalence of last purchasing cigarettes from a First Nations reserve.

Regression models accounted for the stratified sampling design and were estimated using GEE to account for repeated measures using an exchangeable working correlation matrix. Regression models controlled for all covariates listed above. A province X wave interaction term was included to test whether the overall temporal trend differed by province. In addition, the adjusted percentages of on-reserve purchases were compared between provinces and within provinces, relative to 2002 (Wave 1). Statistical tests controlled for multiple comparisons using the false discovery rate (FDR) (Benjamini and Hochberg, 1995).

Separate GEE models were estimated for each province to estimate the linear effect of distance to nearest reserve on the log odds of last purchasing cigarettes on reserve. In these models, a wave X distance interaction effect was included to test whether the effect of distance changed over time. A final set of logistic regression models were estimated for each province to examine the association between attempts to quit in the previous year and last purchasing cigarettes on reserve. In these models, a quit attempt X distance interaction effect was specified in addition to a main effects model. SAS (version 9.4) was used for estimating descriptive statistics while SAS-callable SUDAAN (version 11.0.3) was used to estimate weighted mean distances and all GEE models.

Results

Sample characteristics

Over the course of the study, 2105 smokers from Ontario and 1427 smokers from Quebec participated in at least one wave of the ITC Canada Survey. On average, respondents from Ontario remained in the study slightly longer than respondents from Quebec (mean time-in-sample = 2.79 waves vs. 2.50 waves, respectively). Table 1 presents the respondent characteristics based on their initial wave of recruitment. About 53% of respondents from either province were female. The age distribution of respondents was similar in each province. A slightly greater percentage of respondents from Ontario were ethnic minorities, with 3.7% of smokers reporting First Nations ancestry compared to only 1.4% of smokers in Quebec. Slightly more than one third of respondents from Ontario had high household incomes (\geq \$60,000/year) compared to only one fifth of smokers from Quebec. Respondents from Ontario tended to be better educated, with 57% reporting moderate to high education levels, compared to only 48% of respondents from Quebec. While a smaller percentage of smokers from Ontario exclusively smoked RYO cigarettes compared to Quebec smokers (1.6% vs. 8.4%, respectively), a similar percentage of smokers from either province smoked on a daily basis. Daily cigarette consumption patterns were similar in each province and just over 40% of smokers reported they planned to quit smoking within the next six months.

On-reserve purchasing

Fig. 1 presents the model adjusted percentage of smokers who last purchased cigarettes from a First Nations reserve from 2002 to 2014. The temporal trend differed significantly between provinces ($p = 0.009$). While on-reserve purchases were relatively rare in 2002 and 2003 in both provinces, by 2006 (Wave 4), a significantly greater percentage of smokers last purchased cigarettes on reserve in Ontario compared to Quebec (FDR $p < 0.001$). For the remainder of the study, smokers from Ontario were significantly more likely to make their last purchase of cigarettes on reserve than smokers from Quebec (all FDR $p < 0.001$).

In Ontario, the prevalence of on-reserve purchasing was significantly higher in 2006 than in 2002 (FDR $p < 0.001$). On-reserve purchasing remained significantly higher in subsequent years compared to 2002 (all FDR $p < 0.001$). In Quebec, however, the prevalence of last purchasing on reserve peaked in 2006 and 2008 at 5.6%. By 2010, only 3.1% of smokers reported last purchasing on reserve, similar to the

Table 1
Characteristics of smokers from Ontario and Quebec participating in the ITC Canada Survey (2002–2014) at the time of recruitment.

	Ontario (n = 2105)		Quebec (n = 1427)	
	%	(Freq.)	%	(Freq.)
Sex				
Female	52.7	(1110)	54.1	(772)
Male	47.3	(995)	45.9	(655)
Age group				
18–24	11.4	(240)	11.8	(169)
25–39	28.9	(609)	29.8	(425)
40–54	37.1	(782)	36.4	(520)
55+	22.5	(474)	21.9	(313)
Ethnicity				
First Nations	3.7	(77)	1.4	(20)
Other	9.5	(200)	6.2	(88)
White	86.8	(1828)	92.4	(1319)
Household income				
Low	23.7	(498)	32.9	(469)
Moderate	32.6	(687)	37.9	(541)
High	35.8	(754)	20.4	(291)
Not reported	7.9	(166)	8.8	(126)
Education				
Low	43.1	(908)	51.6	(737)
Moderate	38.9	(819)	33.9	(484)
High	18.0	(378)	14.4	(206)
Wave of recruitment				
Wave 1	38.7	(815)	35.3	(504)
Waves 2 - 5	35.9	(756)	39.3	(561)
Waves 6 - 9	25.4	(534)	25.4	(362)
Time-in-sample*				
Mean (SD)	2.79	(2.09)	2.50	(1.98)
Smoking status				
Non-daily	7.6	(160)	7.1	(101)
Daily	92.4	(1945)	92.9	(1326)
Cigarettes/day				
31+	4.4	(92)	4.7	(67)
21–30	21.3	(449)	25.4	(363)
11–20	42.5	(895)	40.3	(575)
≤ 10	31.8	(669)	29.6	(422)
Product type				
RYO	1.6	(33)	8.5	(121)
FM or both	98.4	(2072)	91.5	(1305)
Plans to quit in next 6 months				
No plans	59.6	(1253)	57.5	(820)
Plans to quit	40.4	(849)	42.5	(605)

* Based on last wave of participation.

baseline percentage of 1.4% (FDR $p = 0.188$).

Geographic proximity and on-reserve purchasing

In both provinces, smokers who did not make their last purchase of cigarettes from a First Nations reserve lived further away from a reserve, on average, compared to smokers who did (Table 2). This was true across all survey waves. Among smokers who made their last purchase on reserve, the average distance between smokers' residences and the nearest reserve increased from Wave 1 (2002) to Wave 6 (2007/2008). This suggests that smokers living further away from reserves at the time of Wave 6 were more inclined to purchase cigarettes on reserve. This increase in average distance corresponds to the peak prevalence of on-reserve purchasing in both provinces. After 2008, the average distance between smokers' residences and the nearest reserve decreased among smokers who made their last purchase on reserve, suggesting that smokers living further away from a reserve were less inclined to purchase cigarettes from a First Nations reserve after 2008.

Table 2 also presents the average self-reported price paid for a standardized "pack" of 25 cigarettes among smokers who last purchased cigarettes on or off reserve. Prices were based on smokers' last purchase and reflect real prices adjusted to 2014 CAD. In Ontario, smokers who last purchased on reserve paid anywhere from \$1.81 to

\$6.25 less per pack over the course of the study compared to smokers purchasing off reserve. In Quebec, smokers purchasing on reserve faced similar cost savings, ranging from \$1.31 to \$6.68 per pack.

Separate logistic regression models were then estimated within each province to examine the effect of distance to the nearest reserve on the log odds of having last purchased cigarettes on reserve (Fig. 2). Province-specific models controlled for sociodemographic covariates and smoking characteristics. A wave X distance interaction effect was also included to test whether the effect of distance varied over time. There were significant interaction effects in both provinces, even after controlling for other factors ($p = 0.005$ in Ontario; $p = 0.016$ in Quebec).

In Ontario, a 10 km reduction in proximity to a First Nations reserve was associated with significantly increased odds of having last purchased cigarettes on reserve. While there was an association between proximity and on-reserve purchasing in every survey wave, the weakest effect was observed in Wave 6, when a 10 km reduction in proximity was associated with only 16% greater odds (aOR = 1.16; 95% CI: 1.05–1.28) of last purchasing on reserve (Fig. 2). This compares to adjusted odds ratios of 1.55 in Wave 1, 1.40 in Wave 8 and 1.46 in Wave 9. These findings suggest that in 2007/2008, smokers were willing to travel greater distances to purchase cigarettes on reserve than at other times.

This result is corroborated in Fig. 3, which presents the adjusted predicted marginal probability of last purchasing cigarettes on reserve as a function of proximity. From Wave 1 to Wave 3, there was only a small probability (< 5%) of purchasing on reserve among smokers living more than 25 km from a reserve in either province. By Wave 6, however, 25% of Ontario smokers living 25 km from a reserve were predicted to have last purchased cigarettes on reserve while as many as 14% of Ontario smokers living 75 km from a reserve were predicted to have done so. By Waves 8 and 9, a smaller percentage of Ontario smokers living further from a First Nations reserve were predicted to have last purchased on reserve (25% and 21% of smokers living 25 km from a reserve, respectively, and only 6% and 4% of smokers living 75 km from a reserve, respectively). Thus, in later waves, Ontario smokers living further away from a First Nations reserve were less likely to have last purchased cigarettes on reserve.

Different effects were observed in Quebec. In that province, proximity to reserves was associated with purchasing on reserve only in Waves 1, 2, and 8, where a 10 km reduction in distance was associated with 1.38 to 4.19 times the odds of last purchasing on reserve (Fig. 2). In the remaining waves, distance was not associated with purchasing on reserve. Fig. 3 demonstrates how the predicted probability of purchasing on reserve remained relatively constant irrespective of proximity to the nearest reserve.

Across all waves, other factors besides proximity were associated with last purchasing on reserve. In Ontario, income, cigarettes smoked/day, and intentions to quit smoking were associated with last purchasing cigarettes on reserves (all $p < 0.01$, Fig. 2). In that province, younger smokers had significantly lower odds of last purchasing on reserve compared to smokers aged 55 and older. Low- (aOR = 2.20; 95% CI: 1.57–3.08) and moderate- (aOR = 1.79; 95% CI: 1.33–2.40) income smokers had significantly higher odds of last purchasing on reserve compared to high-income smokers as did smokers who smoked more than 11 cigarettes per day (vs. 10/less). Smokers not planning to quit smoking in the next 6 months also had higher odds of last purchasing cigarettes on reserve relative to smokers who planned to quit in the next 6 months (aOR = 1.36; 95% CI: 1.13–1.65). In Quebec, other factors associated with last purchasing cigarettes on reserve were sex ($p = 0.002$), ethnicity ($p = 0.045$) and education ($p = 0.035$). Across all waves, male smokers had significantly greater odds of purchasing on reserve compared to female smokers (aOR = 2.34; 95% CI: 1.35–4.06). In addition, smokers of First Nations ancestry had significantly greater odds of purchasing on reserve compared to white smokers (aOR = 6.11; 95% CI: 1.46–25.51) as had the least educated smokers relative to the most educated smokers (aOR = 3.08; 95% CI: 1.10–8.56).

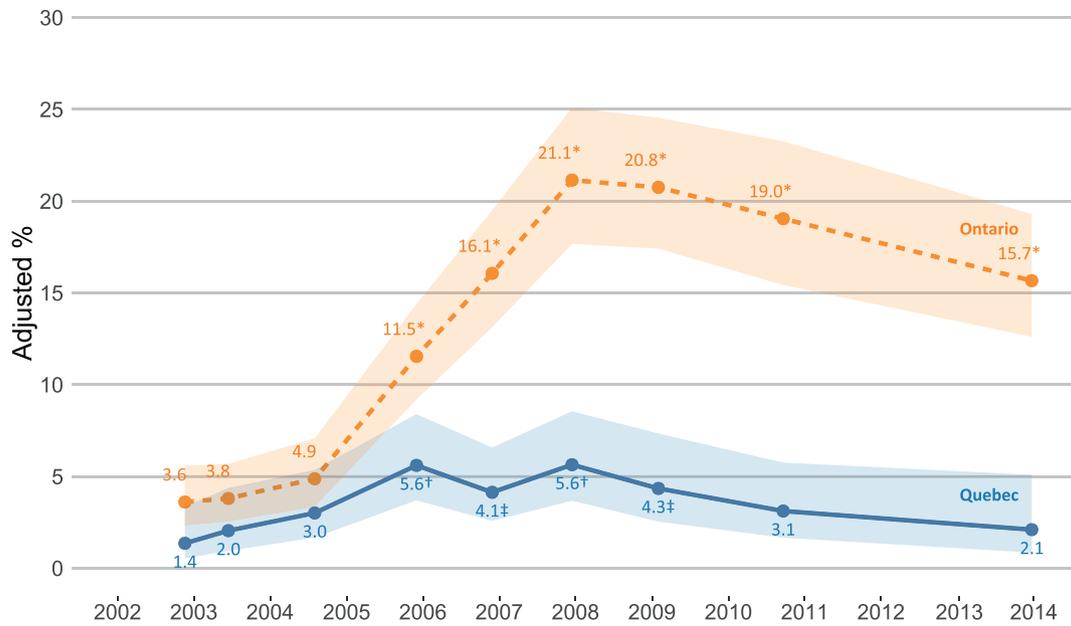


Fig. 1. Adjusted percentage of smokers last purchasing cigarettes from a First Nations reserve in Ontario and Quebec from 2002 to 2014 (n = 3532; *p < 0.001; †p < 0.01; and ‡p < 0.05 test the percentage in the given year against the baseline year *within province*, controlling for multiple comparisons using the false discovery rate). Shaded areas represent the 95% confidence interval. See Supplementary Table A3 for all GEE parameter estimates.

Attempts to quit smoking and on-reserve purchasing

The final set of logistic GEE models examined whether past-year attempts to quit smoking were associated with purchasing cigarettes from First Nations reserves. Controlling for other factors, smokers from Quebec who did not try to quit in the previous year were no more likely to purchase cigarettes from a reserve than smokers who did try to quit (p = 0.550, Table 3). In Ontario, however, there was a significant interaction between proximity and past-year quit attempts (p = 0.002).

Across all waves, the odds of purchasing from reserves decreased significantly the further smokers lived from reserves. For every 10 km increase in distance to the nearest reserve, smokers who did not try to quit had 0.79 times the odds of last purchasing on reserve (95% CI: 0.74, 0.85) while smokers who did try to quit had lower odds (aOR = 0.67 for a 10 km increase; 95% CI: 0.60, 0.74). Put another way, distance was less of a barrier for smokers who did not try to quit relative to those who did.

Table 2

Average distance (in km) between smokers' residential locations and the nearest First Nations reserve and average self-reported price paid per standardized "pack" of 25 cigarettes* by province and last purchase type (on/off reserve).

Wave (Year)	Ontario						Quebec					
	On reserve			Off reserve			On reserve			Off reserve		
	n	Mean	(SE)	n	Mean	(SE)	n	Mean	(SE)	n	Mean	(SE)
Distance (km) to Nearest Reserve												
1 (2002)	21	27.6	(4.09)	789	48.4	(0.87)	5	14.4	(2.96)	496	37.3	(1.47)
2 (2003)	29	27.0	(3.55)	739	47.5	(0.91)	5	10.8	(3.16)	426	38.9	(1.73)
3 (2004)	42	25.2	(3.17)	669	46.3	(0.97)	15	20.4	(4.65)	421	36.4	(1.69)
4 (2005/2006)	77	29.9	(2.53)	587	47.7	(1.07)	23	38.8	(5.13)	362	33.6	(1.45)
5 (2006/2007)	112	35.3	(2.53)	519	47.5	(1.14)	21	31.5	(4.61)	409	34.3	(1.50)
6 (2007/2008)	137	37.0	(2.29)	481	47.7	(1.20)	24	37.0	(6.59)	364	34.5	(1.57)
7 (2008/2009)	126	34.6	(2.54)	416	47.4	(1.24)	15	35.1	(5.72)	318	35.4	(1.83)
8 (2010/2011)	109	29.0	(2.18)	339	44.9	(1.52)	8	24.9	(3.43)	249	35.0	(1.94)
9 (2013/2014)	90	27.6	(2.31)	363	46.7	(1.35)	5	27.0	(5.04)	252	38.8	(2.73)
Average Price Paid/Pack*												
1 (2002)	17	6.22	(0.99)	763	8.03	(0.05)	4	4.50	(0.59)	443	7.83	(0.06)
2 (2003)	22	5.17	(0.45)	697	9.04	(0.05)	5	7.43	(1.61)	340	8.74	(0.11)
3 (2004)	39	5.54	(0.27)	639	9.31	(0.07)	13	4.95	(0.38)	378	8.69	(0.09)
4 (2005/2006)	64	4.56	(0.24)	572	9.28	(0.08)	14	3.18	(0.26)	324	8.63	(0.10)
5 (2006/2007)	97	3.72	(0.22)	491	9.40	(0.11)	16	2.99	(0.48)	364	8.60	(0.10)
6 (2007/2008)	112	3.38	(0.18)	443	9.25	(0.12)	12	2.06	(0.25)	317	8.55	(0.12)
7 (2008/2009)	97	3.15	(0.21)	387	9.40	(0.15)	8	2.05	(0.43)	277	8.73	(0.12)
8 (2010/2011)	90	4.05	(0.16)	315	9.67	(0.13)	5	4.16	(0.87)	213	8.19	(0.13)
9 (2013/2014)	82	4.10	(0.19)	319	9.56	(0.16)	5	2.28	(0.49)	206	8.68	(0.15)

* All prices are adjusted for inflation to 2014 Canadian dollars, where 1 CAD = 0.862 USD in the fourth quarter of 2014.

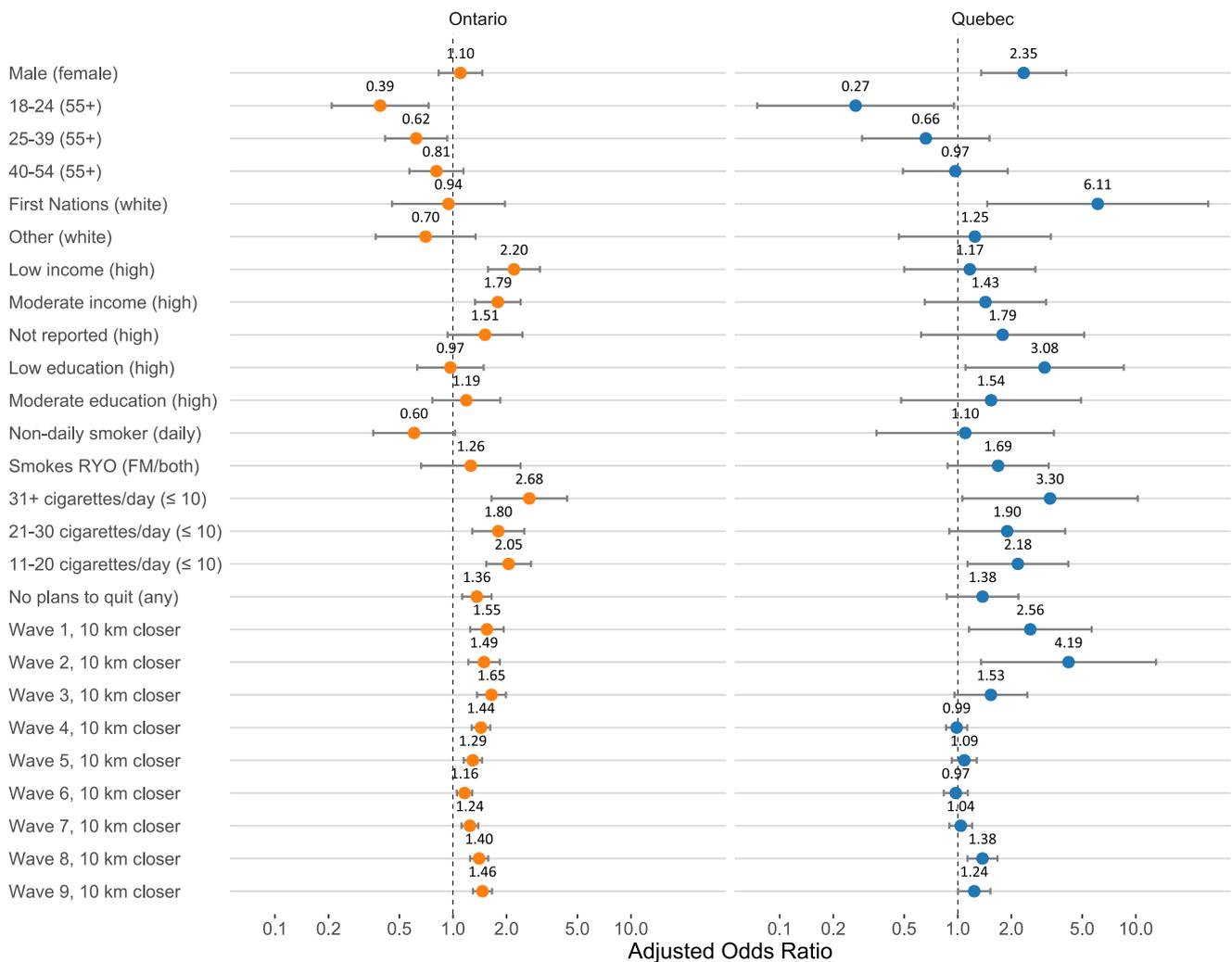


Fig. 2. Adjusted odds of last purchasing cigarettes from a First Nations reserve in Ontario (n = 2105) and Quebec (n = 1427) from 2002 to 2014. Odds ratios are adjusted for all factors shown, as well as the main effects of time-in-sample, distance, and survey wave (not shown). See Supplementary Table A2 for all GEE parameter estimates.

Discussion

The results of this longitudinal study of contraband purchasing among provincially representative samples of smokers from Ontario and Quebec demonstrate that potential access to low- and untaxed sources of cigarettes influences smokers’ purchasing behaviours. While the purchase of contraband cigarettes from First Nations reserves peaked in both provinces around 2008, such purchases were more prevalent among Ontario smokers from 2006 to 2014 compared to Quebec smokers. Moreover, potential access, as defined by the geographic distance between smokers’ residences and the nearest reserve, was consistently associated with a significantly increased likelihood of Ontario smokers purchasing contraband cigarettes from a reserve. While geographic proximity played almost no role in the purchasing behaviours of smokers from Quebec, the consistent effects over time among Ontario smokers corroborate existing cross-sectional research from the United States demonstrating a link between geographic proximity to low- and untaxed sources of cigarettes and purchasing behaviours (DeCicca et al., 2015; Hyland et al., 2005; Xu et al., 2014). In Ontario, potential savings of as much as \$6.25 CAD per pack (\$5.39 2014 USD) may more than offset any additional costs incurred by travelling to nearby reserves.

Over the course of the study, there were important differences between Ontario and Quebec in attempts to limit the availability of

contraband tobacco. As early as 2001, Quebec introduced ACCES Tabac, a program designed to limit the supply of contraband tobacco through concerted enforcement. Additional enforcement strategies implemented by the RCMP in 2008 may have helped maintain the relatively low prevalence of contraband purchasing in Quebec. As Sen (2017) notes, increased enforcement may have had some effect in reducing the availability of contraband tobacco in Quebec, which may partly explain the lack of a consistent association between geographic proximity and on-reserve purchasing in that province. These findings underscore the importance of minimizing the potential availability of contraband tobacco, thereby eliminating sources of low- and untaxed cigarettes for price-sensitive smokers who actively seek out lower-cost cigarettes.

On-reserve purchases peaked in 2008 in both provinces. At this time, smokers from Ontario were willing to travel greater distances to purchase cigarettes on reserve. Interestingly, the timing of these factors coincided with the beginning of the global financial crisis. While the effects of the economic downturn may not have yet been felt by smokers from Ontario at the beginning of the recession, it is possible that price-sensitive smokers attuned to prevailing economic conditions might be more inclined to seek out lower-cost cigarettes. If so, smokers might be willing to travel greater distances to obtain cheaper cigarettes, especially if the price of contraband products offset any additional travel costs.

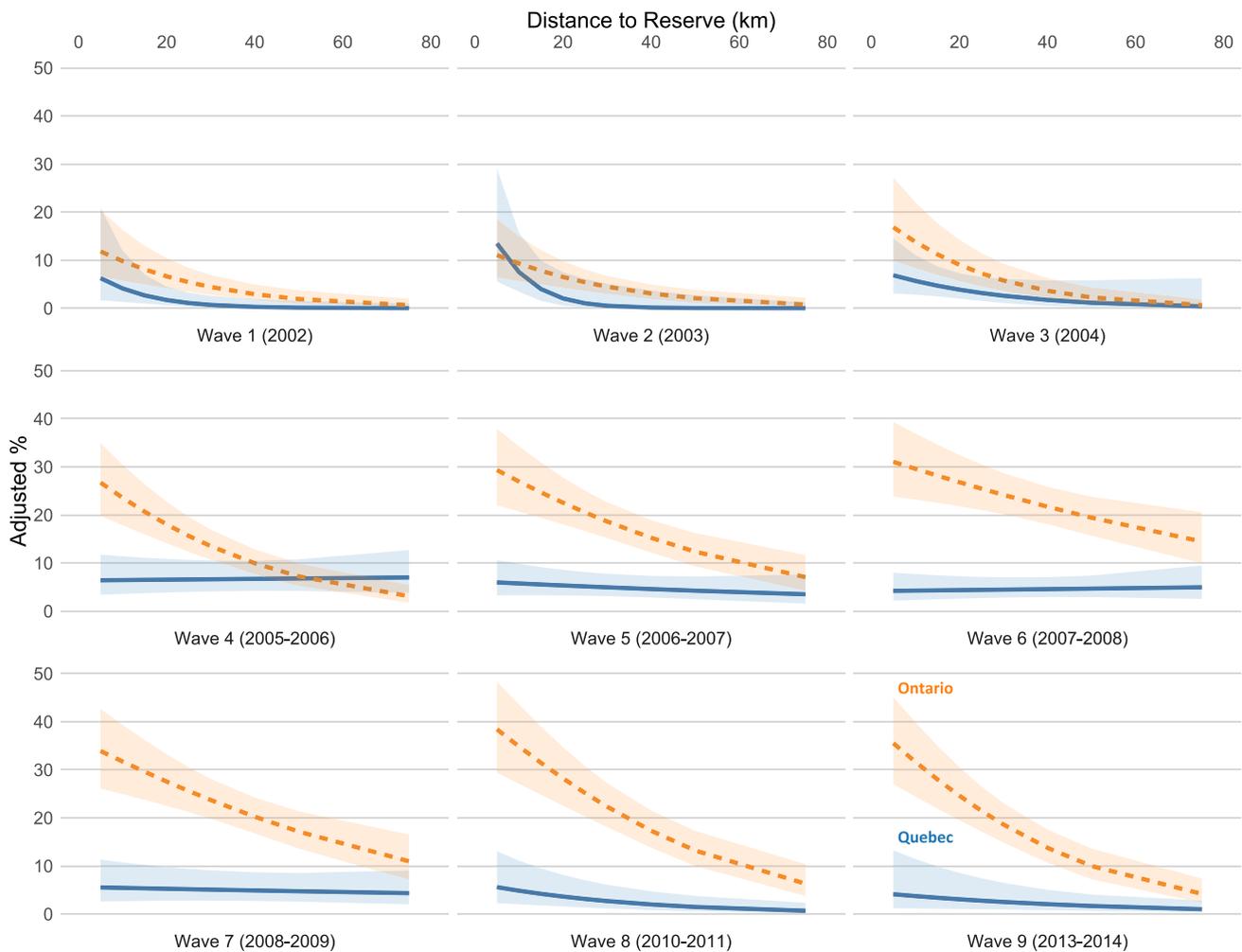


Fig. 3. Adjusted predicted marginal probability of smokers purchasing cigarettes from a First Nations reserve as a function of distance to the nearest reserve in Ontario and Quebec from 2002 to 2014 (n = 3532).

Attempts to quit smoking were also associated with last purchasing cigarettes on reserve, at least in Ontario. In that province, there was a significant interaction between proximity to the nearest reserve and whether smokers tried to quit smoking in the previous year. Specifically, living further from a reserve was less of a deterrent to purchasing from a reserve for smokers who did not actively try to quit in the previous year compared to smokers who did. It is plausible that smokers who did not actively try to quit in the previous year were more willing to travel further distances to purchase lower-cost cigarettes.

In light of these findings, additional research is needed to better understand how potential access to lower-cost cigarettes influences smokers' purchasing behaviours. In this study, geographic distance to First Nations reserves was used as a measure of potential accessibility to lower-cost cigarettes. However, the way in which smokers navigate their environments on a daily basis may further influence their purchasing behaviours. For example, while some smokers may live near sources of lower-cost cigarettes, if their daily travel patterns do not bring them into areas where they can readily purchase lower-cost cigarettes, they may not make such purchases. On the other hand, smokers who are less interested in quitting may be more inclined to travel longer distances to purchase lower-cost cigarettes. Novel activity-space research developed in the field of time geography may identify how smokers travel through their environments on a daily basis and whether specific travel behaviours influence cigarette purchasing behaviours (Rainham et al., 2010; Wang and Kwan, 2018). Such approaches may

also consider differences between smokers such as levels of addiction and willingness to quit and whether the effects of typical travel patterns are moderated by such differences. This approach has implications for the purchase of other substances including alcohol and cannabis.

Strengths and limitations

This study relied on a unique source of longitudinal data to assess temporal trends in the purchase of contraband tobacco from First Nations reserves among smokers from two different Canadian provinces where the use of contraband tobacco is most prevalent. As a result, this study could assess differences in trends between provinces. It was also possible to examine how potential access to contraband influences smokers' purchasing decisions. Geographic proximity was measured consistently over the entire study period for all survey respondents and used as a means to assess potential access to contraband cigarettes under the assumptions that smaller distances between smokers' residences and the nearest First Nations reserve represented greater accessibility to low- and untaxed sources of cigarettes. In Ontario, smokers' proximity to reserves consistently increased the odds of purchasing contraband cigarettes from reserves over the course of this 12-year study.

That said, this study has some limitations that must be considered. First, distance was treated as a continuous covariate in GEE models which assumes a monotonic linear relationship between distance and

Table 3

Odds of last purchasing cigarettes on reserve in Ontario* and Quebec† across all survey waves as a function of covariates and attempts to quit smoking in the previous year.

Covariate (reference)	Ontario (n = 2105)			p‡	Quebec (n = 1427)			p‡
	OR	(95% CI)			OR	(95% CI)		
Sex (female)								
Male	1.10	(0.83,	1.46)	0.517	2.32	(1.33,	4.04)	0.003
Age group (55 +)								
18-24	0.40	(0.21,	0.73)	0.014	0.25	(0.07,	0.92)	0.177
25-39	0.65	(0.43,	0.97)		0.65	(0.28,	1.50)	
40-54	0.83	(0.59,	1.17)		0.93	(0.46,	1.87)	
Ethnicity (White)								
First Nations	1.00	(0.47,	2.14)	0.672	7.37	(1.77,	30.69)	0.022
Other	0.74	(0.38,	1.44)		1.27	(0.48,	3.34)	
Income (high)								
Low	2.29	(1.64,	3.19)	< 0.001	1.29	(0.56,	2.98)	0.78
Moderate	1.75	(1.31,	2.36)		1.42	(0.66,	3.06)	
Not reported	1.53	(0.95,	2.46)		1.63	(0.56,	4.79)	
Education (high)								
Low	0.99	(0.65,	1.52)	0.442	2.92	(1.03,	8.33)	0.058
Moderate	1.20	(0.78,	1.85)		1.56	(0.48,	5.11)	
Smoking status (daily)								
Non-daily smoker	0.63	(0.37,	1.07)	0.086	1.16	(0.36,	3.78)	0.805
Smokes RYO/FM (FM/both)								
Smokes RYO	1.19	(0.62,	2.27)	0.608	1.71	(0.90,	3.23)	0.101
Cigarettes/day (≤ 10)								
31 +	2.76	(1.71,	4.45)	< 0.001	3.24	(0.99,	10.62)	0.151
21-30	1.80	(1.28,	2.52)		1.84	(0.83,	4.06)	
11-20	2.05	(1.54,	2.74)		2.18	(1.07,	4.41)	
Quit intentions (within 6 months)								
No plans to quit	1.23	(1.02,	1.50)	0.032	1.35	(0.85,	2.17)	0.207
Past-year attempts to quit (any attempt)								
No attempt to quit			N/A		1.16	(0.71,	1.88)	0.550
Distance to reserve								
10 km increase			N/A		0.90	(0.81,	1.00)	0.045
Past-year quit attempts X distance								
Did not try vs. tried X 10 km increase	1.19	(1.15,	1.22)	0.002				N/A
10 km increase, if tried to quit	0.67	(0.60,	0.74)	< 0.001				N/A
10 km increase, if did not try	0.79	(0.74,	0.85)	< 0.001				N/A

N/A = not applicable

* **Notes:** Separate GEE logistic regression models were estimated for Ontario and Quebec. Odds ratios for time-in-sample and survey wave were excluded for brevity. For the Ontario sample, the past year quit attempts X distance interaction effect was statistically significant (p = 0.002). See Supplementary Table A3 for all GEE parameter estimates.

† For the Quebec sample, estimated odds ratios were from a main effects model only. The past year quit attempts X distance interaction effect was not statistically significant (p = 0.077). See Supplementary Table A3 for all GEE parameter estimates.

‡ ‡Wald χ^2 omnibus test

the likelihood of last purchasing cigarettes on reserve. Since this is a strong assumption, a sensitivity analysis was conducted to examine the effect of distance as a categorical measure using different classification schemes (supplementary Table A4). In Ontario, the adjusted predicted marginal probability of last purchasing on reserve decreased as distance to the nearest reserve increased. This was true irrespective of the classification scheme used. In Quebec, distance had little effect on the probability of last purchasing on reserve. In both provinces, the overall main effect of distance under each classification scheme was broadly consistent with the wave-specific effects displayed in Fig. 3. Thus, while a linear relationship is a strong assumption, it seems reasonable for these data.

Second, not all respondents provided valid postal code information; as a result, some smokers were excluded from the analysis. However, valid postal code information was provided by almost 99% of respondents, therefore any bias resulting from the exclusion of these smokers should be minimal.

Another bias to consider is that postal codes were used to identify smokers' residential locations in order to compute the geographic distance between smokers and the nearest reserve. In Canada, postal codes are only approximate indicators of residential location. Moreover, postal codes are more accurate in urban areas than rural areas, because rural postal codes span much larger land areas than urban postal codes.

While 80% of smokers included in this study were from urban areas, including an urban/rural covariate in GEE models estimating the effect of distance on purchasing from a First Nations reserve had no discernible influence on estimated odds ratios.

Another factor possibly affecting the accuracy of computed distances is that they were computed to the centroid of the nearest First Nations reserve, not to the exact location where cigarettes were purchased. Furthermore, distances were approximate because they were calculated as Euclidean distances, rather than actual distance travelled. What is more, distance effects were included in GEE models as linear effects while the exact functional relationship between distance and the probability of last purchasing cigarettes on reserve may be non-linear. However, the results reported here clearly demonstrate that when contraband tobacco is readily available, as in Ontario during the study period, potential access, as measured by approximate physical distance to contraband sources, clearly influences smokers' purchasing behaviours.

Computed distances also assume that smokers travel from their homes to reserves to purchase cigarettes. It does not account for their daily travel patterns, such as trips to work which may bring them in closer proximity to a reserve. Computed distances also assumed that contraband cigarettes were available from all reserves which likely does not reflect the true availability of contraband.

Finally, some on-reserve cigarette purchases may have been legitimate purchases. Specifically, Indigenous people, having status as per the Canadian Indian Act, may legally purchase tobacco on reserves. In order to examine whether potentially legitimate purchases of on-reserve cigarettes influenced the results, a sensitivity analysis was conducted that excluded all respondents of First Nations ancestry ($n = 77$ in Ontario and $n = 20$ in Quebec). In both provinces, these exclusions had almost no effect on the estimated odds of last purchasing contraband cigarettes on reserve as a function of distance to the nearest reserve (compare Fig. 2 to Supplementary Figure A1).

Conclusion

In conclusion, this study demonstrates that the purchase of contraband tobacco from First Nations reserves was more prevalent among smokers from Ontario than among smokers from Quebec from 2006 to 2014. As early as 2001, the province of Quebec introduced measures to curb the availability of contraband tobacco whereas Ontario did not. The potential availability of contraband tobacco in Ontario seems to influence the purchasing behaviours of some price-sensitive smokers in that province. In particular, geographic proximity to potential sources of contraband on First Nations reserves was strongly associated with smokers' purchasing behaviours in Ontario over a 12-year period while unrelated to smokers' purchasing behaviours in Quebec. The effect of geographic proximity to potential sources of contraband was further moderated by attempts to quit smoking in Ontario, such that increasing distance was less of a deterrent of last purchasing on reserve among smokers who did not try to quit in the previous year compared to smokers who did. In the absence of policies limiting the availability of lower-cost cigarettes, these findings point to the need to better understand how price-sensitive smokers may travel through their environments and how these travel behaviours might influence purchasing behaviours.

In order for tobacco taxation policies to achieve maximal benefit for all smokers, it is important for governments to limit potential sources of lower-cost cigarettes that price-sensitive smokers might rely on to continue smoking. In some Canadian provinces, provincial governments actively partner with First Nations communities to ensure the prices of tobacco products sold on-reserve are consistent with those sold off-reserve. In Manitoba, for example, tobacco products sold on-reserve are subject to a tobacco tax equal to the province tobacco tax, and First Nations communities in that province are allowed to keep the revenue generated by those taxes (Canadian Cancer Society, 2017). By partnering with First Nations communities, provincial governments may be able to limit potential sources of lower-cost cigarettes. From an international perspective, such collaborative governance can be an effective way to minimize cigarette price differentials between countries, especially in the European Union, where smokers may travel between nations with relative ease in order to purchase lower-cost cigarettes across national borders.

Funding

The Canada arm of the ITC Four Country Survey was supported by grants from the US National Cancer Institute/NIH (R01 CA100362, R01 CA090955, P50 CA111236 (Roswell Park Transdisciplinary Tobacco Use Research Center), and P01 CA138389), the Canadian Institutes of Health Research (MOP-57897, MOP-79551, MOP-115016), and the Canadian Tobacco Control Research Initiative (014578). Geoffrey T. Fong was supported by a Senior Investigator Grant from the Ontario Institute for Cancer Research and a Senior Prevention Scientist Award from the Canadian Cancer Society Research Institute. G. Emmanuel Guindon holds the Centre for Health Economics and Policy Analysis (CHEPA)/Ontario Ministry of Health and Long-Term Care (MOHLTC) Chair in Health Equity, an endowed Chair funded in part by the MOHLTC and an Ontario Ministry of Research, Innovation and Science,

Early Researcher Award. None of the funding sources had any involvement in study design, data collection, interpretation of results, in the writing of this manuscript, nor in the decision to publish this manuscript.

Conflicts of Interest

Geoffrey T. Fong and David Hammond have served as expert witnesses on behalf of governments in litigation involving the tobacco industry. All other authors have no competing interests to declare.

CRediT authorship contribution statement

Pete Driezen: Conceptualization, Methodology, Formal analysis, Visualization, Writing - original draft, Writing - review & editing. **G. Emmanuel Guindon:** Conceptualization, Methodology, Writing - review & editing. **David Hammond:** Methodology, Writing - review & editing. **Mary E. Thompson:** Funding acquisition, Methodology, Writing - review & editing. **Anne C.K. Quah:** Project administration, Writing - review & editing. **Geoffrey T. Fong:** Funding acquisition, Methodology, Writing - review & editing.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at [10.1016/j.drugpo.2019.102612](https://doi.org/10.1016/j.drugpo.2019.102612)

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