


Ban on menthol-flavoured tobacco products predicts cigarette cessation at 1 year: a population cohort study

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ABSTRACT

Objectives The province of Ontario, Canada, banned the use of menthol-flavoured tobacco products as of 1 January 2017. The long-term impact of a menthol ban on smoking behaviour has not been previously evaluated.

Methods Population cohort study with baseline survey conducted September–December 2016 and follow-up January–August 2018 among residents of Ontario, Canada, 16 years old and over who reported current smoking (past 30 days) at baseline survey and completed follow-up (n=913) including 187 reporting smoking menthol cigarettes daily, 420 reported smoking menthol cigarettes occasionally, and 306 were non-menthol cigarette smokers. Relative rates of making a quit attempt and being a non-smoker at follow-up were estimated with Poisson regression controlling for smoking and demographic characteristics at baseline.

Results At follow-up, 63% of daily menthol smokers reported making a quit attempt since the ban compared with 62% of occasional menthol smokers and 43% of non-menthol smokers (adjusted relative rate (ARR) for daily menthol smokers compared with non-menthol smokers: 1.25; 95% CI 1.03 to 1.50). At follow-up, 24% of daily menthol smokers reported making a quit since the ban compared with 20% of occasional menthol smokers and 14% of non-menthol smokers (ARR for daily menthol smokers compared with non-menthol smokers: 1.62; 95% CI 1.08 to 2.42).

Conclusions The study found higher rates of quitting among daily and occasional menthol smokers in Ontario 1 year after the implementation of a menthol ban compared with non-menthol smokers. Our findings suggest that restrictions on menthol may lead to substantial improvements in public health.

INTRODUCTION

Menthol is a flavouring agent added to cigarettes that masks the taste of tobacco, induces sensory effects and recruits and retains smokers.^{1–3} The Food and Drug Administration (FDA),⁴ the Tobacco Products Scientific Advisory Committee (TPSAC)⁵ and the WHO⁶ independently examined the evidence on the health rates of menthol cigarettes and produced separate reports. The FDA report concluded that ‘menthol cigarettes pose a public health rate above that seen with non-menthol cigarettes’, and removing them from the market would be of public health benefit.⁴ WHO made similar recommendations of ‘banning the use of menthol and its analogues, precursors or derivatives in cigarettes and possibly all tobacco products’.⁶

The FDA noted in their scientific evaluation that menthol has a physiological impact on smoking that increases initiation and progression to regular cigarette smoking, increases nicotine dependence and decreases smoking cessation success.⁴ These findings were consistent across three independent reports (TPSAC report, FDA report and a 2017 systematic review by Villanti *et al.*).^{4,5,7} Further, the FDA report found that menthol smoking patterns differed by subpopulation.⁴ For instance, younger populations, women and black Americans were more likely to smoke menthol cigarettes.⁴ These menthol smoking patterns among subpopulations perfectly matched the targeted marketing strategies employed by the tobacco industry.⁴

Although there are strong recommendations for banning menthol tobacco products, very few countries have banned menthol cigarettes.^{8,9} Canada has implemented a new national ban to address rates of menthol cigarette use among youth.¹⁰ Other nations such as Brazil, Ethiopia, Turkey and the European Union have passed regulations to ban menthol tobacco products.^{8,9} In the USA, the FDA has announced intentions to regulate the sale of menthol in tobacco.¹¹ San Francisco has already banned the sale of menthol cigarettes and other tobacco products with flavours and many other local and state jurisdiction have or are considering implementing restrictions.^{12–14} Evaluating the impact of a menthol ban could inform the implementation of restrictions in other jurisdictions.

Several studies that have attempted to estimate the behavioural intentions following a menthol ban found that between 35% and 66% of current menthol smokers in the USA stated they would quit if there was a menthol ban.^{15–17} Further, a simulation study was conducted to predict the effects of a hypothetical menthol ban in the USA on smoking prevalence and smoking-attributable deaths 40 years forward—to the year 2050.¹⁸ Data from the 2003 Tobacco Use Supplement to the Current Population Survey were used, and three plausible parameters or ‘scenarios’ were considered for the proportion of smokers who would permanently quit after a hypothetical menthol ban and the proportion of individuals who would have initiated as menthol smokers but do not initiate as a result of the ban (ie, 10%, 20% or 30%).¹⁸ The simulation study predicted that there would be between 4.8% and 9.7% relative reduction in smoking prevalence 40 years after a hypothetical menthol ban when compared with the prevalence in the absence of a menthol ban

and between 323 000 and 633 000 smoking-attributable deaths could be avoided.¹⁸ The largest projected relative reduction was among black Americans (24.8%).¹⁸ Regardless of the scenario, a menthol ban was associated with a notable reduction in smoking-related deaths.¹⁸

The TPSAC menthol report (2011) also modelled the public health impact of a menthol ban 40 years forward to the year 2050 by comparing the status quo (ie, USA 2010 patterns of menthol and non-menthol smoking) to a counterfactual scenario without the availability of menthol cigarettes.⁵ Based on the TPSAC best estimates, there were an estimated 327 565 cumulative excess deaths by 2050 associated with the availability of menthol cigarettes.⁵ Although the results from the Mendez modelling in the TPSAC report and Levy *et al* were based on different models and assumptions, they both showed similar estimates of a 10% effect for the potential impact of a menthol ban.^{5 18}

In Canada, menthol sales are less prevalent than in the USA, accounting for only about 5% of the cigarette sale market, whereas in the USA, 35% of all cigarettes sold are mentholated.^{19–21} Among Canadians age 15 and older in 2015, more than one-third (35.3%) of all respondents said they had ever smoked a menthol cigarette; 1.6% of all respondents had smoked one in the past 30 days.²² Similar to the USA,⁷ a considerable number of Canadian youth report smoking menthol cigarettes.^{10 21} According to the 2010–2011 Canadian Youth Smoking Survey, as many as 32% of current cigarette smokers used menthol cigarettes, and in the 2012–2013 iteration, almost 15% of students from grades 10–12 reported using flavoured tobacco (including menthol products).¹⁰

The concerns over the health effects of flavoured tobacco products led the Canadian government to limit flavoured tobacco, but this legislation did not include mentholated products. However, on 1 January 2017, a year after the Canadian legislation on flavoured tobacco products, the province of Ontario implemented a ban on menthol-flavoured tobacco products. Shortly after the ban, a population-wide evaluation of smoking behaviour in Ontario was conducted.¹⁹ The study compared the planned behaviour of menthol smokers before the ban with their actual behaviour 1 month postban and found that a greater percentage of menthol smokers attempted to quit after the ban than had planned before the ban.¹⁹ This suggests that the ban substantially increased quit attempts in the short duration after the ban; however, the long-term impact of the menthol ban is not known. It is uncertain what the long-term effects of the ban on smoking behaviour will be given that we have seen the tobacco industry change its tactics to prepare consumers for the menthol ban.²³ Therefore, this study aims to estimate the effect of the menthol ban on smoking behaviours more than 1 year after the ban.

METHODS

Study sample

This study was based on a cohort of Ontario residents, ages 16 and over, who were current smokers at baseline (ie, past month smokers) before the ban. Participants at baseline were recruited between September and December 2016 through random digit dialling of Ontario smokers (n=1026), plus a supplemental convenience sample of past year smokers (n=772). For the telephone sample, a simple single stage sampling design without stratification was used to randomly select Ontario residential telephone numbers from a commercial telephone list. The next birthday method was used to select the individual in the household over 16 who spoke English. Participation rate for

the Random Digit Dial was 44% with 6.7% refusal rate among known eligible participants. Smokers from the convenience sample were recruited through an email invitation. Participants were contacted at 1 year after the implementation of the menthol ban to complete an online survey. Participants who did not complete the online survey or did not have online access were interviewed by telephone. The online follow-up survey was conducted between January and August 2018 to examine smoking behaviour changes, with complete data on 913 participants. The subset of past year menthol smokers at baseline also completed a follow-up survey January–March, 2017. An analysis comparing those with complete data compared with the baseline sample found that the complete sample varied by menthol status, education and convenience or telephone sample (see online supplementary appendix).

Measures

At baseline, participants reported the past year use of menthol cigarettes as ‘every day’, ‘occasionally’, ‘on rare occasions’ or ‘not at all’. Menthol cigarette use was categorised into three categories: (1) ‘non-menthol users’ defined as participants who had not used menthol cigarettes in the past year; (2) ‘daily menthol users’ defined as people who used menthol cigarettes daily in the past year and were daily or almost daily users and (3) ‘non-daily (occasional) menthol users’ defined as people who used menthol occasionally or rarely in the past year. At the follow-up interview, participants reported their current use of menthol or non-menthol cigarettes (‘every day’, ‘almost every day’, ‘occasionally’, ‘not at all’). An answer of ‘not at all’ for menthol and non-menthol smoking was deemed to represent quitting smoking (outcome of interest). The secondary outcome was quit attempt, defined as self-reporting making a serious quit attempt since the beginning of the menthol cigarette ban in January 2017 (‘Since 1 January 2017, have you made a serious attempt to quit smoking? By serious, we mean that you made a conscious attempt to stay off cigarettes for good’). All those who reported not smoking at follow-up were considered to have made a quit attempt. The use of e-cigarettes or cigars since the ban was assessed. Variables that were collected during the baseline survey included age, sex (male, female, other), education (‘some elementary or some high school’, ‘completed high school’, ‘some community or technical college’, ‘completed community or technical college’, ‘some university’, ‘completed university’, refused), race (white, Asian, black, Latin American, Arab, Aboriginal, multiple cultural backgrounds, refused, other) and the number of cigarettes smoked per day on days that they smoked.

Statistical analysis

Proportions with corresponding 95% CIs and the Pearson’s χ^2 test were used to describe the study sample. Separate crude and adjusted Poisson regression models were performed for the primary outcome point prevalence ‘quit’ and for the secondary outcome ‘quit attempt’. All Poisson regression were estimated with robust SEs. Models were adjusted for baseline age, sex, education, race, as well as baseline number of cigarettes per day, baseline report of daily or non-daily smoking, use of e-cigarettes or cigars since the ban, survey source (ie, RDD or convenience sample) and the number of days between the baseline and follow-up survey. Sensitivity analyses examined subpopulation estimates stratified by sex, age group (under the age of 30 and age 30 and above), race (white vs non-white), daily versus non-daily smoking and time of follow-up after implementation of the menthol ban (less than or equal to median time vs more than

Table 1 Characteristics of smokers, overall and by menthol use, in Ontario, Canada (N=913), 2016–2018

Characteristics	No menthol use	Occasional menthol use	Daily menthol use	Total	n	P value
	n=306 (34%)	n=420 (46%)	n=187 (21%)	N=913		
	%	%	%	%		
Sex						
Female	50	60	65	58	527	0.017
Male	49	40	34	42	380	
Other	1	1	1	1	6	
Age						
16–29	4	24	16	16	143	p<0.001
30 and over	96	76	84	84	770	
Education						
≤High school	41	22	27	29	267	p<0.001
>High school	59	78	73	71	646	
Race						
Non-white	11	20	18	17	153	p=0.002
White	89	80	82	83	760	
Cigarettes per day						
0 to 10	32	37	35	35	318	p=0.012
11 to 20	46	35	36	39	357	
21 to 30	14	17	13	15	139	
Over 30	7	11	16	11	99	
Smoking pattern						
Daily	95	82	100	90	824	p<0.001
Non-daily	5	18	0	10	89	
Quit postban						
No	86	80	76	81	742	p=0.014
Yes	14	20	24	19	171	
Quit attempt postban						
No	57	38	37	44	400	p<0.001
Yes	43	62	63	56	513	

median time). Likelihood ratio test was used to assess if an interaction term was statistically significant between models with and without the interaction term of the population subgroup and menthol status. The sensitivity of the outcome was examined by limiting the definition of quit to those who had not reported smoking within the past month and within the past 6 months. An additional sensitivity analyses was performed to account for missing data using an ‘intent to treat’ approach, whereby missing outcomes were coded as continued smokers. All analyses were performed using STATA V.14.0 (StataCorp).²⁴

RESULTS

Of the 913 participants who completed both the baseline and 1-year follow-up surveys, 306 (34%) were non-menthol cigarette smokers, 420 (46%) were occasional menthol smokers and 187 (21%) were daily menthol cigarette smokers at baseline. More than half of the participants were female (58%), the majority of participants were over the age of 30 (84%) and white (83%), about 71% had more than a high school degree and about 39% smoked anywhere from 11 to 20 cigarettes a day with 10% being non-daily smokers. Overall, 19% of baseline smokers reported successfully quitting smoking, and 56% reported making a quit attempt after the ban (table 1). The three groups of participants—non-menthol smokers, occasional menthol smokers and daily menthol smokers—differed significantly by sex, age, education, race and smoking behaviours (table 1). Daily and occasional menthol smokers were more likely to be female, non-white and have more than a high school education than non-menthol

smokers. Those who smoked menthol cigarettes occasionally had the highest percentage of young adults (ie, between 16 and 29 years of age).

The median follow-up time after the ban was 408 days with a range of 394–595 days. At follow-up, 0.3% of the non-menthol smokers at baseline, 5% of the occasional menthol users and 22% of the daily menthol users reported purchasing menthol cigarettes after the ban (p<0.001). The primary source for purchasing menthol cigarettes was on First Nations Reserves, but this purchasing pattern did not increase over time among prior daily menthol smokers (short-term follow-up: 21%; long-term follow-up: 21%).

Menthol users, both daily and occasional, were more likely to report having quit smoking (24% and 20% vs 14%; p=0.014) or having made a quit attempt (63% and 62% vs 43%; p<0.001) than non-menthol smokers (table 1). Of the 40 daily menthol users who reported being quit at the short-term follow-up (1–3 month post ban), 40% remained quit at the long-term follow-up, compared with 52% of the 227 occasional users who were quit at the short-term follow-up (non-menthol users at baseline did not have a short-term follow-up) (p=0.258). Daily menthol smokers reported an average of 1.9 quit attempts (0.42 SE) since the ban compared with 1.7 (0.17 SE) attempts among occasional menthol smokers and 1.0 attempts (0.12 SE) among non-menthol smokers.

Of the 287 menthol smokers who predicted that they would switch to non-menthol cigarettes when surveyed prior to the ban, 15% reported being quit at the long-term follow-up. This

Table 2 Associations between menthol smoking status prior to menthol ban and postban quit attempt and quit in Ontario, Canada, using Poisson regression with robust variance estimation, 2016–2018 (N=913)

Menthol use	Quit Attempt Quit			
	Crude RR (95% CI)	Adjusted† RR (95% CI)	Crude RR (95% CI)	Adjusted† RR (95% CI)
No menthol	1.00	1.00	1.00	1.00
Occasional	1.44*** (1.24 to 1.66)	1.09 (0.92 to 1.30)	1.47* (1.05 to 2.07)	1.09 (0.74 to 1.62)
Daily use	1.45*** (1.23 to 1.72)	1.25* (1.03 to 1.50)	1.71** (1.17 to 2.51)	1.62* (1.08 to 2.42)

*p<0.05, **p<0.01, ***p<0.001.

†Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.
RR, rate ratio.

compares to quit rates of 38% of those (n=60) who predicted that they would quit in response to the ban, 34% of those who predicted they would switch to other flavoured products, 19% (n=101) who predicted switching to contraband and 24% of the 100 people who did not know their response (p<0.001).

Table 2 presents the crude and adjusted Poisson regression models for the association between postban self-reported smoking abstinence and having attempted to quit with menthol smoking at baseline (see details in the online supplementary appendix). Daily menthol smokers had significantly higher rate of reporting having quit smoking after the ban (adjusted rate ratio (ARR) 1.62; 95% CI 1.08 to 2.42) compared with non-menthol smokers, controlling for smoking and demographic characteristics. After adjustment, the rate of occasional menthol smokers reporting having quit was 1.09 (95% CI 0.74 to 1.62) times higher than the rate of non-menthol smokers reporting having quit. Unadjusted analysis displayed a significantly higher rate of reporting a quit attempt for daily and occasional menthol smokers compared with non-menthol smokers. In the adjusted analyses, only the daily menthol smokers were more likely to have tried to quit than non-menthol smokers (ARR 1.25; 95% CI 1.03 to 1.50). Stratified analyses are shown in tables 3 and 4 to show the variation in the population. Interactions between menthol status and subpopulations were not significant (data not shown) except for date of follow-up (p=0.022) on the quit outcome and age (p=0.035) on the quit attempt outcome where the magnitude of the estimate was higher among those with short date of follow-up and among those with older age, respectively.

In the sensitivity analyses (see online supplementary appendix) including those who did not complete the 1-year follow-up survey (N=1738), allowing all missing outcomes to represent continued smokers did not change the significance of our results nor did it greatly alter the magnitude of the estimates; daily menthol smokers had a relative rate of 2.34 (95% CI 1.51 to 3.62) of reporting quitting at follow-up compared with non-menthol smokers (p<0.001), adjusted for age, sex, education, race, cigarettes per day, daily or occasional smoking, date of baseline survey and survey type. Using alternate, more stringent definitions of cessation did not change interpretation. One month (ARR:1.56; 95% CI 1.04 to 2.35) and 6-month self-report cessation outcomes (ARR:1.61; 95% CI 1.01 to 2.55) both had similar magnitudes to point prevalence smoking comparing daily menthol smokers with non-menthol smokers. Similarly, limiting the sample to only those who had not purchased menthol cigarettes since the ban did not change interpretation (ARR: 2.39; 95% CI 1.56 to 3.65).

Discussion

To our knowledge, this is the first long-term population-based pre–post evaluation of smoking behaviours after the implementation of a menthol-flavoured tobacco ban. Overall, the study found that there was a significantly higher rate of reported smoking cessation 1 year after the menthol ban for baseline daily menthol smokers when compared with non-menthol smokers. An association was also found between daily menthol cigarette smokers and reports of quit attempts 1 year postban compared with non-menthol smokers. Unadjusted effects for baseline occasional menthol smokers were attenuated after control for other demographic and baseline characteristics.

The results of this study support findings from previous studies conducted in the USA of behavioural intentions and beliefs in the event of a menthol ban by the FDA.^{11–14} In this study, behavioural intentions were correlated with quitting outcome—particularly those who felt that they would be satisfied with non-menthol cigarettes and those who expected to quit. Menthol smokers who intended to substitute with other means had substantial levels of quitting behaviour. In USA studies, estimates of menthol smoker intention to quit smoking varied from 40%¹⁶ to 35%,¹⁵ 30%,¹⁸ with a 10% best estimate of effect from the TPSAC report.⁵ Our previous study evaluating short-term quitting behaviour in Ontario 1 month after the ban found that 17% planned to quit long term.¹⁹ Although the demographics of menthol smokers in our study sample of Canadian smokers may not represent USA menthol smokers, our findings suggest that the effect of the menthol ban may be greater in countries where a greater number intend to quit because of the ban. In the current study, we found that 20% of occasional menthol smokers and 24% of daily menthol smokers reported quitting in the long term, which exceeded what was predicted by smokers at baseline. The quit rates reported by the non-menthol smokers are consistent with a previous population-representative longitudinal studies of quit rates in Ontario (8.9% sustained self-reported quit rate).²⁵ In Ontario, there were no public education campaigns to inform of the menthol ban, and the ban was implemented without noticeable controversy. Greater awareness of the ban and greater support for cessation among menthol smokers may increase the effectiveness of the ban. However, the tobacco industry had promoted non-menthol cigarette brand alternatives to menthol smokers at point of sale.²³

Twenty-two per cent of daily menthol smokers reported purchasing menthol cigarettes after the ban, which is consistent with O'Connor and colleagues' finding that 25% of menthol smokers claim that they would find some way to purchase menthol cigarettes despite a ban.¹⁵ Access to other provinces who had legal sales of menthol during a period of the ban in

Table 3 Associations between menthol smoking status prior to menthol ban and postban quit in Ontario, Canada, using Poisson regression with robust variance estimation stratified by sex, age group and race and daily/non-daily smoking, 2016–2018

Menthol use	RR (95% CI)							
	Female† N=516	Male† N=374	Age <30† N=140	Age ≥30‡ N=756	Non-whites§ N=148	Whites§ N=748	Daily¶ N=807	Non-daily¶ N=89
No menthol	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Occasional	1.24 (0.73 to 2.09)	0.95 (0.51 to 1.77)	0.67 (0.24 to 1.83)	1.19 (0.79 to 1.80)	1.09 (0.32 to 3.74)	1.08 (0.72 to 1.63)	1.08 (0.70 to 1.65)	1.24 (0.46 to 3.29)
Daily use	1.55 (0.91 to 2.65)	1.6 (0.84 to 3.04)	1.34 (0.39 to 4.60)	1.62 (1.05 to 2.48)*	2.03 (0.60 to 6.89)	1.55 (1.00 to 2.39)*	1.62 (1.07 to 2.45)*	

*p<0.05, **p<0.01, ***p<0.001.

†Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

‡Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

§Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

¶Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

RR, relative rate.

Table 4 Associations between menthol smoking status prior to menthol ban and postban quit attempt in Ontario, Canada, using Poisson regression with robust variance estimation stratified by sex, age group and race and daily/non-daily smoking, 2016–2018

Menthol use	RR (95% CI)							
	Female† N=516	Male† N=374	Age <30† N=140	Age ≥30‡ N=756	Non-whites§ N=148	Whites§ N=748	Daily¶ N=807	Non-daily¶ N=89
No menthol	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Occasional	1.16 (0.91 to 1.49)	1 (0.78 to 1.29)	0.65 (0.40 to 1.08)	1.15 (0.96 to 1.38)	0.87 (0.57 to 1.34)	1.13 (0.93 to 1.36)	1.13 (0.93 to 1.37)	0.92 (0.75 to 1.14)
Daily use	1.27 (0.98 to 1.65)	1.2 (0.91 to 1.57)	0.88 (0.48 to 1.61)	1.25* (1.03 to 1.53)	1.07 (0.67 to 1.72)	1.26* (1.03 to 1.55)	1.27* (1.04 to 1.54)	

*p<0.05, **p<0.01, ***p<0.001.

†Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

‡Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

§Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, daily or non-daily smoking, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

¶Analyses controlling for age, sex, race, education, survey source, cigarettes smoked per day, use of cigars or e-cigarettes since the ban and number of days between the menthol ban and the follow-up survey.

RR, relative rate.

Ontario and close proximity to the USA did not appear to have significant impacts on availability. Access to sources from First Nations Reserves was high but did not appear to change over the course of the study.

The results from our study suggest that the ban on the sale of menthol tobacco products was associated with a higher level of quitting or attempting to quit smoking at 1-year follow-up among daily menthol smokers. In the USA, where no national menthol ban has been implemented, cross-sectional studies showed that menthol users were less successful in quitting than non-menthol users despite increased quit attempts or intentions to quit.⁷ Considering that menthol smokers may be more nicotine dependent and have reduced cessation success,⁴⁻⁶ our findings that daily menthol smokers were significantly more likely to reporting smoking cessation relative to non-menthol smokers after the ban suggest that the menthol ban could have tremendous public health impact at the population level in Canada and in other jurisdictions as well from an overall reduced level of cigarette smoking.

This study has several strengths, namely, it is a large population study with a long follow-up period. As with any cohort study, there is the potential issue of loss to follow-up. However, the sensitivity analysis using the intention-to-treat analysis led to similar results and did not change the conclusions of the study. While some of the study participants were recruited through random digit dialling, given the limitations of RDD, we do not expect that sample to be fully representative of the population. While representative samples can be valuable, understanding the effect in subpopulations as presented can be more helpful for generalisability to other jurisdictions outside of Ontario.²⁶ While we found that self-reported quitting behaviour estimates did not differ statistically between subgroups, this may be due potentially to sample size, despite previous studies showing effects.⁴⁻⁷ Another limitation of this study was using a point measurement self-reported measures of menthol use and quitting behaviour and the possibility that participants may not identify accurately the timing of activities that had occurred just before or after the implementation of the ban. However, there is no evidence that menthol smokers and non-menthol smokers would recall the quitting behaviour differently. Only menthol smokers were surveyed for short-term smoking status, and the effect of quitting long term appeared to include the effect of initial short-term quitting and lower levels of relapse among the daily menthol smokers compared with the occasional menthol smokers. Inclusion of objective biomarkers of cessation (eg, expired air CO;

saliva or urine cotinine concentration) would strengthen future studies.

Our findings suggest an increased rate of quitting 1 year following Ontario's ban on the sale of menthol tobacco products. Although this impact was observed in older but not younger adults, the difference may be due to younger adults not having a brand preference and switching to other flavoured tobacco or nicotine products. Therefore, we would expect that a menthol ban would have an even greater impact in at-risk subpopulations such as the youth and young adults in an environment in which there was less availability of any flavoured tobacco or nicotine products. Future work will need to examine the impact of all other flavoured products on long-term cessation.

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Competing interests Dr Eissenberg is a paid consultant in litigation against the tobacco industry and is named on a patent application for a device that measures the puffing behavior of electronic cigarette users.

Patient consent for publication Not required.

Ethics approval This study was approved by the research ethics board of the University of Toronto, Ontario, Canada and participants gave consent to participate.

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What is already known on this subject

- Tobacco companies use menthol in cigarettes to increase smoking, reinforce addiction and discourage cessation. Existing studies have found reduced cessation among menthol cigarette smokers; it is unknown how a menthol cigarette ban would affect smoking cessation behaviour.

What this paper adds

- Our study is a real-world assessment of the impact of a menthol cigarette ban. One year after the implementation of a menthol cigarette ban, daily menthol cigarette smokers were significantly more likely to report quit attempts and being quit compared with non-menthol cigarette smokers.

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