Evaluating a real world ban on menthol cigarettes: an interrupted time series analysis of sales.

Michael Chaiton, Robert Schwartz, Jennifer Shuldiner, Gabrielle Tremblay, Robert Nugent

Author Affiliations:

Ontario Tobacco Research Unit, Ontario, Canada (Michael Chaiton, Robert Schwartz, Jennifer Shuldiner); Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada (Michael Chaiton, Robert Schwartz, Jennifer Shuldiner);Office of Research and Surveillance, Tobacco Control Directorate, Health Canada (Gabrielle Tremblay, Robert Nugent)

Corresponding Author:

Michael Chaiton
Ontario Tobacco Research Unit
155 College St.
Toronto, Ontario, M5T 3M7
Tel: 416-978-7096
Fax: 416-595-6068
email: Michael.chaiton@utoronto.ca

Abstract

Background: Menthol in cigarettes has been shown to increase regular cigarette smoking and nicotine dependence, and decrease success in smoking cessation. Due to these reasons, in May 2015, the Province of Ontario introduced a menthol ban on tobacco products that came into effect in January 2017 prior to a Federal Canadian Ban in October 2017. The objective of this paper is to assess the effect of a provincial menthol ban on cigarette wholesale sales in Ontario.

Methods: Wholesale data submitted by tobacco manufacturers to Health Canada pursuant to the federal *Tobacco Reporting Regulations* from October 2012- September 2017 was analyzed using interrupted time series analysis. Changes in sales of cigarettes with and without menthol were estimated, using the province of British Columbia as a comparison. Analyses were seasonally adjusted.

Results: Sales of menthol and non-menthol cigarettes increased from 2013 until the implementation of the 2017 provincial ban. Subsequently, a sharp decline of 55 million menthol cigarettes and 128 million total cigarettes was observed in Ontario. As a comparison, no significant changes were observed in British Columbia.

Conclusion: This study supports the conclusion that implementation of a menthol ban in Ontario was associated with significant reduction of menthol cigarette sales and total cigarettes sales, compared to British Columbia where there was no provincial menthol ban. This suggests that menthol regulations in jurisdictions with a larger percentage of menthol smokers are likely to be highly effective.

Implications

The 2017 menthol ban was associated with significant reduction of menthol cigarette sales and total cigarette sales suggesting that menthol regulations will have important effects on cigarette consumption.

BACKGROUND

Menthol in cigarettes has been shown to increase regular cigarette smoking and nicotine dependence, and decrease success in smoking cessation[1,2]. On January 1st, 2017, the Province of Ontario implemented a ban on all use of menthol in tobacco products[3]. A Canada-wide federal menthol ban was then implemented in October 2017, banning the use of menthol in cigarettes, blunt wraps and most cigars sold in Canada[4]. Menthol sales comprised approximately 5% of cigarette sales in Canada in 2015 [5-7], in comparison, menthol sales are estimated to be about 25% of tobacco products[8] and 30% of the cigarette market in the US [1,9].

In the United States, the US Food and Drug Administration (FDA) is currently assessing the potential benefits of regulating menthol in cigarettes, and their advisory committee concluded that the "removal of menthol cigarettes from the marketplace would benefit public health"[1,9]. Other countries, including Brazil, Ethiopia, Turkey, and the European Union, have introduced menthol cigarette bans and restrictions along with partial bans in the city of Chicago, San Franscico, and potentially New Jersey among other juridictions[10-12].

There is very little data looking at the effectiveness of menthol bans[13]. Therefore, to investigate the impact of the 2017 menthol ban in Ontario, this study uses wholesale sales data to examine trends in menthol sales in Ontario and uses the province of British Columbia, which did not implement menthol legislation, as a comparator during the period of October 2012- September 2017. British Columbia (2016 population of 4.6 million) is the province with the lowest smoking prevalence in Canada (**10.2% in 2015 compared to 11.3% in Canada for ages 15+)** but shares some similar demographic characteristics with Ontario (2016 population of 14.0 million) such as high immigrant population and a robust economy **and have a similar age distribution in the 16-65 age range.**[14,15]

METHODS

Data source

The data used for this study is from wholesale sales data that is reported to Health Canada. Manufacturers are required to report by province, each brand of tobacco product, the number of units sold, package sizes, as well as the value of the units sold pursuant to the *Tobacco Reporting Regulations* (TRR) *(Tobacco Reporting Regulations*, SOR/2000-273*)*. Cigarette sales are reported on a monthly basis and returns to companies from wholesalers and retailers are reported as negative values. All data are subject to future review as a result of re-submissions by companies and audits by Health Canada.

Statistical analysis

Sales data were merged into a master database using Stata 14. For each month, net unit sales by product type (menthol, non-menthol, all cigarettes) in Ontario and British Columbia were calculated for the period October 1, 2012 to September 30th, 2017—a total of 80 monthly periods. To provide comparability between the provinces, the wholesale sales were centred at baseline in October 2012 and divided by 1,000,000. **Starting values in October 2012 were 300 million non menthol and 17 million menthol cigarettes sold per month in British Columbia, and 1 billion non menthol cigarettes and 44 million menthol cigarettes sold per month in Ontario.**

This study uses an interrupted time series design to assess the 2017 regulations using aggregate monthly sales using the program ITSA.[16,17]

The basic model was:

$$Yt = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

Where t is the time since October 2012, X_t is an indicator variable representing the intervention, β_0 represents the starting level of cigarette sales in British Columbia, $\beta_1 T_t$ is the slope or trajectory of sales until the introduction of regulations in British Columbia, $\beta_2 X_t$ represents the change in the level of sales that occurs in the month immediately following the regulations (compared to the counterfactual without regulations) in British Columbia, and $\beta_3 X_t T_t$ represents the difference between the pre intervention and post intervention slopes or trajectories in British Columbia. Z is an indicator for Ontario, so that $\beta_4 Z$ and $\beta_5 Z T_t$ represent the difference in level and trend between Ontario and British Columbia at baseline, and $\beta_6 Z X_t$ and $\beta_7 Z X_t T_t$ represents the differences in Ontario post intervention. The magnitude and confidence intervals of β_6 estimate the immediate association of the regulation in Ontario, and β_7 for the treatment effect over time.). Dummy variables representing each month were added to control for seasonality. Newey-West robust standard errors were used to control for autocorrelation.

RESULTS

Figure 1 displays trends in unit sales of menthol, non-menthol and all cigarettes in Ontario, and in British Columbia for comparison. Data are displayed as raw unit sales for each month from 2012 to 2017. Sales of menthol cigarettes increased from 2013 until the implementation of the 2017 provincial ban with sharp increases in sales over the period of 2016. Sales of menthol cigarettes (decline of 15%; Beta=-17.9; 95% CI: -35.2. 71.0); non-menthol cigarettes (increase of 1%; beta=7.5; 95% CI: -49.8, 64.7); and overall sales (1% decline; Beta=-17.9; 95% CI: -35.2. 71.0) are consistent with the absence of an intervention in the control province British Columbia.

In contrast, a sudden decline was observed in menthol sales in Ontario with the model attributing a decline of 55.0 million cigarettes (95% CI: --78.5, -31.5) (See Table 1**) as sales of menthol cigarettes fell to approximately 0 after the ban**. The model-based estimate suggests a non-significant decline of 4% of

non-menthol sales associated with the implementation of the ban in Ontario (Beta=-72.8; 95% CI: -155.6, 10.0); Figure 1 and Table 1). Overall, sales of all cigarettes fell by 127.8 million cigarettes (95% CI: -208.2, -47.4) **or 11% of all sales.** However, there was a significant increase in the sales of all cigarette and non-menthol cigarettes in Ontario after the ban, suggesting a slight rebound effect.

DISCUSSION

This study supports the conclusion that implementation of a ban restricting the sale of menthol cigarettes in Ontario was associated with significant reduction of menthol cigarette sales and total cigarettes sales, using British Columbia as a comparator. As expected, the ban was successful at eliminating legal sales of menthol cigarettes; furthermore, the ban was associated with an overall change on sales of cigarettes in Ontario. This change was consistent with the levels of sales of menthol cigarettes prior to the **ban but may have also affected smokers who did not use menthol or used menthol rarely**.

The increase in sales of menthol prior to the ban may have been due to the introduction of cigarettes brands that contained a novel menthol breakable "capsule".[16] These products were advertised in at least one instance to be used to help smokers transition from menthol to regular cigarettes. These results are consistent with Chaiton *et al*.[13] which show that 29% of menthol smokers made quit attempts in Ontario after the ban. The observed decrease in menthol cigarette sales after the ban and the evidence of some rebound effect is **consistent with high levels of quitting** behaviour followed by some level of relapse.

Other aspects of the model support the hypothesis that the menthol cigarette ban affected cigarette sales. The lack of a significant effect, among non-menthol cigarettes post intervention suggests that the impact was menthol specific. There was also no effect on level or trend post intervention in British

Columbia suggesting that the effect was Ontario-specific. Similarity in baseline trends between Ontario and British Columbia suggests comparability between the two provinces.

Contraband sales are not included in these figures. **Estimates suggests that approximately 11.5% of Canadians had purchased tax-evaded cigarettes.**[14] Smoking behaviour studies suggest that the smokers who were purchasing menthol cigarettes from contraband sources after the implementation of the ban had been previously purchasing from these sources.[13] A tax increase in Ontario effective April 28th, 2017 may have influenced tobacco use during the period of the study. **Furthermore, a temporary decline may be due to retailers and smokers stockpiling menthol cigarettes in advance of the ban.** Additionally, a limitation of this study is that the menthol smoking population in Canada **differs from the menthol smoking population compared to the United States as menthol smoking is much less prevalent than in the United States, most menthol smokers in Canada are white, and that most smokers who use menthol do so only occasionally rather than using menthol as their primary brand.**[7] Because of the greater percentage of menthol cigarette use in the US, it is expected that a ban would have a greater effect.

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Declarations of Interests RN and GT are employed by Health Canada who is responsible for the administration of the menthol cigarette regulations.

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Table 1. Interrupted time series regression results for the 2017 menthol ban in Canada. Outcome wholesale sales of cigarettes (millions of units) per month, total and by brands with or without menthol descriptors. Sales levels centred on October 2012 baseline. N=160.

	All Cigarettes (B, 95% CI)	Non-Menthol Cigarettes (B, 95% CI)	Menthol Cigarettes (B, 95% CI)
BC initial level (2012 October) β_0	-32 [-65.7,1.8]	-24.6 [-57.3,8.0]	-7.9 [-15.9,0.1]
BC pre Intervention trend $\beta_1 T_t$	-0.5 [-1.3,0.3]	-0.9* [-1.7,-0.1]	0.4* [0.1,0.7]
ON difference in baseline level vs BC	-15.9 [-63.8,31.9]	-14.6 [-58.8,29.6]	-0.1 [-11.2,10.9]
ON difference in baseline trend vs BC	-1.0 [-2.5,0.4]	-1.1 [-2.5,0.3]	0 [-0.5,0.6]
BC post intervention level change $\beta_2 X_t$	17.9 [-35.2,71.0]	7.5 [-49.8,64.7]	10.5 [-4.4,25.3]
BC post intervention change in trend $\beta_3 X_t T_t$	-4.3 [-14.0,5.3]	-2.8 [-13.1,7.5]	-1.6 [-4.0,0.8]
ON difference in post intervention level vs BC	-127.8** [-208.2,-47.4]	-72.8 [-155.6,10.0]	-55.0*** [-78.5,-31.5]
ON difference in post intervention change in trend vs BC	23.0*** [10.3,35.6]	23.8*** [10.2,37.4]	-0.8 [-2.9,1.3]

* p<0.05,** p<0.01,*** p<0.001
Implementation date of regulation: January 1st, 2017
All analyses control for seasonality by month.
ON=Ontario, BC=British Columbia

Figure 1: Menthol, non-menthol and cigarette sales in net wholesale per quarter Ontario and British Columbia, October 2012- October 2017 with model predicted sales. Intervention date is January 1st, 2017. All analyses control for seasonality by month. Sales are wholesales sales difference from wholesale sales in October 2012. Sales levels centred on October 2012 baseline.