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Editorial

Tobacco smoking prevention and control in Canada: where do we go from here?

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Despite steady declines in the past 30 years, with a record low prevalence of 15% in 2019, tobacco smoking continues be a leading public health burden in Canada, especially in socially disadvantaged groups.[1] New and unforeseen tobacco-related issues continue to emerge that threaten these declines and challenge our understanding of tobacco use. Rapid uptake of vaping among youth, unanticipated effects of new legislation (e.g. cannabis) on tobacco smoking, evolving evidence on the distribution of vaping and its relationship with smoking initiation and cessation, and the effects of the COVID-19 pandemic on tobacco use are, among others, critical issues that will drive tobacco control research and policy agendas into the future.

In partnership with *Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice* (the HPCDP Journal), we stewarded a special issue on tobacco and vaping prevention and control in Canada, calling for new evidence on policy gaps and implementation challenges, inequalities in tobacco and vaping use and associations among use of vaping products, smoking cessation and harm reduction behaviours in smokers.

We received 20 submissions from tobacco and vaping control advocates and researchers in Canada, which, after peer review, resulted in 10 that would go to publication. Although the majority of submissions addressed vaping, the number and scope of accepted manuscripts prompted us to publish two issues. This first issue focusses, for the most part, on cutting-edge issues related to tobacco smoking and the upcoming issue will spotlight vaping. In the current issue, we present two commentaries—one led by Hagen[2] and one by Melamed[3]—that challenge the past five years of tobacco control and question the complex role of the COVID-19 pandemic in future tobacco control efforts. In one of two original research papers, Pelekanakis et al.[4] delve into the reasons underpinning continued provincial differences in smoking prevalence. In the second, Williams et al.[5] identify predictors of e-cigarette uptake among high school students in Canada. Finally, an "At-a-glance" report by Worrell and Hagen[6] offers new estimates of cigarette affordability across provinces over time.

Each paper sheds new light on current core issues related to Canadian capacity to support declines in smoking prevalence. First, Hagen[2] reminds us that current obstacles include both the hesitation of provincial and federal governments to continue championing tobacco control as a priority, and their consequent failure to redirect sufficient funds towards bold new action. The Pelekanakis[4] study asked which proximal contributor is most relevant to smoking prevalence and found that youth initiation likely drives differences in prevalence between Quebec and other provinces. The authors argue that addressing initiation therefore represents a key target to support continued declines in smoking prevalence, at least in Quebec.

Cigarette affordability and vaping have been associated with youth initiation,[7,8] and findings by both Worrell and Hagen[6] and Williams et al.[5] offer insights to this end.

Worrell and Hagen[6] highlight that cigarette affordability cannot be gleaned from tax rates alone because the effects of taxation on consumption depends on purchasing capacity (e.g. using WHO standards, the authors calculated that the CAD 10.90 increase in Prince Edward Island and the CAD 15.00 increase in Alberta in excise tax rates per 200 cigarettes between 2009 and 2019 were associated with the same increases in relative affordability). To ensure meaningful change, new tax increases must take this into account. Importantly, strong taxation strategies are likely to have a positive impact on reducing socioeconomic inequalities in smoking initiation.[9]

Reminding us of the significance of inequalities in smoking initiation, Williams et al.[5] report that vaping initiation among high school students is more common among adolescents who skip school, perform less well academically and who have trouble with emotional coping—supporting that vaping may also represent a new mechanism by which vulnerable youth are more likely to initiate tobacco smoking, thereby perpetuating social inequalities.

Continuing on this theme, the Melamed[3] commentary highlights that inequalities in smoking must be a critical research focus as society emerges from the COVID-19 pandemic. Pandemic-related lockdowns altered numerous circumstances that influence smoking behaviour, including the environments in which smokers spend time, their financial security and their

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capacity to cope with distress and boredom. The first year of the pandemic resulted in a bevy of fast-tracked scientific papers, often with weak evidence. We now need robust, high-quality evidence to better understand how COVID-19 has affected smokers' behaviour and whether these changes will influence initiation and cessation after the pandemic.

Despite the ongoing, immense public health burden of tobacco use, only a small number of researchers in Canada are engaged in population-based tobacco research. In the early 2000s, the Canadian Tobacco Control Research Initiative (CTCRI) represented a creative and bold endeavour that aimed to build a collaborative tobacco control research community in Canada, facilitate new leadership, support young researchers that could sustain this community and provide "protected" funding for high-quality, high-impact tobacco research.[10] The organization was dismantled in 2009 after approximately 10 years, on the premise that it had attained these objectives, that the tobacco problem was "solved" and that Canada needed to move on to new, more pressing public health issues such as obesity.

It is our contention that, while the CTCRI initiative may have sown the seeds to achieve its objectives, its promise has fallen short in the ensuing years. Population-based tobacco research in Canada is now undertaken by a handful of disconnected research teams, and the number of new, highly trained tobacco control researchers emerging from within these teams will not suffice to carry the torch. We believe that Canadian research capacity in tobacco control needs a critical boost into the next decade to support relevant cutting-edge research that deeply probes and can usefully inform the analysis of the complex and emerging issues highlighted in this issue of the HPCDP Journal and beyond. Canada must attract the next generation of well-trained researchers with well-honed methodological skills to lead Canada toward a tobacco endgame.

As guest editors, we thank our contributors (and peer reviewers) for providing content that calls for renewed attention to the longstanding public health problem of tobacco use. In conjunction with other tobacco-related position statements recently released in Canada,[11] we hope that these special issues inspire reflection in Canada on past successes in tobacco control, in recognition that the battle is far from over as new and even more challenging issues emerge, and in acceptance that renewed commitment is needed to maintain and build Canadian capacity in tobacco control research.

Research priorities include assuring that the interventions that have supported the decline in smoking prevalence up to 2020 continue to be relevant and effective, and discovering whether vaping will contribute to a next generation of youth grappling with nicotine addiction. Also, top on our research agenda is the need for deeper, evidence-based understanding of the impact of COVID-19 on tobacco use, particularly in vulnerable subgroups, and of gaps in programs and policy that perpetuate social inequalities in smoking. We particularly hope that renewed attention to tobacco control research will help practitioners and policy makers anticipate and better prepare for the inevitable new challenges that will continue to emerge until a tobacco endgame is fully realized.

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Conflicts of interest

The authors declare no competing interests.

Statement

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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Commentary

Protecting vulnerable groups from tobacco-related harm during and following the COVID-19 pandemic

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Abstract

Marginalized populations are being disproportionally affected by the current pandemic. Direct effects include higher infection rates with greater morbidity and mortality; indirect effects stem from the societal response to limit the spread of the virus. These same groups also have smoking rates that are significantly higher than the general population. In this commentary, we discuss how the pandemic has been acting to further increase the harm from tobacco endured by these groups by applying the syndemic framework. Using this approach, we elaborate on the factors that promote clustering of harms from tobacco with harms from COVID-19. These include the worsening of psychological distress, a potential increase in smoking behaviour, greater exposure to second-hand smoke and less access to smoking cessation services. Then, we offer mitigation strategies to protect disadvantaged groups from tobacco-related harm during and following the COVID-19 pandemic. These strategies include affordable smoking cessation services, a proactive approach for smoking treatment using information technology, opportunistic screening and treatment of tobacco dependence among individuals presenting for COVID-19 vaccination, policy interventions for universal coverage of cessation pharmacotherapy, comprehensive smoke-free policies and regulation of tobacco retail density. Now more than ever, coordinated action between clinicians, health care systems, public health organizations and health policy makers is needed to protect vulnerable groups from the harm of tobacco.

Keywords: *COVID-19, pandemic, vulnerable groups, tobacco, smoking, health disparities, tobacco control, socioeconomic status, policy*

Highlights

- Vulnerable groups with socioeconomic disadvantage have disproportionally high rates of tobacco use.
- The syndemic framework is a biosocial approach for exploring risk for harm from tobacco in vulnerable groups that is augmented by changes brought about by the pandemic.
- Worsening of economic status and stress levels compounded by limited access to health care and tobacco treatment act to increase tobacco use and second-hand smoke exposure.
- Coordinated action is needed to protect vulnerable groups by lowering barriers for tobacco treatment, enforcing smoke-free policies and integrating tobacco treatment into community, workplace and health care organizations that serve socioeconomically disadvantaged groups.

Why has tobacco use gained attention during the COVID-19 pandemic?

Smokers have higher rates of common respiratory infections such as pneumonia compared with nonsmokers, and the link between smoking and infection is well established.[1] Cigarette smoking is responsible for a multitude of mechanisms that predispose to respiratory infections, including structural lung changes (e.g. airway constriction) and malfunction of both cell-mediated and humoral immune responses.[2] It is not surprising, therefore, that SARS-CoV-2 causes greater morbidity among smokers. Early reports from China found that 26% of COVID-19 patients with a complicated disease course (e.g. need for ventilator, intensive care admission, death) were smokers, compared with only 12% in the group with a lesser disease severity.[3] Since that time, more evidence has accumulated. A recent meta-analysis found that smoking is a risk factor for severe COVID-19 illness (pooled OR = 2.17; 95% CI: 1.37-3.46),[4] and emerging data suggest a dose-response association between pack years and unfavourable COVID-19 outcomes.[5] Moreover, there is consensus that

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tobacco-related conditions (e.g. chronic obstructive pulmonary disease and coronary artery disease, which are common among both current and former smokers) are linked with excess COVID deaths.[6]

The link between smoking and COVID-19 complications has not gone unnoticed by the public and has propelled many to quit. Surveys from the UK have found that more smokers tried to quit during the pandemic compared with the year before (40% vs. 30%).[7] Moreover, they were more successful in their quit attempts (21% vs. 14%), and a larger number of smokers reached out to remote counselling services such as quitlines (11% vs. 3%) for additional behavioural support.[7] Conversely, the pandemic has created numerous stressors including health worries, financial uncertainty and social isolation, which have translated into elevated psychological distress, a known correlate of smoking behaviour.[8] Indeed, these two opposing trends are captured in recent surveys of smokers. For instance, a study from the Netherlands that interviewed smokers found that 14% had decreased their smoking behaviour during the pandemic, while 19% had increased it. Change in smoking behaviour in either direction was closely tied to high levels of stress.[9]

Cross-sectional data from the Canadian Perspectives Survey Series (CPSS) show similar opposing trends, in which 3% of respondents increased their smoking behaviour during the pandemic while 4% decreased it.[10] Consistent with the aforementioned Dutch study, pandemic-related financial stressors were predictors of both an increase and a decrease in smoking behaviour in Canada. This study also sheds light on socioeconomic disparities and change in tobacco use. Those with a high school education or less were nearly three times more likely to increase their smoking compared with those with university degrees.[10] To date, changes in smoking behaviour in response to pandemic-related stress have been noted in nonrepresentative survey data;[11] however, larger, longitudinal, population-based studies are needed to fully explore the effect of the pandemic on smoking prevalence and assess for the presence of socioeconomic disparities.

The potential of the pandemic to increase smoking intensity among socially disadvantaged smokers is of concern and merits immediate actions, given that, even prior to the pandemic, these groups saw a higher burden of tobacco-related health conditions. The pandemic's effects have further contributed to a widening of health disparities.

In this commentary, we first present evidence of smoking disparities between affluent and disadvantaged groups. Second, using the syndemic framework, we explain how the pandemic and its societal effects act particularly to worsen tobacco-related harm in groups with higher smoking rates. Third, we suggest mitigation strategies, to be anchored within Canada's tobacco strategy,[12] to protect the health of disadvantaged groups from tobacco-related harm during and after the pandemic.

Pre-pandemic smoking prevalence is higher among socioeconomically disadvantaged groups

Tobacco use remains the leading cause of preventable death in Canada. Each year, approximately 40 000 Canadians die from tobacco-related illnesses.[13] Canada's adoption of public health policies to limit tobacco use, such as bans on smoking in public places, mass media antismoking campaigns, restrictions on cigarette marketing, publicly funded quitlines and cigarette price increases have successfully reduced smoking rates to a historic low of 15%.[14]

Affluent population groups, relative to socioeconomically disadvantaged groups, have greater uptake of public health interventions.[15] Thus, while smoking rates have gone down in the general population, smoking disparities have become accentuated over time. For instance, those who work in manual jobs are two times more likely to smoke compared to individuals with professional jobs.[15] Similarly, those who did not complete a high school education were three times more likely to smoke compared with university graduates.[15] Also, a near two-fold greater smoking rate has been found among Indigenous Canadians,[16] and a study in the United States found a three- to four-fold greater rate for people with mental illness and addiction disorders.[17]

Smoking disparities may be explained by a myriad of biopsychosocial factors including greater exposure to tobacco in the social environment and permissive attitudes towards smoking, lower social support for quitting, higher levels of psychological distress and greater levels of tobacco dependence. This is further compounded by systemic factors that include the limited enforcement of smoke-free policies in workplaces of manual labourers, the lack of universal coverage for smoking cessation pharmacotherapy, the high density of tobacco outlets in neighbourhoods of low socioeconomic status (SES) and a decrease in funding for tobacco control public health actions as the rate of smoking has declined over the years.[18]

As a result, relative to affluent groups, disadvantaged populations have a higher tobacco initiation rate, a lower rate of quit attempts and lesser success on a given attempt.[19] Disproportionate tobacco use among disadvantaged groups is a main driver of the health inequity these groups face. The tobacco-related health burden is responsible for 40% of the difference in life expectancy seen across education levels in Canada.[20] This is worrisome, given that the pandemic is likely to increase tobacco use disproportionally in vulnerable groups.

COVID-19 undermines tobacco control efforts and exacerbates tobacco-related harm among socioeconomically disadvantaged groups

COVID-19 is causing unprecedented changes in all aspects of society. Widespread "lockdowns" and closures of businesses, educational institutions, community organizations, places of worship and many "nonessential" medical services, together with strict rules for social distancing, have been implemented to limit the spread of the virus.

While these measures are necessary to protect the public from the virus, they disproportionally affect vulnerable groups such as people of low SES, racialized minorities and those with mental health and addiction conditions.[21] For example, 38% of Canadians employed in lower-wage positions experienced job loss in March and April of 2020, compared with only 13% in other positions.[22] Unemployment is linked with poor health and mental health, especially among those who lack a social support network.[23] Reduced access to health care services, most of which moved to a telemedicine format, has also disproportionally affected groups

with socioeconomic disadvantage and highlighted the current societal "digital divide."[24] Wage losses, unemployment and reduced access to health care have contributed to pandemic-related stress and poor mental health, above and beyond that seen in the general population. For example, suicidal thoughts were reported in higher levels in Indigenous individuals (16%) and individuals with disabilities (15%) and low income (14%) compared with the general public (6%).[25] Taken together, these data demonstrate that vulnerable groups are more likely to experience harm as a result of the pandemic.

The commonalities between the risk of harm from the societal effects of the pandemic and the risk of harm from tobacco can be better understood using the syndemic framework, a broad-based biosocial framework for understanding social and environmental factors that promote clustering of disease conditions and their interaction with each other.[26] In this case, pre-pandemic inequalities in smoking and the resulting tobacco-related health burden are concentrated among disadvantaged populations. The pandemic's disproportionate effects on these groups have been interacting synergistically[27] to further increase harm from tobacco. There are a number of factors that account for the synergy between tobacco-related harm and the pandemic.

First, the far-reaching effects of the pandemic on economic, social and health care systems have been more pronounced among disadvantaged populations groups who lack the financial means and social capital to endure the hardships. This has caused an increase in psychological distress and, for some, a concomitant increase in smoking as means of coping. There is also a concern that those who had quit smoking before the pandemic might start smoking again due to the added stressors in their lives, as stress is a well-documented risk factor for smoking relapse.[28]

Second, disparities in second-hand smoke (SHS) exposure were noted prior to the pandemic, showing a dose-response association with socioeconomic status. For example, a study from Quebec found that SHS exposure in the home was nearly 5-fold more common among youth in the lowest versus the highest income quintiles.[29] Since public health orders to stay at home have likely increased the number of smokers who use tobacco indoors, it is probable that more individuals with low socioeconomic status have been and will continue to be exposed to SHS. Indoor smoking is especially concerning in multi-unit housing, mostly populated by low-income families, as smoke is carried in shared ventilation systems and therefore affects multiple dwellers.[30] In turn, greater SHS exposure is linked with adverse health outcomes and an increase in health care utilization.[31]

Third, health care systems play a critical role in screening for tobacco use and assisting smokers to quit. Data from Ontario suggest that a large, government-funded smoking cessation program that is integrated into primary care settings and offers pharmacotherapy at no cost sees a greater uptake among patients with socioeconomic disadvantage, with over 50% of participants in the Ontario program belonging to the two lower income quintiles.[32] The pandemic has put an unprecedented burden on health care systems that has resulted in delays in chronic disease management and cancer screening. This is likely to shift attention away from helping smokers to quit. This is of concern, given that unaided "cold turkey" quit attempts, which are more common among persons with lower compared to higher income levels, have lower odds of sustained success.[14]

Fourth, the pandemic diverted the attention and resources of public health organizations, including staff and funding, to protect the public from the direct harms of COVID-19 infections. Consequently, fewer resources are now available for tobacco control activities such as enforcement, education and cessation support. Hence, action is urgently needed to protect people with socioeconomic disadvantage from the harms of tobacco, given that tobacco disparities are compounded by the societal effects of the pandemic.

Protecting the health of socioeconomically disadvantaged groups from tobacco-related harm during and after the COVID-19 pandemic

Reducing the harm from tobacco to disadvantaged populations during and after the pandemic can be achieved with coordinated, multilevel actions aligned with Canada's Tobacco Strategy[12] (Table 1).

First, there is a need to eliminate access barriers for tobacco treatment to allow smokers to receive the recommended treatment for tobacco cessation, which consists of both pharmacotherapy and behavioural counselling. Public insurance programs that cover these medications should be extended to the working poor or those on unemployment insurance. Keeping in line with societal measures to limit COVID-19 spread, tobacco treatment can be delivered remotely by the use of telephone counselling (i.e. quitlines) and by mailing out pharmacotherapy. The former practice is already well established in most jurisdictions, and the latter has seen local success that needs to be scaled up.[33]

Second, to ensure disadvantaged smokers are not underrepresented in general public health efforts, they should be complemented by community-level actions. For example, treatment for tobacco should be routinely offered in community settings that serve vulnerable populations such as employment agencies, social assistance programs, housing and hotelling services for COVID-positive people experiencing homelessness, and food banks. This will necessitate collaboration and coordination between different levels of government, smoking cessation services and community organizations.

Third, most large health care organizations house information technology systems that can identify smokers among their patients. This allows for a proactive approach in which smokers are invited to receive tobacco treatment and has proved effective in increasing uptake of treatment among smokers with socioeconomic disadvantage.[34] Similarly, integrated tobacco treatment within health care organizations that treat populations affected by smoking disparities, such as psychiatric hospitals and addiction treatment programs, are also likely to increase uptake.[35] Additionally, tobacco treatment can also be proactively offered via remote delivery following screening for tobacco use among those who test positive for COVID-19.

Fourth, coordinated government action, through a package of policy interventions, is needed to prioritize tobacco control activities at this time, particularly those that have a positive equity impact and the potential to reduce harm among vulnerable groups.[36] For example, the enforcement of comprehensive smoke-free policies in workplaces of manual labourers and multi-unit housing would reduce disparities in SHS exposure. Also, the cost of

TABLE 1
Actions aligned with Canada's Tobacco Strategy to protect vulnerable groups from tobacco-related harm

Pillar	Action
Cessation	Increase access to no-cost cessation programs in health care settings, especially those that serve patients with high smoking prevalences (e.g. psychiatric and addiction services)
	Offer remote cessation programs (phone and internet) and mail-out pharmacotherapy
	Use information technology within health systems to proactively invite smokers into cessation programs
	Raise prices of tobacco cigarettes
	Perform opportunistic screening and treatment of tobacco use in COVID testing and vaccination centres
	Offer workplace and local community support for cessation
Protection	Enforce comprehensive smoke-free policies, especially in workplaces of manual labourers
	Ensure smoke-free policies in all government-funded multi-unit housing
Industry	Limit tobacco retail density in neighbourhoods with low socioeconomic status
	Ban tobacco product discounts

tobacco cigarettes is more prohibitive for smokers in lower socioeconomic groups; hence, increases in pack prices together with stricter enforcement on black market tobacco may motivate many to quit.[37] Regulation of tobacco outlet density is another powerful tool to address smoking disparities,[38] and recent studies suggest that it is effective in narrowing the tobacco retail gap found in low- versus high-income neighbourhoods.[39]

Fifth, consistent with the syndemic framework, actions that mitigate systemic factors that contribute to health disparities among vulnerable groups, such as limited education or employment opportunities, housing insecurity, precarious access to health care and discrimination, are likely to have a positive impact on tobacco use and tobacco-related outcomes as well as general health outcomes.[40]

Conclusion

Even before the current pandemic, populations with socioeconomic disadvantage were experiencing disparities in tobacco use and tobacco-related health conditions that contribute greatly to health inequalities. The syndemic framework is a conceptual approach to understanding how pre-pandemic tobacco-related health risks have been interacting with the societal impact of the pandemic and together make the risk of harm from tobacco more pronounced among disadvantaged groups. It also sheds light on potential measures for mitigating a sizeable proportion of this risk, such as reducing existing barriers to receiving tobacco-cessation treatment by remote counselling and mailing out of cessation medication, proactive outreach to smokers enrolled within health care systems, comprehensive smoke-free policies in workplaces of manual labourers and multi-unit housing and integration of tobacco treatment into community agencies that serve those with socioeconomic disadvantage. To ensure that tobacco and health disparities will narrow over time, these mitigation measures should be complemented by strategies to reduce systemic factors that drive social inequality.

Conflicts of interest

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Authors' contributions and statement

OM and PS conceived the idea for this commentary. OM, LZ, RS, LB and PS participated in the analysis and interpretation. OM drafted the manuscript. OM, LZ, RS, LB and PS critically revised the manuscript for important intellectual content. OM, LZ, RS, LB and PS approved the final version of the manuscript.

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Commentary

Is "less than 5 by 35" still achievable?

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Five years of struggle and setbacks

This year marks the fifth anniversary of Canada's Tobacco Endgame Summit. On September 30, 2016, dozens of tobacco control researchers, leaders, advocates and policy makers from across the country converged at Queen's University in Kingston for an ambitious, two-day deliberation on the future of tobacco control in Canada.[1] The lofty goal of the summit was to reshape and reignite tobacco control in Canada and to set the stage for accelerated and substantial reductions in tobacco use, referred to as the "endgame." One of the major outcomes of the summit was a proposed new national target—to reduce tobacco use to less than 5% prevalence by 2035 ("< 5 by 35").

The proposed target of < 5 by 35 was quickly adopted by Health Canada following a national consensus forum convened by Health Minister Jane Philpott in Ottawa in March 2017.[2] At the forum, the Minister delivered a clarion call for strong and immediate measures to accelerate tobacco reduction in Canada. Prior to the forum, Health Canada published an ambitious guiding document titled *Seizing the Opportunity: The Future of Tobacco Control in Canada*[3] that proposed a number of endgame measures. It appeared that tobacco control was on a renewed path with greater focus, unanimity and resolve and that the endgame was in sight.

Five years later, Canada continues to engage in incremental, erratic and reactive tobacco control with no coherent plan to reduce tobacco use or to achieve < 5 by 35, and with little buy-in from subnational governments and nongovernmental stakeholders. There are no milestones, benchmarks or tangible national plans beyond optimistic guidance documents. The federal government has never put forth an operational plan to achieve < 5 by 35, and only one province (New Brunswick) has reportedly adopted the goal.[4] The territories would likely struggle to achieve this target, due to elevated rates of tobacco use that are well above the national average. Although progress has been made in prohibiting flavoured tobacco products, securing plain packaging and restoring federal grants and contributions, the clarion call from Minister Philpott has gone largely unheeded. Provincial governments have done little to fill the gap, with some isolated exceptions such as age 21 laws in Nova Scotia and Prince Edward Island and retail reforms in Quebec. Moreover, the legalization of nicotine vaping products and cannabis followed by the COVID-19 pandemic have created further delays and obstacles to substantive endgame action.

Tobacco control has suffered numerous setbacks since September 2016.

The 2018 legalization of nicotine vaping products and their resulting mass promotions contributed to an explosive rise in youth vaping that governments and tobacco control stakeholders are desperately attempting to reverse engineer. After a 50-year absence from broadcast media, tobacco companies were effectively given the green light by the federal government to promote nicotine products on television and radio and to aggressively target youth through extensive social media promotions. Over 400 000 school-aged Canadian youth are now vaping and risking nicotine addiction and potential tobacco use.[5] According to a recent meta-analysis, youth who vape are three times more likely to start smoking.[6] This inescapable distraction has absorbed immense time, energy and resources from those who should be working fervently to tackle tobacco use head-on. The final impact of vaping on youth smoking initiation and adult smoking cessation continues to remain in question.

The untimely closure of the Non-Smokers' Rights Association (NSRA) in 2017 represents another significant setback. The restoration of Health Canada tobacco control grants in 2018 did not come soon enough to save the NSRA or the Canadian Council on Tobacco Control, which closed its doors several years earlier. The recent termination of the Ontario Campaign for Action on Tobacco is another unfortunate casualty of reduced funding for tobacco control. The capacity of tobacco control NGOs is now at its lowest point in three decades.

Cannabis legalization and its widely sanctioned public consumption may jeopardize tobacco control efforts through the potential renormalization of smoking,[7,8] although these effects have yet to be fully identified and reported. Health Canada's < 5 by 35 proposal to increase the national minimum age for tobacco sales to 21 was effectively killed when the legal age for cannabis sales was coincidentally aligned with the legal voting age of 18. The federal government's simultaneous approval of cannabis pre-rolls (combustible joints) conflicted with its own reduced risk guidelines for cannabis use and facilitated the use of tobacco blunt wraps, which are often smoked with cannabis. Many cannabis smokers are also joint tobacco users,

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with about one-third of users mixing tobacco and cannabis.[9]

On top of these serious challenges, the COVID-19 pandemic has exacted an enormous toll on tobacco control, with public health staff, funding and resources redeployed to fight the coronavirus. Health charities laid off precious tobacco control staff across the country due to the impact of the pandemic restrictions on public fundraising efforts. Numerous federal, provincial and regional tobacco control staff have been redeployed to COVID-19 mitigation efforts, including the Director-General of Health Canada's Tobacco Control Directorate. The capacity of governments, civil society and health professionals to fight the tobacco epidemic has been reduced substantially by the impact of COVID-19. The need for sustainable funding for tobacco control has never been greater.

The tobacco industry continues to innovate and has transformed itself in the past few years by taking over a substantial portion of the vaping business. The sharp rise of the youth and young adult nicotine vaping market and the development of high-nicotine formulations and heat-not-burn products reveal an industry that has no plans to phase itself out of existence. While the long-term public health impacts of nicotine vaping are not well established, current evidence indicates a high degree of likelihood of substantial respiratory and cardiovascular effects.

Moreover, there is considerable evidence indicating that nicotine vaping by youth has the potential to increase smoking rates if governments allow it to happen, although these effects have yet to be reported in Canada. The potential smoking cessation benefits of nicotine vaping products will continue to be outweighed by the public health liabilities of youth and recreational nicotine use until these problems are successfully curbed. According to one model, for every smoker who quits smoking by vaping, there are an estimated 80 youth vapers who will become smokers.[10]

Obvious deficiencies

Canada is still struggling with major shortcomings in its tobacco control strategy that jeopardize its < 5 by 35 target.

One obvious deficiency is Canada's incomplete implementation of the World Health Organization (WHO) MPOWER policy package. Although the MPOWER package has been criticized as a relatively conservative policy approach, Canada does not meet this minimum global standard. Several MPOWER components have yet to be implemented in Canada, including raising tobacco taxes to 75% of the retail price; deploying evidence-based, well-financed and sustained mass media campaigns; and subsidizing smoking cessation treatment for all. In sharp contrast, Brazil and Turkey have fully implemented MPOWER, and several other countries are poised to follow suit.[11]

Canada has yet to adopt the global WHO protocol to reduce contraband tobacco despite substantial and ongoing smuggling.[12] The federal and provincial governments often turn a blind eye to the illegal distribution of untaxed commercial tobacco products from factories on First Nations reserves. Tobacco taxes remain repressed in Quebec and Ontario due in large part to the impact of the contraband market and the political sensitivities that accompany this overt criminal activity.

Mass media campaigns remain in suspended animation due to the sustained political fallout of a federal government scandal that occurred almost two decades ago, which resulted in a national commission of inquiry into federal sponsorship and advertising activities.[13]

Canadian governments continue to collaborate with tobacco companies in violation of Article 5.3 of the WHO Framework Convention for Tobacco Control (FCTC). One such disturbing collaboration involves the development of a potential new COVID-19 vaccine that is co-sponsored by Philip Morris and the federal government.[14]

These are serious deficiencies that are stalling progress in tobacco control and threatening efforts to achieve < 5 by 35.

Getting back on track

The goal of < 5 by 35 is in serious jeopardy. A concerted, expedient and determined effort is required to get tobacco control back on track. The five years since the declaration of < 5 by 35 have been horrendous. Virtually none of the important measures needed to get there have been adopted. These measures are spelled out clearly in the reports of the national endgame initiative,[1,15] and in an excellent report on modernizing Ontario's tobacco control strategy.[16] They include:

(1) introducing substantially higher tobacco taxes, effective price control policies and stronger measures to reduce contraband activity;

(2) preventing the industry from circumventing tax increases by reducing the price differential between different types and brands of cigarettes and prohibiting volume discounts;

(3) fully implementing the WHO MPOWER policy package and endorsing the FCTC global protocol to reduce contraband tobacco;

(4) banning all industry incentives offered to retailers;

(5) reducing the number of tobacco retailers;

(6) reducing the supply of tobacco products in a systematic manner that aligns with the < 5 by 35 target;

(7) increasing government support for free and effective smoking cessation treatment;

(8) restoring and expanding evidence-based mass media campaigns that include tobacco industry denormalization;

(9) ensuring full government adherence to Article 5.3 of the FCTC to minimize tobacco industry interference; and

(10) implementing system enablers, including:

- substantial and sustainable funding for tobacco control derived from tobacco industry levies;
- a coherent national strategy with concrete workplans, benchmarks, milestones and oversight; and
- full engagement of provincial and territorial governments, NGOs, health professions and researchers.

There is now an additional urgent need for a plan to reduce the use of all nicotine products to ensure that the tobacco smoking epidemic is not replaced by a nicotine vaping epidemic, and to avoid the resulting implications for nicotine addiction, tobacco dependence, respiratory and cardiovascular health.[17] With over 400 000 school-aged youth using vaping products in 2019, the potential for a lasting epidemic

of nicotine addiction and increased tobacco use should not be underestimated.

Seizing the opportunity

It appears that Minister Philpott's ambitious appeal has fallen on deaf ears, especially when examining the report and policy proposals that accompanied her 2017 directive. Several of the promising measures proposed in *Seizing the Opportunity* remain largely or completely unimplemented.

The federal government could use more nudging, direction and support. Perhaps it is time for provincial and territorial governments, NGOs, health professions and researchers to come together and collectively set the national agenda in consultation with the federal government. A truly national tobacco control strategy will involve all key stakeholders, with the federal government playing a coordinating role and with leadership coming from all parties. The next clarion call needs to be delivered by an orchestra instead of a lone bugler.

Much of the heavy lifting on tobacco control has occurred at the regional level over the past two decades, including workplace smoking bans, tobacco tax increases, flavour bans, mass media campaigns and smoking cessation programs. All provinces and territories have adopted their own tobacco control strategies to complement the federal strategy.

The legal jurisdiction over public health and tobacco control is shared between provinces or territories and the federal government, according to the *Constitution Act*. This shared responsibility has been very apparent during the COVID-19 pandemic, with provinces and territories playing pivotal roles that are reflected in weekly meetings between the prime minister and the premiers.

A renewed and united clarion call is desperately needed for all Canadian health ministers to commit to achieving < 5 by 35 and to putting concrete measures in place to get there. Other countries, including Ireland[18] and New Zealand,[19] have developed coherent action plans with tangible strategies, benchmarks, milestones and oversight to achieve "5 by 25."

Almost 50 000 Canadians die annually from tobacco-related illness, and this number has not changed appreciably in over two decades.[20,21] More than 400 000 youth vapers are currently risking nicotine addiction and potential tobacco use.[5] Almost a million Canadians are currently suffering the direct consequences of tobacco use according to an established 20:1 morbidity to mortality ratio.[22] The health care system is overburdened by chronic diseases, of which tobacco use is a major cause. Our economy is also suffering from the consequences of tobacco use due to reduced productivity, which accounts for almost half of the total economic impact.[23]

Hopefully, the COVID-19 pandemic will create a renewed national focus on public health that will encourage Canadian governments, civil society, health professions and other key players to take further collective action to substantially reduce tobacco use.

Perhaps we all need to seize the opportunity presented by COVID-19.

Conflicts of interest

LH is employed by an organization that receives public and private sector funding that is not derived from tobacco or vaping companies. RS declares no conflicts of interest.

Statement

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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Original quantitative research

Investigating individual-level correlates of e-cigarette initiation among a large sample of Canadian high school students

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This article has been peer reviewed.

Abstract

Introduction: Having a better understanding of individual factors associated with e-cigarette initiation can help improve prevention efforts. Therefore, this study aimed to (1) identify baseline characteristics associated with e-cigarette initiation, and (2) determine whether changes in these baseline characteristics were associated with e-cigarette initiation.

Methods: This study used data from Year 6 (2017/18, baseline) and Year 7 (2018/19, follow-up) of the COMPASS study. The final sample included 12 315 students in Grades 9 to 11 who reported never having tried e-cigarettes at baseline. Students reported demographic information, other substance use, school behaviours, physical activity, sedentary behaviour, sleep, symptoms of anxiety and depression, and emotional regulation and flourishing scores. Hierarchical GEE models, stratified by gender, examined the association between (1) baseline characteristics and e-cigarette initiation at follow-up and (2) changes in baseline characteristics and e-cigarette initiation at follow-up.

Results: In total, 29% of students who had not yet initiated e-cigarette use reported initiating e-cigarette use at follow-up. Students in Grades 10 and 11 were less likely to initiate e-cigarette use. Other substance use, skipping school and meeting the physical activity guidelines at baseline and one-year changes to these behaviours were associated with e-cigarette initiation among both male and female students. Additionally, some differences were noted between females and males.

Conclusion: Given that other health behaviours were associated with e-cigarette initiation, prevention approaches should target multiple health-risk behaviours to help prevent youth e-cigarette use. Additionally, school-based approaches may benefit by being implemented at the beginning of high school or in junior high school.

Keywords: *vaping, adolescent, alcohol drinking, cannabis smoking, cigarette smoking, mental health, exercise, sedentary behaviour*

Highlights

- Twenty-nine percent of students who had not yet initiated e-cigarette use reported initiating e-cigarette use at follow-up. Other substance use (i.e. alcohol, cannabis and cigarettes) was strongly associated with e-cigarette initiation.
- Students who met the Canadian physical activity guidelines were more likely to initiate e-cigarette use, and female students who met the screen time guidelines were less likely.
- Anxiety and depression were not significantly associated with e-cigarette initiation, but there was an association with higher emotional dysregulation for females and higher flourishing for males.
- The majority of students maintained their behaviours over time; results for changes from baseline were largely consistent with findings at baseline.

Introduction

E-cigarettes are rapidly evolving devices that deliver an aerosol (or another substance), often containing nicotine, to the user in the absence of tobacco and combustion.[1] The prevalence of e-cigarette use, also known as vaping, has increased dramatically among youth in recent years.[2-5] Both Canada and the United States have seen notable increases in e-cigarette use among adolescents.[4] The US saw an increase in prevalence among high school students from 1.5% to 20.8% from 2011 to 2018, with the largest jump between 2017 and 2018 (from 12% to 21%).[5] Similarly, e-cigarette use among adolescents aged 15 to 19 in Canada doubled from 10% in 2016 to 20% in 2018.[2] Among Canadian adolescents who report e-cigarette use, 40% report daily or almost daily use and 90% report using products with nicotine.[2] E-cigarette use among youth is concerning due to the unknown effects of exposure to aerosolized chemicals and the known negative impacts of nicotine on the developing brain.[6,7]

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While many studies have linked e-cigarette use and cigarette initiation,[8] few have focussed on the individual factors associated with e-cigarette use initiation. Evidence suggests that tobacco use (e.g. cigars, cigarillos) and substance use,[9-12] high levels of sensation seeking,[13,14] poor mental health,[15,16] exposure to e-cigarette marketing,[9,17,18] and positive attitudes towards e-cigarettes among individuals, friends and family[9,19-21] are factors associated with initiating e-cigarette use. While many studies have identified a significant association between e-cigarette initiation and gender, they have not explored further gender differences in predictive factors.[9,10,13-15,18,19] A better understanding of individual factors associated with e-cigarette initiation can improve prevention efforts by identifying the characteristics (both modifiable and nonmodifiable) of at-risk groups. However, there has been little investigation into the influence of other risk behaviours (e.g. truancy, poor grades), movement behaviours[22] and mental wellbeing on e-cigarette initiation, and how these change over time.

There is a well-established literature demonstrating that less healthy behaviour patterns among adolescents increase over time. For example, substance use and screen time tend to increase over time, while physical activity and sleep tend to decrease with age.[2,23-25] Although many of these changes have been well documented, there is a lack of evidence concerning how changes over time are associated with more novel experiences, including e-cigarette initiation. To date, studies examining e-cigarette initiation have examined baseline behaviours only, and it is unknown how changes in behaviour may be associated with e-cigarette initiation.

Given the novelty of e-cigarettes, there is a need to further explore the individual-level factors that are associated with e-cigarette initiation among adolescents. The objectives of this study were to identify (1) the baseline characteristics associated with e-cigarette initiation, and (2) whether changes in these baseline characteristics were associated with e-cigarette initiation among Canadian adolescents.

Methods

Host study

COMPASS is a prospective cohort study that collects data from students in Grades 9 to 12 (aged 13–18 years) in British Columbia, Alberta and Ontario, and in Secondary I–V (aged 12–17 years) in Quebec, Canada.[26] All procedures were approved by the University of Waterloo Office of Research Ethics (reference number 30118) and appropriate school board committees. A full description of the COMPASS study methods can be found in print[26] or online (www.compass.uwaterloo.ca).

Participants

This study used data from Year 6 (2017/18, baseline) and Year 7 (2018/19, follow-up) of the COMPASS study. A total of 40 388 students in Grades 9 to 11 (and Secondary III–V in Quebec) from 111 schools participated at baseline (81.5% participation rate), and 23 168 of these (57%) were linked across both baseline and follow-up. Linked students were younger, comprised more females and had lower frequencies of substance use, including e-cigarette use, at baseline (data available upon request). Students for whom information on covariates was missing at baseline or at both baseline and follow-up (n = 5338, 23%) were removed. Students who were missing data and those who were not did not differ by frequency of e-cigarette use (data available upon request). Finally, those who had ever tried e-cigarettes at baseline were also removed from the sample (n = 5515, 31%). Thirty-three percent of students removed based on this criterion were in Grade 9 (n = 1805), 42% were in Grade 10 (n = 2304), and 25% were in Grade 11 (n = 1406). The final sample included 12 315 students in Grades 9 to 11 who reported never having tried e-cigarettes at baseline. We additionally examined a subsample of students (n = 10 727) who had complete data both at baseline and follow-up to explore whether changes in these baseline characteristics were associated with e-cigarette initiation.

Measures

Student responses were captured using the COMPASS questionnaire, which was administered during class time. Consistent with other youth health research,[27] students reported their grade, gender, ethnicity and weekly spending money.

To identify e-cigarette initiation, students were asked, "Have you ever tried an electronic cigarette, also known as an e-cigarette?" Students who indicated "yes" at baseline were removed from the sample. Students who indicated "no" at baseline and "yes" at follow-up were considered to have initiated e-cigarette use.

The questionnaire also collected information on the use of other substances, including alcohol, cannabis and cigarettes. For alcohol and cannabis use, students were categorized as "monthly" users if they indicated use once per month or more, and "infrequent" users if they indicated use less than once per month. For cigarette use and e-cigarette use, students were categorized as "ever" users or "past month" users.

The questionnaire also collected data about behaviours at school, including skipping school in the past four weeks, and English grades (French grades in Quebec).

Additionally, students were asked to report the amount of time per day spent doing moderate-to-vigorous physical activity (MVPA), engaging in sedentary screen time activities (watching or streaming TV or movies, playing video or computer games, surfing the internet and texting, messaging or emailing), and sleeping. Students were categorized as meeting or not meeting the targets for each of these movement behaviours as set by the Canadian 24-Hour Movement Guidelines for Children and Youth.[22] It is recommended that each day children and youth should accumulate at least 60 minutes of MVPA, less than 2 hours of screen time, and 8 to 10 hours of uninterrupted sleep.[22]

Finally, mental health and wellbeing were assessed using the Centre for Epidemiological Studies Depression Scale (CES-D-10),[28] the Generalized Anxiety Disorder 7 (GAD-7) scale,[29] the Difficulties in Emotional Regulation Scale (DERS),[30] and the Flourishing Scale.[31] The CES-D-10 and the GAD-7 are continuous scales ranging from 0 to 30 and 0 to 21 respectively, where a score of 10 or higher is indicative of clinically relevant symptomatology; scales were dichotomized to reflect this.[28,29] The DERS is a continuous scale with a range of 6 to 30, where a higher score indicates poorer emotional regulation. The Flourishing Scale is a continuous scale with a range of 8 to 40, where a higher score indicates better flourishing. Flourishing is a state of overall wellbeing

used to describe the presence of mental health;[32] the scale included level of agreement with questionnaire items such as "I lead a purposeful and meaningful life," "I am engaged and interested in my daily activities" and "I am optimistic about my future." We modelled a 3-unit change in both DERS and flourishing scores to capture a relevant change in score (> 1/2 a standard deviation) that was not due to chance alone. These scales have been previously validated among adolescents.[28,30,33-37]

Analyses

The analyses were conducted in two parts. First (Part 1), we examined the association between baseline individual-level characteristics and follow-up e-cigarette initiation. Chi-squared tests compared categorical variables and *t*-tests compared continuous variables across e-cigarette use initiation at follow-up. Generalized estimating equations (GEE) via PROC GENMOD in SAS with an exchangeable correlation structure were used to identify baseline variables associated with e-cigarette initiation at follow-up while accounting for the nesting of students within schools. We first ran partially adjusted models examining the association between each variable and e-cigarette initiation, adjusting only for province, grade and gender. We then ran fully adjusted models adjusting for all other variables. All models were stratified by gender due to known differences in behaviour and differences identified using chi square and bivariate analyses.

Second (Part 2), we explored how changes in individual-level characteristics between baseline and follow-up were associated with e-cigarette initiation at follow-up. Students were categorized into different groups based on the change in their behaviours between baseline and follow-up. For substance use, "abstainers" did not engage in a specific behaviour at baseline or follow-up; "maintainers" continued the same level of frequency of the behaviour at baseline and follow-up; "escalators" increased the frequency of the behaviour from baseline to follow-up; and "reducers" decreased the frequency of the behaviour from baseline to follow-up. For binary variables such as skipping school, meeting movement behaviour guidelines, and depression and anxiety, students were categorized based on having "yes" responses for "both years," "neither year," "follow-up only" or "baseline only." For continuous variables, including DERS and flourishing, students were categorized as "no change," "increase" or "decrease" based on the difference between their responses at baseline and at follow-up. We used the same analytic approach as in Part 1. All analyses were performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Descriptive characteristics

Just over half of the sample was female (56%); 41% of students were in Grade 9, 36% in Grade 10 and 23% in Grade 11; 65% were White. Between baseline (2017/18) and follow-up one year later (2018/19), 29% of students who had not yet initiated e-cigarette use reported initiating e-cigarette use (Table 1).

Part 1: Association between baseline characteristics and e-cigarette initiation

After adjusting for all other factors, being in Grade 10 or 11 was associated with lower odds of e-cigarette initiation among both female and male students compared to being in Grade 9 (Table 2). More spending money was associated with increased odds of e-cigarette initiation.

After adjusting for all other factors, infrequent and monthly alcohol use and ever and past month cigarette smoking were associated with e-cigarette initiation among both female and male students. Infrequent and monthly cannabis use was associated with e-cigarette initiation among female students, while only infrequent use was associated with e-cigarette initiation among male students. Skipping school and getting lower grades were associated with increased likelihood of e-cigarette initiation.

Various movement behaviours were also associated with e-cigarette initiation. After adjusting for all other factors, meeting the physical activity guidelines was associated with e-cigarette initiation for both female (adjusted odds ratio [aOR] = 1.14; 95% CI = 1.02–1.27) and male (1.35; 1.16–1.57) students. Meeting the screen time guidelines was associated with decreased odds of e-cigarette initiation only among female students (0.69; 0.58–0.84). Meeting the sleep guidelines was not significantly associated with e-cigarette initiation.

After adjusting for all other factors, reporting clinically relevant symptoms of anxiety or depression was not associated with e-cigarette initiation among either female or male students. However, among females, each 3-point increase in the DERS, representing poorer emotional regulation, was associated with slightly increased odds of e-cigarette initiation (1.07; 1.02–1.12), whereas among males, each 3-point increase in the Flourishing Scale, representing stronger flourishing, was associated with a slightly increased odds of e-cigarette initiation (1.09; 1.04–1.15).

Part 2: Association between changes in covariates and e-cigarette initiation

Across both genders, most students maintained their behaviours over time between baseline and follow-up, although, notably, 29% of students reported increasing their alcohol use (Table 3).

Similar to the results from Part 1, female and male students who abstained from other substance use, specifically alcohol use, cannabis use and cigarette smoking, at both baseline and follow-up had lower odds of initiating e-cigarette use compared to those who maintained their frequency of substance use in the fully adjusted models (Table 4).

Significant results were found for students who did not skip classes either year and for female students who skipped class in the baseline year only.

Male students who met the physical activity guidelines both years, who started meeting the guidelines and who stopped meeting the guidelines were at increased risk of e-cigarette initiation compared to those who did not meet the guidelines either year. Female students who met the screen time and sleep guidelines both years were less likely to start using e-cigarettes than those who met the guidelines neither year.

Changes in mental health and well-being indicators were not significantly associated with e-cigarette initiation.

Discussion

Over the course of one year, almost one-third (29%) of the Canadian secondary school students who had not yet initiated e-cigarette use reported initiation. This is consistent with research showing a rapid increase in the popularity of e-cigarette use among students,[3] and highlights the

TABLE 1
Characteristics of students in Grades 9 to 11 who had not tried e-cigarettes at baseline, by gender and e-cigarette initiation status at follow-up, 2017/18 to 2018/19 COMPASS study

Variable	Total (n = 12 315)		Female (n = 6891)			Male (n = 5424)		
			E-cigarette initiation status			E-cigarette initiation status		
	n	%	No (%) (n = 4791)	Yes (%) (n = 2100)	*p*-value	No (%) (n = 3907)	Yes (%) (n = 1517)	*p*-value
Grade								
9	5 049	41.0	40.3	41.1	0.83	41.5	42.0	0.16
10	4 478	36.4	36.9	36.6		35.3	37.1	
11	2 788	22.6	22.8	22.4		23.2	20.9	
Ethnicity								
White	8 041	65.3	61.3	73.5	< 0.01	63.1	72.4	< 0.01
Non-White	4 274	34.7	38.7	26.5		36.9	27.6	
Weekly spending money								
Zero	2 627	21.3	21.6	13.8	< 0.01	26.3	17.9	< 0.01
$1–$20	3 622	29.4	29.9	28.1		29.7	28.9	
$21–$100	2 612	21.2	20.3	26.5		18.8	23.1	
$100+	1 361	11.1	8.9	15.4		9.8	15.1	
Don't know/missing	2 093	17.0	19.3	16.2		15.4	15.0	
Alcohol use								
None	8 325	67.6	74.4	41.2	< 0.01	79.9	51.0	< 0.01
Infrequent	2 315	18.8	17.3	30.9		11.8	25.1	
Monthly	1 675	13.6	8.4	28.0		8.3	23.9	
Cannabis use								
None	11 597	94.2	96.6	85.1	< 0.01	97.5	90.4	< 0.01
Infrequent	410	3.3	2.1	8.5		1.3	5.3	
Monthly	308	2.5	1.3	6.4		1.2	4.4	
Cigarette use								
None	11 673	94.8	97.1	87.7	< 0.01	97.5	90.2	< 0.01
Ever use	480	3.9	2.3	8.7		2.1	7.1	
Past month use	162	1.3	0.6	3.7		0.4	2.7	
Skipping school								
No	10 182	82.7	84.6	71.4	< 0.01	88.1	78.4	< 0.01
Yes	2 133	17.3	15.5	28.6		11.9	21.6	
English grade[a]								
80%–100%	7 489	60.8	71.8	63.1	< 0.01	53.1	43.0	< 0.01
70%–79%	3 115	25.3	19.9	24.6		29.2	33.4	
60%–69%	1 166	9.5	6.0	7.9		11.8	16.6	
< 60%	545	4.4	2.4	4.4		5.9	7.1	
Meeting PA guidelines								
No	7 355	59.7	66.5	61.6	< 0.01	55.8	45.8	< 0.01
Yes	4 960	40.3	33.5	38.4		44.2	54.3	
Meeting screen time guidelines								
No	11 250	91.4	88.3	93.2	< 0.01	93.0	94.1	0.15
Yes	1 065	8.7	11.7	6.8		7.0	5.9	

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TABLE 1 (continued)
Characteristics of students in Grades 9 to 11 who had not tried e-cigarettes at baseline, by gender and e-cigarette initiation status at follow-up, 2017/18 to 2018/19 COMPASS study

Variable	Total (n = 12 315)		Female (n = 6891)			Male (n = 5424)		
			E-cigarette initiation status			E-cigarette initiation status		
	n	%	No (%) (n = 4791)	Yes (%) (n = 2100)	*p*-value	No (%) (n = 3907)	Yes (%) (n = 1517)	*p*-value
Meeting sleep guidelines								
No	6 872	55.8	57.8	60.1	0.07	51.9	53.7	0.22
Yes	5 443	44.2	42.2	39.9		48.1	46.3	
Depression symptoms								
No	8 366	67.9	62.9	54.4	< 0.01	77.6	77.5	0.93
Yes	3 949	32.1	37.1	45.6		22.4	22.5	
Anxiety symptoms								
No	9 484	77.0	70.6	65.7	< 0.01	87.3	86.6	0.46
Yes	2 831	23.0	29.4	34.3		12.7	13.5	
DERS (mean, SD)	13.8, 4.6		14.3, 4.8	15.2, 4.9	< 0.01	12.8, 4.1	13.0, 4.1	0.15
Flourishing Scale (mean, SD)	32.2, 5.4		32.1, 5.5	31.8, 5.5	0.03	32.2, 5.3	32.9, 4.8	< 0.01

Abbreviations: DERS, Difficulties in Emotional Regulation Scale; PA, physical activity; SD, standard deviation.

[a] English grade in all provinces except Quebec, where the French grade was considered instead.

importance of investigating e-cigarette initiation. We identified multiple demographic and behavioural factors that were associated with e-cigarette initiation. Furthermore, we explored how changes to baseline behavioural factors among both female and male students were associated with e-cigarette initiation. The stratified findings illustrate some differences in factors associated with e-cigarette initiation between the genders that could inform tailored e-cigarette use prevention programs.

This study adds to the current literature by exploring an expanded range of factors associated with e-cigarette initiation. Younger students were more likely to initiate e-cigarette use, possibly because they are less resistant to peer influence.[38] This suggests that e-cigarette prevention efforts are needed prior to starting Grade 9 and may need to be reinforced in secondary school. Consistent with previous evidence for cigarette smoking[39] and e-cigarette initiation,[16] female and male students with more spending money were more likely to initiate e-cigarette use. The cost of devices can be a deterrent for price-sensitive youth; therefore, taxation policies that increase the cost of e-cigarette devices and accessories (e.g. e-liquid, pods) may help to reduce e-cigarette initiation among youth.

As expected, participation in other substance use (i.e. alcohol, cannabis and cigarettes) was strongly associated with e-cigarette initiation. At baseline, monthly alcohol use posed the greatest risk for females and past month cigarette use posed the greatest risk for males, followed by monthly alcohol use. Due to the relatively high number of students who reported alcohol use (33% for alcohol use vs. 6% for cannabis use and 5% for cigarette use) and the high odds of initiation, prevention efforts in this domain may also help prevent e-cigarette use, although additional evaluation evidence is required.

Results for changes in substance-use behaviours over time were similar. Many earlier studies have noted the clustering of health-risk and substance-use behaviours among adolescents, and it is likely that impulsivity and high levels of sensation seeking are underlying risk factors for these behaviours.[9,10,12-15,21] Prevention programs should therefore address multiple substances and the underlying reasons that students use these substances, although additional evaluation of such programs on multiple health-risk behaviours is necessary.

Other health related behaviours were also associated with e-cigarette initiation, though results were sometimes complex and some differences between male and female students were observed. For example, students who met the Canadian physical activity guidelines were more likely to initiate e-cigarette use. An earlier Canadian study also identified a link between physical activity and e-cigarette use;[40] however, other US-based studies have identified no link.[41-43] There is also evidence that youth view e-cigarettes as a less harmful alternative to cigarettes.[44] While students are increasingly aware of the harms of regular nicotine vaping, fewer students perceive harms with non-nicotine vaping or occasional nicotine vaping.[2,45] This may explain their appeal to youth participating in sport who have been found to avoid other inhaled substances such as cannabis and cigarettes.[46]

Meeting screen time guidelines, however, was negatively associated with e-cigarette initiation among female students who met screen time guidelines at baseline and follow up (i.e. maintainers). Previous research has identified a link between exposure to e-cigarette advertising and e-cigarette initiation,[9,17,18] and students who meet Canadian screen time recommendations could have lower levels of exposure to advertising, particularly online. E-cigarette promotion is prevalent online, and youth who report exposure are more likely to initiate use.[47,48] This result may have only been found among female students due to gender differences in how students engage in screen time: male students are more likely to spend time playing video games while

TABLE 2
GEE logistic regression models examining the association between individual-level characteristics at baseline and adjusted odds of e-cigarette initiation at follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study (n = 12 315)

Variable	Female		Male	
	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)
Grade				
9	1.00	1.00	1.00	1.00
10	0.99 (0.87–1.13)	0.65 (0.57–0.75)*	1.06 (0.92–1.21)	0.81 (0.70–0.94)*
11	1.10 (0.96–1.25)	0.54 (0.46–0.63)*	1.02 (0.87–1.21)	0.62 (0.51–0.75)*
Ethnicity				
White	1.00	1.00	1.00	1.00
Non-White	0.70 (0.61–0.80)*	0.76 (0.66–0.87)*	0.83 (0.70–0.98)*	0.86 (0.72–1.03)
Weekly spending money				
Zero	1.00	1.00	1.00	1.00
$1–$20	1.50 (1.29–1.75)*	1.34 (1.14–1.58)*	1.45 (1.20–1.75)*	1.29 (1.06–1.58)*
$21–$100	2.01 (1.70–2.39)*	1.65 (1.37–1.99)*	1.82 (1.50–2.19)*	1.42 (1.16–1.74)*
$100+	2.63 (2.14–3.24)*	1.89 (1.50–2.38)*	2.27 (1.86–2.77)*	1.65 (1.32–2.06)*
Don't know/missing	1.26 (1.08–1.47)*	1.19 (1.00–1.41)*	1.43 (1.17–1.75)*	1.29 (1.05–1.58)*
Alcohol use				
None	1.00	1.00	1.00	1.00
Infrequent	3.37 (2.92–3.88)*	2.81 (2.42–3.25)*	3.42 (2.88–4.04)*	2.99 (2.50–3.57)*
Monthly	6.48 (5.50–7.63)*	4.12 (3.45–4.91)*	4.51 (3.71–5.48)*	3.16 (2.55–3.93)*
Cannabis use				
None	1.00	1.00	1.00	1.00
Infrequent	4.68 (3.71–5.90)*	1.87 (1.42–2.46)*	4.45 (3.33–5.96)*	2.00 (1.36–2.95)*
Monthly	5.85 (4.29–7.97)*	1.69 (1.17–2.45)*	4.05 (2.56–6.42)*	1.26 (0.75–2.14)
Cigarette use				
None	1.00	1.00	1.00	1.00
Ever use	4.38 (3.36–5.70)*	2.13 (1.54–2.96)*	3.89 (2.96–5.11)*	2.52 (1.87–3.39)*
Past month use	6.38 (4.16–9.79)*	1.72 (1.00–2.94)*	8.35 (4.23–16.69)*	4.28 (2.02–9.06)*
Skipping school				
No	1.00	1.00	1.00	1.00
Yes	2.28 (1.97–2.63)*	1.54 (1.32–1.79)*	2.01 (1.72–2.35)*	1.42 (1.20–1.67)*
English grade[a]				
80%–100%	1.00	1.00	1.00	1.00
70%–79%	1.37 (1.21–1.55)*	1.23 (1.07–1.41)*	1.32 (1.16–1.51)*	1.33 (1.15–1.54)*
60%–69%	1.48 (1.20–1.83)*	1.26 (0.97–1.63)	1.57 (1.27–1.94)*	1.55 (1.24–1.92)*
< 60%	2.23 (1.77–2.82)*	1.68 (1.28–2.21)*	1.44 (1.13–1.84)*	1.43 (1.09–1.88)*
Meeting PA guidelines				
No	1.00	1.00	1.00	1.00
Yes	1.27 (1.15–1.41)*	1.14 (1.02–1.27)*	1.54 (1.34–1.77)*	1.35 (1.16–1.57)*
Meeting screen time guidelines				
No	1.00	1.00	1.00	1.00
Yes	0.53 (0.44–0.63)*	0.69 (0.58–0.84)*	0.87 (0.68–1.11)	0.97 (0.75–1.27)
Meeting sleep guidelines				
No	1.00	1.00	1.00	1.00
Yes	0.82 (0.73–0.92)*	0.90 (0.80–1.02)	0.88 (0.76–1.02)	0.93 (0.80–1.06)

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TABLE 2 (continued)
GEE logistic regression models examining the association between individual-level characteristics at baseline and adjusted odds of e-cigarette initiation at follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study (n = 12 315)

Variable	Female		Male	
	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)
Depression symptoms				
No	1.00	1.00	1.00	1.00
Yes	1.51 (1.34–1.70)*	1.13 (0.98–1.31)	1.05 (0.88–1.25)	1.00 (0.80–1.24)
Anxiety symptoms				
No	1.00	1.00	1.00	1.00
Yes	1.29 (1.15–1.44)*	0.89 (0.75–1.05)	1.10 (0.91–1.33)	1.02 (0.80–1.30)
DERS (3-unit increase)	1.14 (1.10–1.18)*	1.07 (1.02–1.12)*	1.04 (0.99–1.09)	1.05 (0.99–1.11)
Flourishing Scale (3-unit increase)	0.94 (0.92–0.97)*	1.03 (1.00–1.07)	1.06 (1.02–1.10)*	1.09 (1.04–1.15)*

Abbreviations: aOR, adjusted odds ratio; CI, confidence intervals; DERS, Difficulties in Emotional Regulation Scale; GEE, generalized estimating equations; PA, physical activity.

Notes: Partially adjusted models controlled for grade, ethnicity, province and school-level clustering. Fully adjusted models controlled for all variables in table, province and school-level clustering. Physical activity guidelines: at least 60 minutes of moderate-to-vigorous physical activity per day. Screen time guidelines: less than 2 hours of screen time per day. Sleep guidelines: 8 to 10 hours of uninterrupted sleep. Depression and anxiety symptoms were measured using the CES-D-10 and the GAD-7, respectively. These are continuous scales where a score of 10 or higher was used to indicate clinically relevant symptomatology.

[a] English grade in all provinces except Quebec, where the French grade was considered instead.

*$p < 0.05$

TABLE 3
Change in individual-level behaviours between baseline and follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study

Variable	Total (n = 10 727)		Female (n = 6032)			Male (n = 4695)		
			E-cigarette initiation status			E-cigarette initiation status		
	n	%	No (%) (n = 4191)	Yes (%) (n = 1841)	*p*-value	No (%) (n = 3399)	Yes (%) (n = 1296)	*p*-value
Alcohol use								
Maintainers	2045	19.1	14.9	35.7	< 0.01	11.7	28.1	< 0.01
Abstainers	4977	46.4	55.6	13.1		62.9	20.5	
Escalators	3053	28.5	24.1	43.4		20.0	43.4	
Reducers	652	6.1	5.4	7.8		5.3	7.9	
Cannabis use								
Maintainers	340	3.2	1.5	9.1	< 0.01	1.0	6.0	< 0.01
Abstainers	8950	83.4	91.8	60.3		93.2	63.6	
Escalators	1259	11.7	5.3	27.3		4.9	28.3	
Reducers	178	1.7	1.4	3.3		1.0	2.1	
Cigarette use								
Maintainers	338	3.2	1.6	8.1	< 0.01	1.1	6.5	< 0.01
Abstainers	9511	88.7	95.1	71.4		95.7	74.0	
Escalators	721	6.7	2.4	17.8		2.1	17.3	
Reducers	157	1.5	1.0	2.7		1.1	2.2	
Skipping school								
Skipped both years	1169	10.9	9.1	20.9	< 0.01	6.7	13.4	< 0.01
Skipped neither year	7009	65.3	68.4	46.2		75.2	56.7	
Skipped follow-up only	1882	17.5	16.3	25.4		13.2	21.8	
Skipped baseline only	667	6.2	6.2	7.6		4.9	8.0	

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TABLE 3 (continued)
Change in individual-level behaviours between baseline and follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study

Variable	Total (n = 10 727)		Female (n = 6032)			Male (n = 4695)		
			E-cigarette initiation status			E-cigarette initiation status		
	n	%	No (%) (n = 4191)	Yes (%) (n = 1841)	*p*-value	No (%) (n = 3399)	Yes (%) (n = 1296)	*p*-value
English grade[a]								
No change	7050	65.7	73.3	67.1	< 0.01	60.8	52.2	< 0.01
Increase in grade	1779	16.6	13.0	16.1		19.2	22.0	
Decrease in grade	1898	17.7	13.8	16.8		19.9	25.8	
Meeting PA guidelines								
Met neither year	4884	45.5	52.7	46.8	< 0.01	42.0	29.9	< 0.01
Met both years	2551	23.8	17.9	21.1		27.8	36.0	
Met follow-up only	1519	14.2	13.6	14.8		14.0	15.6	
Met baseline only	1773	16.5	15.8	17.3		16.2	18.5	
Meeting screen time guidelines								
Met neither year	9408	87.7	83.3	90.3	< 0.01	90.2	91.7	0.11
Met both years	333	3.1	4.8	1.8		2.3	1.5	
Met follow-up only	400	3.7	5.1	3.0		3.0	2.2	
Met baseline only	586	5.5	6.8	4.9		4.4	4.7	
Meeting sleep guidelines								
Met neither year	4887	45.6	48.7	50.1	0.09	40.9	41.1	0.22
Met both years	2784	26.0	25.1	22.1		28.7	27.0	
Met follow-up only	1096	10.2	9.0	9.9		10.8	12.8	
Met baseline only	1960	18.3	17.2	17.9		19.6	19.1	
Depression symptoms								
Neither year	5617	52.4	46.6	37.3	< 0.01	64.3	61.1	0.04
Both years	2536	23.6	29.1	34.7		14.4	14.6	
Follow-up only	1647	15.4	16.0	17.8		12.9	16.1	
Baseline only	927	8.6	8.3	10.3		8.3	8.2	
Anxiety symptoms								
Neither year	6948	64.8	57.3	48.9	< 0.01	78.6	75.2	0.04
Both years	1604	15.0	20.1	23.2		7.0	7.4	
Follow-up only	1286	12.0	13.2	16.7		8.4	10.7	
Baseline only	889	8.3	9.4	11.1		5.9	6.7	
DERS								
No change	5399	50.3	48.9	45.4	0.05	54.1	52.1	0.44
Increase	2884	26.9	28.6	30.3		23.7	25.0	
Decrease	2444	22.8	22.5	24.3		22.2	22.9	
Flourishing Scale								
No change	5567	51.9	52.3	50.3	0.26	52.5	51.3	0.77
Increase	2276	21.2	19.9	21.6		22.1	22.6	
Decrease	2884	26.9	27.7	28.1		25.4	26.1	

Abbreviations: DERS, Difficulties in Emotional Regulation Scale; PA, physical activity.

Notes: Changes in DERS and Flourishing Scale reflect a 3-unit change.

For substance use, "abstainers" did not engage in a specific behaviour at baseline or follow-up; "maintainers" continued the same level of frequency of the behaviour at baseline and follow-up; "escalators" increased the frequency of the behaviour from baseline to follow-up; and "reducers" decreased the frequency of the behaviour from baseline to follow-up.

[a] English grade in all provinces except Quebec, where the French grade was considered instead.

TABLE 4
GEE logistic regression models examining the association between change in individual-level behaviours between baseline and follow-up and e-cigarette initiation at follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study (n = 10 727)

Variable	Female		Male	
	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)
Alcohol use				
Maintainers	1.00	1.00	1.00	1.00
Abstainers	0.09 (0.07–0.11)*	0.19 (0.15–0.23)*	0.13 (0.11–0.16)*	0.26 (0.21–0.33)*
Escalators	0.69 (0.58–0.82)*	0.87 (0.72–1.05)	0.87 (0.71–1.06)	1.13 (0.91–1.40)
Reducers	0.60 (0.47–0.77)*	0.70 (0.54–0.90)*	0.63 (0.48–0.83)*	0.80 (0.58–1.09)
Cannabis use				
Maintainers	1.00	1.00	1.00	1.00
Abstainers	0.10 (0.07–0.14)*	0.31 (0.21–0.45)*	0.10 (0.07–0.15)*	0.30 (0.19–0.49)*
Escalators	0.81 (0.57–1.16)	1.01 (0.68–1.49)	0.87 (0.56–1.34)	1.12 (0.68–1.83)
Reducers	0.40 (0.24–0.66)*	0.60 (0.33–1.07)	0.35 (0.19–0.63)*	0.52 (0.25–1.08)
Cigarette use				
Maintainers	1.00	1.00	1.00	1.00
Abstainers	0.14 (0.11–0.20)*	0.37 (0.25–0.53)*	0.12 (0.08–0.19)*	0.27 (0.17–0.43)*
Escalators	1.45 (1.01–2.08)*	1.55 (0.98–2.45)	1.35 (0.84–2.17)	1.26 (0.73–2.17)
Reducers	0.56 (0.33–0.97)*	0.58 (0.31–1.07)	0.38 (0.20–0.73)*	0.39 (0.19–0.80)*
Skipping school				
Skipped both years	1.00	1.00	1.00	1.00
Skipped neither year	0.26 (0.22–0.31)*	0.58 (0.49–0.69)*	0.35 (0.28–0.43)*	0.72 (0.58–0.90)*
Skipped follow-up only	0.64 (0.53–0.78)*	0.84 (0.68–1.05)	0.82 (0.66–1.01)	1.05 (0.82–1.35)
Skipped baseline only	0.51 (0.39–0.66)*	0.65 (0.50–0.85)*	0.80 (0.60–1.06)	1.14 (0.82–1.59)
English grade[a]				
No change	1.00	1.00	1.00	1.00
Increase	1.37 (1.18–1.59)*	0.98 (0.81–1.19)	1.31 (1.11–1.54)*	1.17 (0.96–1.42)
Decrease	1.39 (1.19–1.62)*	1.06 (0.87–1.29)	1.46 (1.22–1.74)*	1.21 (0.99–1.49)
Meeting PA guidelines				
Met neither year	1.00	1.00	1.00	1.00
Met both years	1.39 (1.20–1.61)*	1.15 (0.97–1.36)	1.91 (1.58–2.30)*	1.48 (1.18–1.84)*
Met follow-up only	1.30 (1.10–1.54)*	1.09 (0.92–1.30)	1.64 (1.34–2.01)*	1.28 (0.98–1.68)
Met baseline only	1.30 (1.12–1.50)*	1.13 (0.95–1.34)	1.69 (1.39–2.06)*	1.36 (1.08–1.71)*
Meeting screen time guidelines				
Met neither year	1.00	1.00	1.00	1.00
Met both years	0.32 (0.22–0.47)*	0.58 (0.39–0.84)*	0.60 (0.38–0.96)*	0.94 (0.57–1.54)
Met follow-up only	0.54 (0.39–0.74)*	0.82 (0.59–1.14)	0.69 (0.43–1.11)	0.79 (0.48–1.32)
Met baseline only	0.64 (0.49–0.83)*	0.88 (0.66–1.16)	1.13 (0.82–1.55)	1.39 (0.92–2.09)
Meeting sleep guidelines				
Met neither year	1.00	1.00	1.00	1.00
Met both years	0.74 (0.63–0.86)*	0.84 (0.71–0.98)*	0.87 (0.72–1.04)	1.01 (0.83–1.23)
Met follow-up only	0.98 (0.78–1.23)	0.96 (0.75–1.22)	1.14 (0.90–1.43)	1.26 (0.99–1.62)
Met baseline only	0.96 (0.82–1.12)	1.02 (0.87–1.20)	0.92 (0.75–1.14)	1.02 (0.81–2.19)

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TABLE 4 (continued)
GEE logistic regression models examining the association between change in individual-level behaviours between baseline and follow-up and e-cigarette initiation at follow-up among students in the 2-year linked sample, by gender, 2017/18 to 2018/19 COMPASS study (n = 10 727)

Variable	Female		Male	
	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)	Partially adjusted aOR (95% CI)	Fully adjusted aOR (95% CI)
Depression symptoms				
Both years	1.00	1.00	1.00	1.00
Neither year	0.62 (0.54–0.72)*	1.04 (0.85–1.27)	0.88 (0.71–1.09)	1.13 (0.82–1.57)
Follow-up only	0.91 (0.75–1.10)	1.19 (0.94–1.51)	1.21 (0.94–1.55)	1.31 (0.90–1.89)
Baseline only	1.02 (0.83–1.26)	1.11 (0.86–1.45)	0.94 (0.72–1.24)	1.02 (0.70–1.49)
Anxiety symptoms				
Both years	1.00	1.00	1.00	1.00
Neither year	0.72 (0.62–0.84)*	0.91 (0.72–1.14)	0.88 (0.69–1.12)	0.99 (0.69–1.44)
Follow-up only	1.09 (0.89–1.33)	1.13 (0.88–1.46)	1.20 (0.89–1.63)	1.26 (0.82–1.93)
Baseline only	1.03 (0.81–1.30)	0.96 (0.72–1.28)	1.09 (0.82–1.45)	1.11 (0.77–1.61)
DERS (3-unit change)				
No change	1.00	1.00	1.00	1.00
Increase	1.16 (1.03–1.30)*	1.05 (0.89–1.23)	1.09 (0.93–1.26)	0.98 (0.81–1.18)
Decrease	1.19 (1.03–1.38)*	1.12 (0.94–1.33)	1.08 (0.92–1.27)	1.03 (0.86–1.24)
Flourishing Scale (3-unit change)				
No change	1.00	1.00	1.00	1.00
Increase	1.13 (1.00–1.28)*	1.04 (0.88–1.23)	1.07 (0.90–1.27)	1.00 (0.82–1.23)
Decrease	1.06 (0.95–1.18)	0.92 (0.80–1.33)	1.04 (0.90–1.20)	0.97 (0.81–1.16)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; DERS, Difficulties in Emotional Regulation Scale; GEE, generalized estimating equations; PA, physical activity.

Notes: Partially adjusted models controlled for grade, ethnicity, province and school-level clustering. Fully adjusted models controlled for grade, ethnicity, spending money, all variables in table, province and school-level clustering.

For substance use, "abstainers" did not engage in a specific behaviour at baseline or follow-up; "maintainers" continued the same level of frequency of the behaviour at baseline and follow-up; "escalators" increased the frequency of the behaviour from baseline to follow-up; and "reducers" decreased the frequency of the behaviour from baseline to follow-up.

[a] English grade in all provinces except Quebec, where the French grade was considered instead.

*$p < 0.05$

female students are more likely to spend time on their mobile phone.[49] However, these results should be interpreted with caution, given that the vast majority of both female and male students did not meet screen time guidelines.

Finally, meeting the sleep guidelines both years among females was negatively associated with e-cigarette initiation. These results are intuitive and add to the literature. While cannabis use and initiating binge drinking have been associated with not meeting the sleep guidelines,[50,51] other research has found no association.[52] This finding may be due to a shift in lifestyle less conducive to sleep, although more research is warranted.

In contrast to previous studies,[15,16,53] mental health indicators were not significantly associated with e-cigarette initiation. Two previous studies identified internalizing problems (e.g. anxiety, depression) were associated with initiation of e-cigarettes only but not dual use of e-cigarettes and conventional cigarettes,[15,16] while another identified depressive symptoms as associated with initiation of e-cigarette use, cigarette use and dual use.[53] However, these studies used different measures, accounted for dual use of cigarettes and e-cigarettes, and two did not control for cannabis use,[16,53] which has also been associated with depression[54] and could confound results. Additional studies are necessary to further explore the association between mental health indicators and e-cigarette initiation.

Results for the Difficulties in Emotional Regulation Scale (DERS) were significant for female students. This is consistent with previous research that has found emotional dysregulation to be associated with cigarette initiation.[55] Higher DERS indicates lower levels of emotional regulation, suggesting that female students are potentially using e-cigarettes as a coping strategy. Therefore, teaching alternative positive coping strategies could be an important component of e-cigarette prevention programs for female students.

In contrast, higher flourishing was associated with increased odds of e-cigarette initiation among males. This is opposite to results that have linked higher flourishing with less substance use or no effect,[56-58] suggesting that e-cigarettes are not being used as a coping mechanism among males. Curiosity about a novel product is a leading reason adolescents try e-cigarettes and could be motivating this group, along with marketing that broadly appeals to youth.[59,60] Previous research has been cross-sectional,[56-58] and it is possible that the direction of association changed after students transitioned to more regular use. Based on these results and the positive associations seen between physical activity and e-cigarette use, e-cigarette use may

be more of a social activity, but more research is needed to explore this hypothesis.

Strengths and limitations

The main strength of this study is the use of a large, school-based longitudinal dataset to examine factors associated with e-cigarette use. In particular, the use of passive consent procedures maximizes the student participation rate and limits selection bias that is common in youth substance-use studies that use active consent procedures.[26,61-64] This study is the first of its kind to examine e-cigarette initiation in the Canadian context and how changes in behaviour may impact e-cigarette initiation among Canadian students. The COMPASS study includes questions that assess a range of health behaviours, allowing a comprehensive examination of the influence of demographic characteristics, behavioural factors and mental health indicators on e-cigarette initiation.

Although the COMPASS study has a large sample size, it was designed to evaluate changes in school programs and policies using natural experiment methodology. Therefore, it is not representative of all Canadian secondary school students. Also, because the questionnaire neither defines "e-cigarette" nor lists brands, and because of the changing language used by youth to refer to e-cigarette devices (e.g. "vaping," "Juuling"), this study may underreport e-cigarette use. It is also likely that the relationship between risk factors and e-cigarette initiation is influenced by other factors not measured in the COMPASS survey, such as exposure to e-cigarette marketing[9,17,18] or e-cigarette susceptibility.[12]

Additionally, as is the case with most self-report surveys, there could be reporting bias with respect to substance use; however, students are assured of the anonymity of their responses. Furthermore, participant drop-out and limitations with linking students across both waves may have resulted in an underestimation of e-cigarette initiation rates and their associations with demographic and behavioural variables, because students who are linked over time are more likely to be younger, female and less likely to use substances.[65,66] There were also some differences between the complete case sample and those removed, as well as differences between the samples in Part 1 and Part 2 that may have resulted in bias. Finally, the use of two time points prevented us from assessing the temporal order between changes in covariates at follow-up and e-cigarette initiation (i.e. e-cigarette initiation could have occurred before or after covariate status at follow-up). Our analysis of changes in characteristics on e-cigarette use should therefore be considered exploratory.

Conclusion

This prospective study examining factors associated with e-cigarette initiation provides novel evidence to support the need for stronger e-cigarette prevention efforts aimed at youth populations. Over the span of just one year, almost one-third of the sample of previous nonusers initiated e-cigarette use. Prevention approaches should target multiple health-risk behaviours to help prevent youth e-cigarette initiation. Additionally, given that Grade 9 students were at higher risk of initiation, school-based approaches may benefit from being implemented before high school.

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Conflicts of interest

Scott Leatherdale is an Associate Scientific Editor with the HPCDP Journal but has recused himself from the review process for this paper. The authors have no other conflicts of interest to declare.

Authors' contributions and statement

GCW collaborated on the study methodology, conducted statistical analysis, interpreted the results and drafted the original manuscript. AGC conceived of the study research questions, collaborated on the study methodology, interpreted study results, contributed to the original manuscript draft and reviewed the manuscript for important intellectual content. MdG, YJ and STL collaborated on the study methodology, interpreted study results and revised the manuscript for important intellectual content. STL is the principal investigator of the COMPASS study, wrote the funding proposal, developed the tools and led study implementation and coordination. All authors read and approved the final manuscript.

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Original quantitative research

Initiation or cessation: what keeps the prevalence of smoking higher in Quebec than in the rest of Canada?

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Abstract

Introduction: We compared smoking initiation and cessation in Quebec versus the rest of Canada as possible underpinnings of the continued higher cigarette smoking prevalence in Quebec.

Methods: Data were drawn from the Canadian Community Health Survey (CCHS). We compared average and sex-stratified prevalence estimates of (1) current cigarette smoking in persons aged 15 years and older; (2) past-year initiation of cigarette smoking in those aged 12 to 17 and 18 to 24 years; and (3) past-year cessation in adults aged 25 years and older in Quebec versus the other nine Canadian provinces in each two-year CCHS cycle from 2007/08 to 2017/18.

Results: The prevalence of current smoking decreased from 25% to 18% among adults aged 15 years and older in Quebec from 2007/08 to 2017/18, and from 22% to 16% in the rest of Canada. Initiation among those aged 12 to 17 years decreased from 9% to 5% in Quebec, and from 7% to 3% in the rest of Canada. Neither initiation among people aged 18 to 24 (at 6% and 7%, respectively) nor cessation among adults aged 25 and older (approximately 8%) changed over time in Quebec or in the rest of Canada. In each two-year CCHS cycle, past-year initiation among those 12 to 17 years of age was consistently higher in Quebec than in the rest of Canada, but there were no substantial or sustained differences in initiation among people aged 18 to 24 or in past-year cessation. Findings were similar when stratified by sex.

Conclusion: Higher levels of smoking initiation among youth aged 12 to 17 years could be a proximal underpinning of the continuing higher prevalence of smoking in Quebec versus the rest of Canada.

Keywords: *Canada, Quebec, smoking, Canadian Community Health Survey*

Highlights

- Between fiscal years 2007/08 and 2017/18, the prevalence of cigarette smoking decreased in both Quebec and the rest of Canada.
- The percent of youth aged 12 to 17 years who initiated smoking was consistently higher in Quebec compared to the rest of Canada from 2007/08 to 2017/18.
- Initiation among those aged 18 to 24 years and cessation among adults aged 25 and older did not differ between Quebec and the rest of Canada.
- The continuing higher smoking prevalence in Quebec could relate in part to continuing higher levels of initiation in adolescents.

Introduction

Cigarette smoking is a primary driver of avoidable death[1] as well as an important underpinning of social inequalities in morbidity and mortality.[2] Historically, and despite marked declines over four decades in both Quebec and the rest of Canada (i.e. the other nine provinces), the smoking prevalence in Quebec consistently surpasses the Canadian average.[3-5] In 2000/01, the prevalence was 30% in Quebec compared to 26% in Canada overall. Two decades later, in 2019, 17% of Quebecers smoked compared to 15% of all Canadians.[6] Previous studies have attributed this differential to lower incomes in Quebec,[5] to greater cigarette tax reductions in Quebec in 1994 to prevent contraband tobacco,[5,7] and to antismoking messages not being optimally adapted for francophones.[8] Reflective of these differences are the 10 400 tobacco-related deaths that occur annually in Quebec,[1] and the age-standardized lung cancer mortality rate (66 deaths per 100 000 in Quebec vs. 52 deaths per 100 000 in Canada). In fact, Quebec has one of the highest provincial lung cancer mortality rates in Canada.[9]

Key proximal drivers of smoking prevalence that can be targeted for intervention

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include the number of young people who initiate smoking and the number of smokers who quit. Historically, higher prevalence is also contributory but cannot in and of itself be targeted for intervention. The first puff on a cigarette is a critical milestone in the natural course of smoking onset[10] and existing data suggest that initiation is higher in Quebec than in Canada overall. In 2017, 9% of Grades 7 to 9 students in Canada had tried smoking compared to 15% in Quebec, which is almost double the national average.[4] The average age at initiation is 13 years,[11] and 99% of adult smokers in the US initiated their first cigarette by age 26.[12]

Although initiation is typically viewed as an adolescent phenomenon, there is growing concern that the tobacco industry is now targeting young adults because of increasingly restrictive tobacco control legislation protecting youth, and several reports support that the incidence of initiation in young adults is increasing.[13-15] Gagné and Veenstra[16] reported that initiation among youth aged 5 to 17 years in Canada decreased from 2003 to 2013, but did not change among young adults aged 18 to 25.

Cessation is also a proximal driver of smoking prevalence.[17] It improves chronic disease incidence, reduces second-hand smoke exposure and decreases mortality. Cessation rates are similar in Quebec and Canada overall. In 2000, 8% of former smokers in Quebec had quit in the previous two years—the same as the Canadian average of 8%.[18] Data from the longitudinal National Population Health Survey showed that 16% of Quebecers who smoked in 1995 were nonsmokers in 2010/11, compared to 12% nationally.[19] More recent data on differences in cessation across provinces are scarce.

Although reports on smoking prevalence, initiation and cessation in Canada are released regularly, no publication to date has studied initiation and cessation as proximal contributors to smoking prevalence in Quebec versus the rest of Canada. Our objective was to compare these two indicators in Quebec versus the rest of Canada in each of six consecutive two-year cycles of the Canadian Community Health Survey (CCHS), between 2007/08 and 2017/18. We hypothesized that if either or both indicators differed between Quebec and the rest of Canada consistently over time, they might represent targets for more intense intervention to facilitate faster decreases in smoking prevalence in Quebec to better align with that in the rest of Canada.

Accordingly, we report prevalence of past-year initiation of a first whole cigarette among youth aged 12 to 17 years in Quebec versus the rest of Canada. We also report past-year initiation among young adults aged 18 to 24 years because of concerns that the incidence of smoking initiation in young adults is increasing.[13-15] Finally, because sustained cessation is relatively rare in smokers aged under 25 years,[4] we present past-year cessation among smokers aged 25 years and older in Quebec versus the rest of Canada. The rest of Canada is used as a comparative because of similar country-wide tobacco control legislation.

Methods

We used data from the CCHS, the largest health surveillance dataset in Canada.[20] CCHS content covers health status, health care utilization and determinants of health in the Canadian population aged 12 years and older. The CCHS provides reliable estimates of health indicators at the health region level (i.e. geographical units) within provinces every two years. Questionnaires were administered using computer-assisted interviews in English or French in 2001, 2003 and 2005, and then annually since 2007.

Approximately 130 000 Canadians (10 000 aged 12–17 years and 120 000 aged ≥ 18), including 20 000 to 24 000 Quebecers, were recruited into the CCHS in each two-year cycle between 2007/08 and 2017/18. National response proportions were 76.4% in 2007/08, 72.3% in 2009/10, 68.4% in 2011/12, 66.2% in 2013/14, 59.5% in 2015/16, and 60.8% in 2017/18. Details of the sampling methods are available elsewhere.[20] This study did not require ethics review because the data are legally accessible to the public and appropriately protected by law.

Study variables

Current smoking was assessed with the question, "Have you smoked more than 100 cigarettes (about 4 packs) in your life?" Participants who responded "no" were coded as never smokers. Those who responded "yes" were asked, "At the present time, do you smoke cigarettes every day, occasionally or not at all?" Participants who responded "every day" or "occasionally" were coded as current smokers.

Past-year initiation of a first cigarette among participants aged 12 to 17 and 18 to 24 was measured by asking, "Have you ever smoked a whole cigarette?" and "At what age did you smoke your first whole cigarette?" We categorized participants as "past-year initiators" if they had smoked their first whole cigarette at or in the year prior to their current age. Participants who had never smoked a whole cigarette and past-year initiators were included in the denominator used to compute the prevalence of past-year initiation. Those who had initiated their first cigarette two or more years prior to their current age were not included in the denominator since they were no longer eligible to initiate a first cigarette in the past year.

Past-year cessation was assessed based on respondents' smoking history. Former smokers included daily or non-daily smokers who had quit smoking completely. In former smokers who had never smoked daily, past-year cessation was measured with the question, "When did you stop smoking?" In former smokers who had smoked daily and stopped completely, it was assessed with the question, "When did you stop smoking daily?" Finally, in former smokers who had smoked daily, stopped smoking daily, but continued smoking on a non-daily basis before stopping completely, past-year cessation was assessed with the question, "When did you stop smoking completely?" Response options ranged from "less than one year ago" to "3 or more years ago." We categorized former smokers as "past-year quitters" if they reported quitting smoking "less than a year ago." Current smokers and past-year quitters were included in the denominator of the computation of the prevalence of past-year cessation.

Statistical analyses

We described prevalence estimates and 95% confidence intervals for both sexes combined and then in males and females separately for (1) current smoking among persons aged 15 years and older (as is commonly reported in other Canadian surveys);[21,22] (2) past-year initiation of a first cigarette among persons aged 12 to 17 and aged 18 to 24; and (3) past-year

cessation among persons aged 25 years and older in the province of Quebec and in the other nine provinces in the rest of Canada across two-year periods between 2007/08 and 2017/18.

Also, to check for differences within the rest of Canada compared to Quebec, we stratified the rest-of-Canada data into four provinces or regions (i.e. the Atlantic provinces, Ontario, the Prairies, British Columbia). Two-year periods were examined because the CCHS is designed to be analyzed in two-year cycles and, because the sample size for any single year is relatively small, to improve the precision of our estimates.

According to the 2017/18 CCHS, there were no missing data on sex or province of residence. Missing data on current smoking (among participants aged ≥ 15 years) was less than 0.1%, on past-year initiation (among participants aged ≥ 12) was 3.7% and on past-year cessation (among participants aged ≥ 25) was 3.4%.[23]

We report the statistical significance of differences in the proportions estimated between Quebec and the rest of Canada (i.e. the other nine Canadian provinces) in each two-year cycle. Sensitivity analyses comparing estimates for occasional and daily smoking separately are available on request. We used the survey and bootstrap weights developed by Statistics Canada to account for the CCHS sampling strategy[24] and produce representative estimates, using the svy:prop command in Stata[25] to estimate proportions and the lincom command to test differences in proportions. Aligned with Statistics Canada's Remote Submit Pilot Project reporting guidelines, estimates are reported without decimals. Analyses were undertaken using a listwise deletion approach in Stata 16.[25]

Results

Current smoking

The prevalence of current smoking among persons aged 15 years and older declined steadily across all 10 provinces from 2007/08 to 2017/18 (Table 1). In Quebec, the proportion of current smokers decreased from 25% in 2007/08 to 18% in 2017/18, and in the rest of Canada it declined from 22% to 16% (*p*-values for the differences between estimates in Quebec vs. the rest of Canada were statistically significant at the 0.05 level at all time points). Absolute rates of decline were similar in Quebec and the rest of Canada (i.e. 7% vs. 6%, respectively) as was the relative decline (i.e. 28% in Quebec vs. 27% in the rest of Canada). This finding was consistent across sex (Table 1). The declines were driven primarily by decreases in daily rather than occasional smoking (data available on request).

A comparison of Quebec with the rest of Canada divided into four provinces and regions suggests that the pattern of decline in Quebec resembles the patterns in the Atlantic provinces and the Prairies. In 2007/08, the prevalence of current smoking was lower in Ontario and British Columbia, and since the absolute declines were similar across provinces, the prevalence in these two provinces remained lower over time. These data suggest that overall, the prevalence of current smoking outside Quebec in the rest of Canada is driven by the lower prevalence in Ontario and the markedly lower prevalence in British Columbia.

Past-year initiation among adolescents

The prevalence of past-year smoking initiation among adolescents aged 12 to 17 years declined from 9% in 2007/08 to 5% in 2017/18 in Quebec, an absolute

TABLE 1
Prevalence of current smoking among persons aged 15 years and older in Quebec versus the rest of Canada,[a] CCHS, 2007 to 2018

	Current smoking					
	2007/08	2009/10	2011/12	2013/14	2015/16	2017/18
	%[b] (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total						
Quebec	25 (24–26)*	24 (23–25)*	23 (22–24)*	21 (20–22)*	19 (18–20)*	18 (18–19)*
Rest of Canada	22 (21–22)*	20 (20–21)*	20 (20–21)*	19 (18–19)*	18 (17–18)*	16 (16–16)*
Atlantic provinces[c]	25 (24–26)	24 (23–25)	24 (22–25)	22 (21–23)	20 (19–21)	18 (17–19)
Ontario	21 (21–22)	20 (19–20)	20 (19–21)	18 (18–19)	17 (17–18)	16 (15–17)
Prairies[d]	24 (23–25)	23 (22–24)	22 (21–23)	20 (19–21)	19 (19–20)	18 (17–19)
British Columbia	19 (18–20)	17 (16–19)	16 (15–17)	16 (15–17)	15 (14–16)	13 (12–14)
Males						
Quebec	28 (26–29)*	26 (25–28)*	26 (24–27)*	24 (22–25)	21 (19–22)	21 (20–22)*
Rest of Canada	25 (24–26)*	24 (23–24)*	23 (22–24)*	22 (21–23)	21 (20–21)	19 (18–20)*
Females						
Quebec	23 (22–24)*	21 (20–23)*	21 (19–22)*	19 (18–20)*	17 (16–18)*	16 (15–17)*
Rest of Canada	19 (18–19)*	17 (17–18)*	17 (17–18)*	15 (15–16)*	15 (15–16)*	13 (12–13)*

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval.

[a] Rest of Canada includes nine Canadian provinces (i.e. British Columbia, Alberta, Saskatchewan; Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

[b] Percentages were rounded to the nearest integer.

[c] New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

[d] Alberta, Saskatchewan and Manitoba.

* Indicates that differences between estimates for Quebec vs. the rest of Canada were statistically significant at the 0.05 level.

difference of 4% (Table 2). The absolute difference was also 4% in the rest of Canada (i.e. the prevalence declined from 7% to 3%). Apart from 2007/08, *p*-values for the differences between estimates for Quebec versus the rest of Canada were statistically significant at all time points. This pattern was consistent across sex (Table 2), and comparison of Quebec with the rest of Canada divided into four regions did not alter interpretation of the data.

Past-year initiation among young adults

Past-year initiation among young adults aged 18 to 24 did not decline in Quebec or in the rest of Canada over time—it remained relatively stable at 6% and 7%, respectively (Table 3). None of the differences between estimates for Quebec versus the rest of Canada at the six time points investigated were statistically significant. Initiation in young adulthood was consistently higher in males than females in both Quebec and the rest of Canada. Comparison of Quebec with the rest of Canada divided into four regions did not alter interpretation of the data.

Past-year cessation

The prevalence of past-year cessation among adults aged 25 years and older remained steady over time at approximately 8% in both Quebec and the rest of Canada (Table 4). Apart from the difference in 2011/12, none of the differences between estimates for Quebec versus the rest of Canada were statistically significant at any of the six time points investigated. This pattern was similar across sex (Table 4), as well as in Quebec compared to four provinces or regions in the rest of Canada.

Discussion

Cigarette smoking has decreased in both Quebec and the rest of Canada over the past decade, underscoring continuing progress in the fight against smoking across the country. Specifically, prevalence declined by 7% in Quebec (i.e. from 25% to 18%) and by 6% in the rest of Canada (i.e. from 22% to 16%). Our results suggest that, in addition to its historically higher prevalence, the generally higher prevalence of smoking in Quebec versus the rest of Canada relates to the consistently higher initiation rate among Quebec youth aged 12 to 17 over the past decade. The identification of proximal drivers of smoking prevalence in Quebec that are amenable to intervention could signal where changes or intensification in policy and programs might accelerate declines, thus rendering the prevalence of smoking in Quebec more comparable to that in the rest of Canada. In particular, the low prevalence of cigarette smoking in British Columbia and Ontario represents an attainable target for Quebec.

In this current study, we compared initiation and cessation in Quebec and the rest of Canada to identify proximal drivers of smoking prevalence in Quebec. Three key findings emerged. First, cessation among adults aged 25 years and older remained virtually unchanged, at 8% over the past decade in both Quebec and the rest of Canada. Second, smoking initiation among young adults aged 18 to 24 years did not differ between Quebec and the rest of Canada or change over time. Third, smoking initiation among adolescents was consistently higher in Quebec than in the rest of Canada, suggesting that adolescent initiation may be an actionable driver of the continued higher smoking prevalence in Quebec.

Despite previous efforts[5,7,8] to understand variations in Quebec versus other Canadian provinces, this persistent gap in initiation may be the result of differences in underlying and more distal drivers of prevalence

TABLE 2
Prevalence of past-year smoking initiation among youth aged 12 to 17 years in Quebec versus the rest of Canada,[a] CCHS, 2007 to 2018

	Past-year smoking initiation					
	2007/08	2009/10	2011/12	2013/14	2015/16	2017/18
	%[b] (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total						
Quebec	9 (7–10)	9 (7–12)*	10 (7–12)*	7 (5–9)*	6 (5–7)*	5 (4–7)*
Rest of Canada	7 (6–8)	6 (6–7)*	5 (5–6)*	5 (4–6)*	4 (3–5)*	3 (2–4)*
Atlantic provinces[c]	7 (5–9)	7 (5–9)	7 (5–9)	6 (5–8)	5 (3–6)	3 (2–4)
Ontario	6 (5–8)	5 (4–6)	4 (4–5)	5 (4–6)	4 (2–5)	4 (2–5)
Prairies[d]	8 (7–10)	8 (6–10)	7 (5–9)	6 (5–8)	5 (5–8)	2 (2–3)
British Columbia	7 (5–9)	6 (4–8)	5 (3–6)	4 (2–5)	3 (2–4)	3 (2–4)
Males						
Quebec	9 (7–12)	10 (7–13)	9 (6–12)*	8 (6–10)*	6 (4–8)	6 (4–8)
Rest of Canada	8 (7–9)	7 (6–8)	6 (5–7)*	5 (4–6)*	4 (3–5)	4 (3–5)
Females						
Quebec	8 (6–11)	9 (6–12)	10 (7–13)*	6 (4–8)	6 (4–8)*	5 (3–7)*
Rest of Canada	6 (5–7)	6 (5–7)	5 (4–5)*	5 (4–6)	4 (3–5)*	2 (2–3)*

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval.

[a] Rest of Canada includes nine Canadian provinces (i.e. British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador).

[b] Percentages were rounded to the nearest integer.

[c] New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

[d] Alberta, Saskatchewan and Manitoba.

*Indicates that differences between estimates for Quebec vs. the rest of Canada were statistically significant at the 0.05 level.

TABLE 3
Prevalence of past-year smoking initiation among young adults aged 18 to 24 years in Quebec versus the rest of Canada,[a] CCHS, 2007 to 2018

	Past-year smoking initiation					
	2007/08	2009/10	2011/12	2013/14	2015/16	2017/18
	%[b] (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total						
Quebec	6 (4–8)	6 (4–8)	8 (5–11)	6 (4–9)	6 (4–8)	6 (4–9)
Rest of Canada	7 (6–8)	7 (6–9)	7 (6–8)	7 (6–8)	6 (5–7)	7 (6–9)
Atlantic provinces[c]	4 (2–6)	8 (5–10)	7 (4–9)	10 (7–13)	4 (2–6)	8 (4–12)
Ontario	8 (6–9)	8 (6–10)	8 (6–9)	6 (5–8)	7 (5–8)	8 (5–10)
Prairies[d]	6 (5–8)	7 (5–9)	5 (4–7)	6 (4–8)	6 (4–8)	8 (6–10)
British Columbia	7 (5–10)	6 (4–8)	5 (3–6)	6 (3–9)	7 (4–9)	6 (4–9)
Males						
Quebec	6 (3–10)	8 (5–12)	9 (5–14)	8 (5–12)	8 (5–12)	8 (4–12)
Rest of Canada	8 (6–9)	9 (7–11)	8 (7–10)	10 (8–11)	7 (5–8)	9 (7–11)
Females						
Quebec	6 (2–9)	3 (1–5)	8 (4–12)	5 (1–8)	5 (2–7)	5 (1–8)
Rest of Canada	6 (5–8)	6 (4–7)	5 (4–6)	4 (3–5)	6 (4–8)	6 (4–8)

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval.

[a] Rest of Canada includes nine Canadian provinces (i.e. British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

[b] Percentages were rounded to the nearest integer.

[c] New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

[d] Alberta, Saskatchewan and Manitoba.

Note: None of the differences between estimates for Quebec vs. the rest of Canada were statistically significant at the 0.05 level.

TABLE 4
Prevalence of past-year cessation among adults aged 25 years and older in Quebec versus the rest of Canada,[a] CCHS, 2007 to 2018

	Past-year cessation					
	2007/08	2009/10	2011/12	2013/14	2015/16	2017/18
	%[b] (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total						
Quebec	8 (7–9)	7 (6–9)	10 (8–11)*	9 (8–10)	9 (8–10)	8 (7–9)
Rest of Canada	8 (8–9)	7 (7–8)	8 (7–8)*	8 (7–9)	8 (7–9)	8 (7–9)
Atlantic provinces[c]	9 (8–11)	8 (6–9)	8 (7–10)	9 (7–10)	10 (8–11)	9 (8–11)
Ontario	8 (7–9)	6 (5–7)	7 (6–8)	7 (6–8)	8 (7–9)	7 (6–8)
Prairies[d]	8 (7–9)	7 (6–9)	8 (7–10)	7 (6–9)	8 (7–9)	7 (6–9)
British Columbia	8 (7–9)	9 (8–11)	9 (7–11)	10 (8–13)	8 (6–10)	11 (9–14)
Males						
Quebec	7 (6–9)	8 (6–10)	9 (7–11)	10 (8–11)	8 (7–10)	9 (7–11)
Rest of Canada	8 (7–9)	7 (6–8)	8 (7–8)	8 (7–9)	8 (7–9)	8 (7–9)
Females						
Quebec	9 (7–10)	7 (5–8)	10 (8–12)	8 (7–10)	9 (7–11)	7 (6–9)
Rest of Canada	8 (8–9)	8 (7–9)	8 (7–9)	7 (6–9)	8 (7–10)	7 (6–9)

Abbreviations: CCHS, Canadian Community Health Survey; CI, confidence interval.

[a] Rest of Canada includes nine Canadian provinces (i.e. British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador).

[b] Percentages were rounded to the nearest integer.

[c] New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

[d] Alberta, Saskatchewan and Manitoba.

*Indicates that differences between estimates for Quebec vs. the rest of Canada were statistically significant at the 0.05 level.

including population characteristics and government investment in public health and in particular, in tobacco control initiatives. The next few paragraphs discuss three possible underpinnings for this latter finding, including differences in the prevalence of specific risk factors for cigarette smoking initiation, timing of tobacco control legislation and differential availability of tobacco control programs in Quebec versus the rest of Canada.

Prevalence of risk factors for initiation

In a systematic review, Wellman et al.[26] identified 98 conceptually different predictors of cigarette smoking initiation in 53 population-based longitudinal studies. An increased risk of smoking onset has consistently been found for increased age and grade, lower socioeconomic status, poor academic performance, low self-esteem, low parental supervision, sensation-seeking and rebelliousness, intention to smoke in the future, receptivity to tobacco promotion efforts, susceptibility to smoking, family members' smoking, having friends who smoke and exposure to films. This evidence base has methodological challenges, and research identifying predictors of adolescent smoking in more recent years remains critical.

However, juxtaposition of the strength of the associations and the prevalence of each predictor across jurisdictions (i.e. in Quebec vs. in other Canadian provinces) could provide actionable evidence on specific predictors relevant for new or intensification of existing tobacco control policies and interventions. For example, if the prevalence of school dropouts or perceived frequency of friends smoking is higher in Quebec than elsewhere, public health planners and policy makers will need to reflect on whether tobacco control interventions in Quebec should address these issues specifically. Further, reflection on the feasibility and effectiveness of preventive intervention addressing each potential predictor (in addition to the strength of the association with initiation and its prevalence) could permit assessment of where the "biggest bang for the buck" might be achieved in terms of programs or policy.

Tobacco control legislation

Beyond underlying population characteristics, sociocultural norms related to smoking are strongly associated with smoking behaviour,[27,28] and population-level tobacco control policies are critical reflections as well as drivers of these norms.[29,30] Quebec has been actively engaged in tobacco control for several decades and has implemented smoking bans similar to those in the other provinces. Relatively recent legislation (i.e. *An Act to amend the Tobacco Act and other legislative provisions* [2005] and *An Act to bolster tobacco control* [2015]) has included provisions to prevent smoking among adolescents, such as prohibiting smoking on school grounds, eliminating sales to minors and banning flavoured tobacco products.[31]

However, despite the similarity in legislative objectives across Canada, the timing of certain specific legislation has lagged in Quebec. For example, Quebec has lagged in tobacco taxation,[32] a measure known to be effective in reducing smoking prevalence in young people.[33] In addition, whereas other Canadian provinces began prohibiting smoking in cars with minors in 2008, Quebec was the last province to do so, only banning it in 2016.[31] It is possible that these timing differences reflect that antismoking social norms evolve differently across provinces and contribute to the persistent differences in youth initiation.

Tobacco control programs

In addition to variability in risk factors for smoking initiation and lags in tobacco legislation across provinces, differences in the number, content and effectiveness of tobacco prevention interventions across provinces could influence the prevalence of youth initiation.

To date, the evidence for community and school-based smoking prevention programs is mixed. For example, in a 2011 review of 25 controlled trials examining the effectiveness of community interventions using coordinated, multicomponent programs in reducing smoking uptake in young people, the authors concluded that there is some evidence to support effectiveness, but the evidence is not strong and contains methodological flaws.[34] A 2013 Cochrane review of 49 randomized controlled trials of interventions aiming to prevent children who had never smoked from becoming smokers found a significant effect of the interventions in preventing young people from starting smoking at longer than one year after completion of the intervention.[35] Programs that used a social competence approach and those that combined a social competence with a social influence approach were more effective than other programs. However, at one year or less there was no overall effect, except for programs that taught young people to be socially competent and to resist social influences.

A more recent (2015) review of 16 controlled trials found no evidence that school-based smoking prevention programs have a significant effect on preventing adolescent girls from smoking.[36] The authors suggested that additional research should focus on combining school-based programs with mass media interventions, and on developing girl-specific interventions, as potentially more effective than school-based intervention programs alone.[36]

Despite the mixed evidence on effectiveness, it might be informative to enumerate and compare the array of community and school-based smoking prevention programs available across provinces to assess whether differences in availability could underpin the persistent higher prevalence of smoking initiation in Quebec. For example, tobacco preventive interventions that target youth, such as *La gang allumée* in Quebec, aim to create awareness about tobacco consumption among youth aged 11 to 17 years.[37] However, tobacco education is not part of the Quebec elementary school curriculum, as it is in several other Canadian provinces. Because of the high smoking prevalence, the Government of Quebec has recently released a new plan known as the "*Stratégie pour un Québec sans tabac 2020–2025*," which among other objectives aims to prevent tobacco use in youth by implementing new mass media campaigns and school-based programs.[38]

Strengths and limitations

This is the first study to study initiation and cessation as proximal contributors to smoking prevalence in Quebec compared to the rest of Canada.

However, this study does have certain limitations. First, it relies on self-reports of cigarette smoking initiation and cessation, which could have resulted in misclassification. Second, participant response proportions decreased over time, which could indicate a potential for selection bias. Finally, CCHS sampling methodology changed in 2015 to update sample allocation

between regions and include a second sampling list to enable more representative estimates of the youth population aged 12 to 17. Statistics Canada advises that estimates before and after 2015 should be compared with caution, although these changes are unlikely to have resulted in differences in smoking prevalence.

Conclusion

Although the prevalence of current smoking has declined in Quebec since 2007/08, it remains higher than in the rest of Canada. The prevalence of both smoking cessation and initiation among young adults was similar in Quebec and the rest of Canada. However, smoking initiation remains higher among Quebec adolescents, likely contributing to the higher prevalence of current smoking in Quebec.

Even if no new interventions are implemented or if current tobacco control efforts are not intensified, Quebec may attain the lower prevalence estimates observed in other provinces as Quebecers continue to positively respond to current norms and tobacco control efforts, and as the prevalence of smoking stabilizes at a very low level in the rest of Canada.

However, continuing declines in the future are not guaranteed, and the time frame in which Quebec might achieve the prevalence estimates observed in the rest of Canada is unknown. Because youth initiation was the only proximal indicator in our study that was higher in Quebec than in the rest of Canada, prioritizing efforts to prevent youth initiation is likely to help ensure continuing declines in smoking prevalence in Quebec. It may also accelerate the rate of decline in smoking so that Quebec attains a prevalence similar to the rest of Canada in a shorter time frame.

Further investigation is needed to identify more distal factors underpinning the higher prevalence of smoking initiation, including the identification of differences in Quebec and the rest of Canada in risk factors for smoking initiation, in tobacco control legislation and in the availability of smoking prevention programs.

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Conflicts of interest

JOL is a member of the HPCDP Editorial Board. JOL and TG are Guest Editors on this special theme issue of HPCDP, but recused themselves from the review process.

Authors' contributions and statement

AP reviewed the literature and drafted the manuscript. JOL contributed to interpretation of the data and wrote sections of the article. TG conducted the analyses and wrote sections of the article. CC critically reviewed the article. KLF obtained funding and critically reviewed the article. All authors commented on and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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At-a-glance

Cigarette affordability in Canadian provinces: a 10-year review

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Abstract

The association between pricing and cigarette consumption is long-established. However, the effects of taxation alone can be diminished if relative income increases. Therefore, affordability is seen as a key determinant of demand for cigarettes, as it combines the impact of changing prices with economic growth or wage increases. This brief analysis employs methods used by the World Health Organization in examining cigarette affordability, and explores the trend in affordability across Canadian provinces over a 10-year period, from 2009 to 2019. The discussion illustrates how monitoring affordability over time can help policy makers in Canadian provinces design tobacco taxation for maximum impact.

Keywords: *cigarettes, smoking, affordability, taxation, Canada, government, provincial*

Highlights

- This paper reports on the comparative analysis of the trend in cigarette affordability rates across Canadian provinces over a 10-year period, from 2009 to 2019.
- This paper discusses the importance of examining affordability as an effective measure of the impact of tobacco taxation on tobacco consumption.

Introduction

The association between pricing and cigarette consumption is long-established. Increases in price, predominantly driven by tax increases, are said to be one of the most effective ways to reduce demand.[1,2] Price increases can prevent youth and other nonsmokers from initiating use, serve as a motivating factor to drive quit attempts, reduce consumption among current smokers and potentially prevent relapse among former smokers.[1,3] Not surprisingly, tobacco taxes play an important role in the implementation of the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC).[4]

However, the effects of taxation on prices can be diminished if relative income increases. Taxation designed to maximize public health therefore requires that cigarette prices increase faster than consumer purchasing power. In other words, the goal of taxation is to reduce tobacco use by making tobacco products progressively less affordable. Therefore, the effect of income growth on purchasing power is an important consideration.[5]

To illustrate, over the 10-year period from 2009 to 2019, the price of cigarettes across Canadian provinces has increased steadily,* in line with a similar rising trend in provincial GDP per capita.[6-9] In 2019, the highest cigarette tax in the country was implemented in Manitoba (CAD 60.00 per carton), ranking the province as the highest for prices of cigarettes. Taxation in British Columbia was comparable, although the resulting price was still lower than in several provinces with lower taxes. Meanwhile, Alberta and Newfoundland and Labrador were ranked in the lower half of all provinces for cigarette pricing despite being among the top three provinces with the highest income. This fact demonstrates disparities not evident when examining cigarette prices or taxation alone, since higher provincial taxes do not necessarily reflect higher prices or provincial differences in GDP per capita.

Tobacco tax increases that result in observable price changes have consistently been found to reduce tobacco consumption.[5] However, in order to measure the relative impact of taxes in reducing consumption, the effect of changes in income are an important consideration.[5] Therefore, when combining the impact of price changes with economic growth or wage increases, affordability is recognized as a key determinant of demand for cigarettes.[10] This comparative analysis explores and reports on the trend in cigarette affordability rates across Canadian provinces over the 10-year period from 2009 to 2019.

Methods

Employing methods used by the WHO in their biennial global reports on tobacco control,[11] affordability was expressed as the percentage of GDP per capita required to purchase 2000 cigarettes. This construct made up what is here referred to as the affordability index (AI).

Provincial retail price of 2000 cigarettes

In order to determine the AI, the retail price of 2000 cigarettes in each province

* Unpublished wholesale prices provided via email by Health Canada, which collects this data in compliance with the *Tobacco Reporting Regulations*, Section 13. https://laws-lois.justice.gc.ca/eng/regulations/SOR-2000-273/index.html

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was first determined. Unpublished wholesale unit cigarette pricing data were provided by Health Canada (*Tobacco Reporting Regulations*, Section 13; https://laws-lois.justice.gc.ca/eng/regulations/SOR-2000-273/index.html). The industry unit price was an average derived by dividing unit volume into the total cigarette sales in each province. This average price was added to federal excise tax rates per unit to arrive at wholesale unit prices. These provincial unit prices were used (multiplied by 200) to obtain the provincial wholesale prices per carton of 200 cigarettes.

Provincial excise tax data were then obtained using historic rates reported by the Propel Centre for Population Health Impact,[6] data from the Smoking and Health Action Foundation[7] and unpublished tax tables (for 2019) compiled by the Canadian Cancer Society (Cunningham R, Senior Policy Analyst, 28 October 2019, via email). These data were added to the provincial wholesale price per carton in each jurisdiction.

Provincial retail prices were then derived by calculating any applicable provincial sales tax (PST), goods and services tax (GST) or harmonized sales tax (HST). Summaries of tax rates and changes over time were sourced from the Propel Centre for Population Health Impact[6] and the Canadian Cancer Society tobacco tax tables. Finally, the provincial retail price per carton was converted to the retail price of 2000 cigarettes (multiplied by 10).

GDP per capita

The income-based provincial GDP at market prices is reported annually by Statistics Canada, and this rate was used in per capita calculations.[8] The provincial GDP was divided into the provincial population at the first quarter (Q1) of each calendar year[9] to determine the GDP per capita.

Affordability index

The retail price of 2000 cigarettes divided into the GDP per capita and expressed as a percentage represents the affordability index (AI). A higher AI value represents lower cigarette affordability, and a lower AI represents higher cigarette affordability.

Trend analysis

The provincial AI trend over a 10-year period from 2009 to 2019 was further analyzed to determine whether affordability changed on average, in each province, over time. The average annual percentage change in affordability was used as the least-squares growth rate to determine if affordability had changed. The least-squares growth rate was determined by fitting a linear regression trend line on the logarithmic values of the AI. Cigarette affordability was deemed unchanged if the least-squares trend in AI was not significant at the 5% level, and deemed more (or less) affordable on average if the trend in AI was positive (or negative) and significantly different from zero at the 5% level.

Results

Figure 1 demonstrates an overall rising trend in the affordability index over time for all provinces, indicating cigarettes were becoming less affordable over time. In the 10-year period examined, the provinces of Nova Scotia and Prince Edward Island had intermittently been the jurisdictions with the lowest cigarette affordability, while Alberta has consistently been the most affordable jurisdiction when comparing price with GDP per capita.

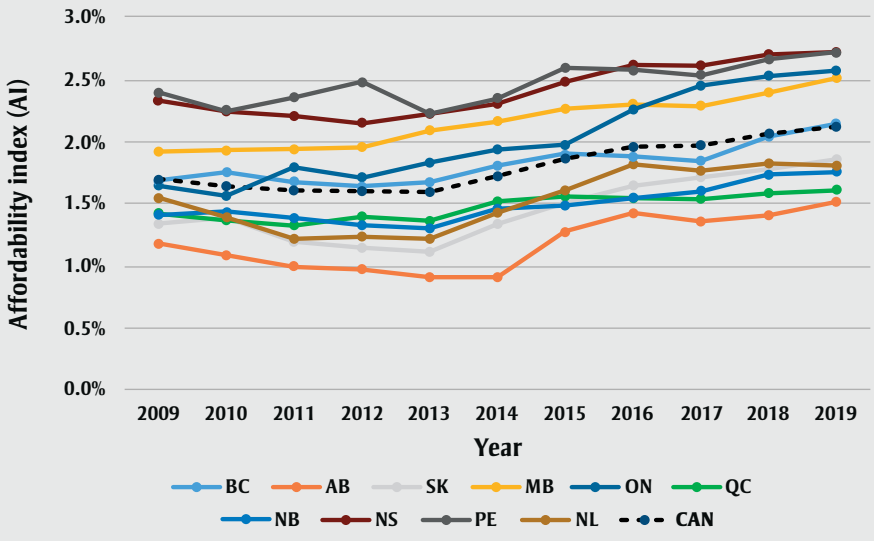
In examining the overall trend for the 10-year period, we found that for all provinces there was an increase in the AI (i.e. a decrease in cigarette affordability) that was significant at the 5% level.

Table 1 provides a comparison between provincial excise tax rates and the corresponding AI value that year, by province. The table illustrates how taxation, while not the sole factor, contributes to changes in affordability. For example, in provinces such as British Columbia, Alberta and Ontario, where tax increases were uncommon in the first half of the decade, cigarette affordability gradually increased, illustrating a need for tax increases during this period. Meanwhile, many provinces reflected a decrease in affordability between 2017 and 2019, despite not implementing provincial tax increases, indicating reduced purchasing power due to factors outside of taxation, such as tobacco manufacturer price increases.

Discussion

Over the past decade, the affordability of cigarettes in all Canadian provinces has declined, despite an overall rise in GDP. On average, cigarettes in Canada were 26% less affordable in 2019 compared to 2009. The magnitude of change in

FIGURE 1
Cigarette affordability, trend in Canadian provinces and national average, 2009 to 2019



Abbreviations: AB, Alberta; BC, British Columbia; CAN, Canada; MB, Manitoba; NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; ON, Ontario; PE, Prince Edward Island; QC, Quebec; SK, Saskatchewan.

Note: Affordability is expressed as an index (AI) representing the percentage provincial GDP per capita required to purchase 2000 cigarettes at an average provincial retail price. Higher AI indicates lower affordability; lower AI indicates higher affordability.

TABLE 1
Provincial excise tax rates[a] (per 200 cigarettes) and affordability index by province and by year, 2009 to 2019, Canada

Province	Tax and AI	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BC	Tax ($)	**37.00**	37.00	37.00	37.00	**44.60**	**47.80**	47.80	47.80	47.80	**55.00**	**59.00**
	AI (%)	1.69	1.75	1.68	1.64	1.68	1.81	1.90	1.88	1.85	2.05	2.15
AB	Tax ($)	**40.00**	40.00	40.00	40.00	40.00	40.00	**50.00**	50.00	50.00	50.00	**55.00**
	AI (%)	1.18	1.09	1.00	0.98	0.92	0.91	1.28	1.43	1.36	1.41	1.51
SK	Tax ($)	36.60	**42.00**	42.00	42.00	**50.00**	50.00	50.00	50.00	**54.00**	54.00	54.00
	AI (%)	1.35	1.39	1.20	1.15	1.12	1.34	1.51	1.65	1.72	1.78	1.86
MB	Tax ($)	**37.00**	**41.00**	**45.00**	**50.00**	**58.00**	58.00	**59.00**	59.00	59.00	59.00	**60.00**
	AI (%)	1.92	1.94	1.94	1.96	2.09	2.17	2.27	2.31	2.29	2.40	2.52
ON	Tax ($)	24.70	24.70	24.70	24.70	24.70	**27.95**	27.95	**30.95**	**32.95**	**36.95**	36.95
	AI (%)	1.42	1.43	1.38	1.33	1.31	1.46	1.49	1.55	1.61	1.74	1.76
QC	Tax ($)	20.60	20.60	**21.20**	**25.80**	25.80	**29.80**	29.80	29.80	29.80	29.80	29.80
	AI (%)	1.43	1.37	1.33	1.40	1.37	1.52	1.57	1.55	1.54	1.59	1.62
NB	Tax ($)	23.50	23.50	**34.00**	34.00	**38.00**	38.00	38.00	**44.52**	**51.04**	51.04	51.04
	AI (%)	1.66	1.57	1.79	1.72	1.83	1.94	1.98	2.26	2.46	2.53	2.58
NS	Tax ($)	**43.04**	43.04	43.04	43.04	**47.04**	47.04	**51.04**	**55.04**	55.04	55.04	55.04
	AI (%)	2.34	2.25	2.21	2.15	2.22	2.31	2.48	2.61	2.61	2.69	2.72
PE	Tax ($)	39.10	39.10	**45.00**	45.00	45.00	45.00	**50.00**	50.00	50.00	50.00	50.00
	AI (%)	2.39	2.25	2.36	2.48	2.23	2.35	2.60	2.58	2.54	2.67	2.72
NL	Tax ($)	36.00	**38.00**	38.00	38.00	**41.00**	**47.00**	47.00	**49.00**	49.00	49.00	49.00
	AI (%)	1.55	1.39	1.22	1.24	1.22	1.43	1.61	1.82	1.77	1.83	1.81
CAN	AI (%)	1.69	1.64	1.61	1.60	1.60	1.72	1.87	1.96	1.97	2.07	2.12

Abbreviations: AB, Alberta; AI, affordability index; BC, British Columbia; CAN, Canada; MB, Manitoba; NB, New Brunswick; NL, Newfoundland and Labrador; NS, Nova Scotia; ON, Ontario; PE, Prince Edward Island; QC, Quebec; SK, Saskatchewan.

[a] CAD. Historic rates reported by the Propel Centre for Population Health Impact,[6] data from the Non-Smokers' Rights Association/Smoking and Health Action Foundation[7] and unpublished tax tables for 2019 compiled by the Canadian Cancer Society (Cunningham R, Senior Policy Analyst, 28 October 2019, via email).

Notes: Bolded type signifies an increase in provincial excise tax from the previous year.

provincial affordability varied significantly, with the largest decrease in New Brunswick, where cigarettes became 55% less affordable over the 10-year period. This substantial change in affordability corresponds to a 117% increase in cigarette taxation over the same timeframe (Table 1), the highest tax increase of any province. Meanwhile, the lowest rate of change in affordability was seen in Quebec, with a 13% decrease. Importantly, this reduction occurred despite a 45% increase in cigarette taxes over the timeframe, which represented greater changes in taxation than was seen in Alberta, Nova Scotia, Prince Edward Island or Newfoundland and Labrador.

The findings of this analysis emphasize that differences in GDP across subnational jurisdictions are an important factor when designing functional tax policy and when making cross-jurisdiction comparisons. This observation is further exemplified by the top three largest economies and tobacco markets in Canada—Ontario, Quebec and Alberta—which are also the provinces with the lowest AI, or highest cigarette affordability rates. The WHO "MPOWER" measures recommend taxes that represent 75% or more of the retail price of cigarettes;[11] a closer examination of the 2019 taxation in these provinces demonstrates that 66% to 69% of the price of a carton of cigarettes is made up of taxes. However, tobacco taxes represent a comparable 69% of the retail price of a cigarette carton in Prince Edward Island, where the affordability rate is one of the lowest in the country. The affordability index presented in this paper therefore serves as a vital adjunct to the measure of pricing and taxation, thus forming a more complete picture to inform tax policy design that addresses context.

Strengths and limitations

Comparing cigarette affordability using GDP per capita across Canadian jurisdictions provides benchmark data that can be used in designing effective tax policy. The trend lines demonstrate which tax increases resulted in sharp changes in affordability, such as the pivotal taxes implemented in Alberta in 2015 that resulted in a 41% increase in AI, or drop in annual affordability. Our study also allows for another important observation: the differences in cross-border affordability, such as between Manitoba and its neighbouring provinces. In 2019, annual affordability in Manitoba was 36% less than Saskatchewan and 43% less than

Ontario. Studies on the implications of such subnational differences in affordability may provide valuable insights that have not previously been documented.

There are, however, certain limitations. This study examines affordability in Canadian provinces over time. The findings reflect a retrospective observation of a trend or impact, but they do not provide a recommended AI value for prospective planning or design. The authors were unable to identify studies recommending an optimal AI value. The WHO monitors changes in affordability and urges countries to ensure that affordability is decreasing over time. While targets to decrease affordability can be set by individual countries or subnational governments through exploration of AI trend lines, a "gold-standard" recommendation for AI value would be useful. Research to determine the optimal AI value at which cigarette consumption is significantly reduced would be valuable to tobacco control.

Conclusion

Provincial cigarette tax increases have resulted in reduced affordability over time, and they have contributed to reduced smoking prevalence and consumption. However, provinces need to ensure that cigarette tax increases are sustained in a manner that exceeds economic growth and wage increases in order to achieve the desired effect of reducing consumption. Provinces can apply an additional indexed (*ad valorem*) tobacco tax that is tied to the Consumer Price Index, relative wage increases or GDP increases to ensure that affordability does not increase over time. Monitoring affordability over time also contributes valuable data to maximize impact in the design of tobacco taxation structures at the subnational level in Canada.

Conflicts of interest

LH is employed by an organization that receives public and private sector funding that is not derived from tobacco or vaping companies. MW has no conflicts of interest.

Authors' contributions and statement

MW and LH contributed to the design and conceptualization of the work and acquisition of the data. Data was analyzed by MW and validated by LH. Both authors contributed to the interpretation of the data and the drafting and revising of the article, and approved the final article..

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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