Understanding the association between neighbourhood socioeconomic status and grocery store alcohol sales following market liberalization in Ontario, Canada

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Abstract

Objectives In 2015, Ontario partially deregulated alcohol sales by allowing grocery stores to sell alcohol. The purpose of this study was to evaluate (1) whether neighbourhood-level socioeconomic status (SES) impacted the likelihood that a grocery store began selling alcohol, and (2) whether increases in alcohol retail availability following deregulation differed between neighbourhoods based on SES.

Methods This was a repeated cross-sectional analysis of 1062 grocery stores in 17,096 neighbourhoods in urban Ontario. The association between neighbourhood-level SES and whether a grocery store began selling alcohol was modeled using mixed effect logistic regression. The annual change in drive-distance from a neighbourhood to the closest off-premise alcohol outlet between 2015 and 2020 was modeled using mixed effect linear regression. An interaction between time and SES was included to evaluate whether this change differed between neighbourhoods based on SES.

Results Grocery stores in neighbourhoods in the lowest SES quintile were 39% less likely to start selling alcohol than grocery stores in neighbourhoods in the highest SES quintile (odds ratio (OR): 0.61, 95% confidence interval (CI): 0.39–0.94). As grocery store sales expanded, the distance to the closest off-premise alcohol outlet decreased by 51.8 m annually (95% CI: 48.8–54.9, $p < 0.01$). A significant interaction between year and SES was observed whereby this trend was more pronounced in high- versus low-SES neighbourhoods.

Conclusion The expansion of grocery store alcohol sales increased alcohol availability, but this increase was proportionately larger in high- versus low-SES neighbourhoods. This reduced historic disparities in alcohol availability between low- and high-SES neighbourhoods.

Résumé

Objectifs En 2015, l'Ontario a partiellement déréglementé les ventes d'alcool en autorisant les épiceries à en vendre. Notre étude visait à évaluer : 1) si le statut socioéconomique (SSE) du quartier avait un effet sur la probabilité qu'une épicerie commence à vendre de l'alcool et 2) si les augmentations de l'accessibilité de l'alcool au détail après la déréglementation différaient d'un quartier à l'autre selon le SSE.

Méthode Il s'agissait d'une analyse transversale répétée de 1 062 épiceries dans 17 096 quartiers urbains de l'Ontario. L'association entre le SSE du quartier et le fait qu'une épicerie commence ou non à vendre de l'alcool a été modélisée par régression logistique à effets mixtes. Le changement annuel de la distance de conduite entre un quartier et le point de vente

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d'alcool hors site le plus proche entre 2015 et 2020 a été modélisé par régression linéaire à effets mixtes. Une interaction entre le temps et le SSE a été incluse pour évaluer si le changement différait d'un quartier à l'autre selon le SSE.

Résultats Les épiceries des quartiers du quintile SSE le plus défavorisé ont été de 39 points de pourcentage moins susceptibles de commencer à vendre de l'alcool que les épiceries des quartiers du quintile SSE le plus favorisé (rapport de cotes [RC] : 0,61, intervalle de confiance de 95 % [(IC) : 0,39-0,94). Avec l'expansion des ventes des épiceries, la distance jusqu'au point de vente d'alcool hors site le plus proche a diminué de 51,8 mètres par année (IC de 95 % : 48,8-54,9, *p* < 0,01). Une interaction significative entre l'année et le SSE a été observée : cette tendance était plus prononcée dans les quartiers de SSE élevé que dans les quartiers de faible SSE.

Conclusion L'expansion des ventes d'alcool des épiceries a fait augmenter l'accessibilité de l'alcool, mais cette augmentation a été proportionnellement plus grande dans les quartiers de SSE élevé que dans les quartiers de faible SSE. Cela a réduit les disparités historiques d'accessibilité de l'alcool entre les quartiers de SSE élevé et de faible SSE.

Introduction

Alcohol use is the seventh leading cause of premature death and disability worldwide (Griswold et al., 2018). In Canada, alcohol use has an annual cost of approximately 17 billion dollars in expenses related to healthcare, criminal justice, and lost productivity (Canadian Centre on Substance Use and Addiction, 2020). A greater physical availability of off-premise alcohol outlets (stores in which alcohol can be purchased but not consumed, e.g., liquor stores) is associated with higher rates of alcohol-related harm, such as alcohol use disorder (AUD), alcohol-related hospitalization, and alcohol-related violent crime (Campbell et al., 2009; Gruenewald, 2011; Sherk et al., 2018). In turn, public health organizations recommend limiting the density of alcohol outlets to minimize the harms associated with alcohol use (Centers for Disease Control and Prevention [CDC], 2017; Crépault, 2020; Ontario Public Health Association, 2018). Despite this recommendation, some Canadian provinces have increased the availability of alcohol over the past two decades. These changes have been associated with increased rates of alcohol-related harms, including alcohol-related emergency department (ED) visits and mortality (Myran et al., 2019b; Stockwell et al., 2013).

Importantly, however, not all populations are equally impacted by alcohol use and harms. A notable example is the 'alcohol-harm paradox', whereby individuals with lower socioeconomic status (SES) tend to consume less alcohol than individuals with higher SES but are disproportionately impacted by the harms associated with alcohol use (Beard et al., 2016; Bloomfield, 2020). The reasons for this are complex and, to date, incompletely understood. However, differences in the types of alcohol consumed, health behaviours, social support networks, and access to health services between low and high SES populations likely underlie some of these trends (Beard et al., 2016; Bloomfield, 2020). The way in which alcohol is regulated may also play a role. For example, in Ontario, the density of government-run off-premise alcohol outlets is highest in low-income neighbourhoods (Myran et al., 2019a), which, as described above, is a known risk factor for alcohol-related harm.

Given the potential relevance of alcohol regulation policy to socioeconomic disparities in alcohol-related harm, it is important to understand how changes in alcohol policy impact the socioeconomic distribution of alcohol outlets. For example, a policy change that increases the density of alcohol outlets in low-income neighbourhoods could foreseeably exacerbate the already high rates of alcohol-related harm in these areas. In 2015, the Ontario government partially deregulated alcohol sales by allowing for up to 450 grocery stores to begin selling beer, wine, and cider. This represented a significant shift in the landscape of alcohol sales in Ontario, which had previously been contained within a limited set of 1500 storefronts that, unlike other jurisdictions, did not include convenience stores or grocery stores. This policy did not specify where eligible grocery stores could start selling alcohol, creating the potential for grocery store alcohol sales to locate close to pre-existing alcohol outlets and, in turn, exacerbate geographic clusters of high alcohol availability (Estill et al., 2018).

A previous study by our group demonstrated that, following the introduction of grocery store alcohol sales in Ontario, (1) alcohol availability increased province-wide, and (2) overall, the availability of alcohol outlets (including grocery store sales) was higher in neighbourhoods with low, relative to high, SES (Myran et al., 2019a). However, we did not specifically evaluate whether socioeconomic disparities in alcohol availability *changed* (e.g., were exacerbated or ameliorated)

as more grocery stores began selling alcohol. Therefore, the purpose of this project was to evaluate how the expansion of grocery store alcohol sales in Ontario following the 2015 policy change impacted socioeconomic disparities in alcohol availability over time. This overarching purpose was broken down into two objectives. The first was to evaluate whether neighbourhood-level SES impacted the likelihood that a grocery store would start selling alcohol. The second was to evaluate whether the increase in alcohol availability precipitated by the expansion of grocery store alcohol sales differed in lower- relative to higher-SES neighbourhoods.

Methods

Study design

For the first objective, we gathered the addresses of grocery stores that were eligible to start selling alcohol in Ontario (see Supplementary Table 1 for eligibility criteria). These stores were then geocoded such that neighbourhood-level indices of SES could be linked to each store based on its geographic location. Grocery stores in rural areas of Ontario (communities with a population size < 10,000) were excluded. This was done because, beginning in 2019, the government authorized additional off-premise stores (*Liquor Control Board of Ontario* [LCBO] Agency Stores) to open in rural areas, and we wanted to isolate the effect of the grocery store alcohol sales policy.

For the second objective, we characterized the change in the physical availability of off-premise alcohol outlets (including grocery stores and other off-premise outlet types) in urban neighbourhoods annually between 2014 and 2020 and evaluated whether neighbourhood-level SES influenced the rate of change. For both objectives, 'neighbourhoods' were defined as dissemination areas (DAs), which are the smallest geographic unit for which census data are available and contain 400–700 residents.

Data sources

The addresses of eligible grocery stores were obtained from the websites of all large grocery retailers in Ontario and were independently verified by two individuals (see Supplementary Methods). Prior to 2015, 122 grocery stores in Ontario had a separate wine sales store located within or adjacent to the grocery store. In our primary analyses, we excluded these stores as they were effectively already selling alcohol; however, we also conducted a sensitivity analysis where they were not excluded. The addresses of all off-premise alcohol outlets (including grocery stores, LCBO outlets, The Beer Store, The Wine Rack, and The Wine Store) operating in Ontario for each year between 2014 and 2020 were obtained from the *Alcohol & Gaming Commission of Ontario* (AGCO) via a

Freedom of Information request, as previously described (Myran et al., 2019a). A grocery store was categorized as having started selling alcohol following sales deregulation if it was listed as an off-premise alcohol sales outlet by the AGCO by 2020. Neighbourhood-level socioeconomic indices were obtained from the Ontario Marginalization Index (Matheson & Van Ingen, 2016). Other neighbourhood-level demographic variables were obtained from the 2016 Canadian census via the *cancensus* package in R version 4.0.2 (von Bergmann et al., 2021).

Outcomes

For the first objective, the outcome was whether an eligible grocery store began selling alcohol between 2015 (sales deregulation) and 2020. For the second objective, the outcome was the physical availability of off-premise alcohol outlets. This was measured by calculating the distance between the geographic centroid of a neighbourhood and the closest off-premise alcohol outlet (any type) on the road network. To account for the fact that individuals may purchase alcohol from more outlets than just the one closest to them, we also measured the average distance between the neighbourhood centre and the closest 3 and 5 off-premise outlets on the road network (Centers for Disease Control and Prevention [CDC], 2017). We chose to use distance on the road network rather than straight-line (Euclidean) distance because the former is more representative of real-world commuting patterns. Finally, we also conducted a sensitivity analysis where the physical availability of off-premise alcohol was reconceptualized as the drive-time to the nearest off-premise alcohol outlet, which incorporates neighbourhood-level variation in the road network, such as posted speed limits and traffic lights.

Exposure and covariates

For both objectives, the exposure of interest was neighbourhood-level SES. This was measured using an Ontario-specific index of SES, 'material deprivation quintile' (a dimension of the Ontario Marginalization Index), which is based on neighbourhood-level income, education, housing quality, and family structure characteristics. Material deprivation quintiles are available for each neighbourhood in Ontario and could therefore be linked to grocery stores based on the neighbourhood in which the grocery store was located. Of note, higher material deprivation corresponds to lower SES and lower material deprivation corresponds to higher SES; therefore, for clarity, throughout the Results section, we will refer to material deprivation quintile 1 as 'high SES' and quintile 5 as 'low SES'.

Additional neighbourhood-level covariates included the proximity of an eligible grocery store to the nearest off-

premise alcohol outlet (any type), population density, % immigrant population, and % of the population between ages 20 and 29. These variables were included a priori based on the rationale that they could confound the association between SES and whether grocery store began selling alcohol due to their known associations with both neighbourhood-level SES and patterns of alcohol sales and use in Ontario (Myran et al., 2019c; Myran et al., 2019b; Myran et al., 2021; Matheson & Van Ingen, 2016). A second-order polynomial term for population density was included due to a hypothesized non-linear association between population density and alcohol sales (Foster et al., 2020; Livingston, 2008).

Statistical analysis

For the first objective, descriptive statistics of grocery store characteristics, stratified by whether they started selling alcohol, were tabulated. Due to the large sample size ($n > 1000$), significant differences between groups were evaluated using standardized differences (SD), where a SD > 0.10 indicated a meaningful difference between groups (Austin, 2009). The association between material deprivation and whether a grocery store started selling alcohol was assessed using a multivariable generalized linear mixed model with a binomial distribution. A random intercept term for census subdivision (CSD, $n = 575$ in Ontario), a census region into which neighbourhoods cluster, was included in the model to account for spatial autocorrelation in the data. The results from both unadjusted (only material deprivation as a fixed effect) and fully adjusted (all covariates as fixed effects) models were tabulated.

For the second objective, the neighbourhood-level availability of off-premise alcohol outlets was calculated for each year between 2014 and 2020 and these annual data were concatenated into a single dataset. The statistical significance of the annual change in the availability of off-premise alcohol outlets was assessed using a one-way analysis of variance (ANOVA). The association between material deprivation and the distance to the closest outlet(s) was assessed using a multivariable linear mixed model that included a random intercept for neighbourhoods nested within CSDs, which accounts for (1) repeated annual measurements and (2) spatial autocorrelation, respectively. In addition to the covariates described above, the model also included a fixed-effect term for year to evaluate the change in alcohol availability over time. Based on our previous work (Myran et al., 2019a), we expected that alcohol availability would increase between 2014 and 2020 (i.e., the distance to the closest off-premise alcohol outlet(s) would decrease) and further hypothesized that this rate of change would differ between neighbourhoods based on material deprivation. To evaluate this hypothesis, we included an interaction term between year and material deprivation, where a statistically significant interaction would indicate that the rate of change in alcohol availability over time differed between neighbourhoods based on material deprivation. In the event of a significant interaction, the marginal effects of the interaction were plotted to visualize how the change in alcohol availability over time differed by material deprivation quintile.

Software

Geospatial analyses were conducted in ArcGIS Pro version 2.8.0 (Esri Inc., 2019). All statistical analyses were conducted in R version 4.0.2. Specifically, the *lme4* package was used to run the mixed effect models and the *effects* and *ggplot2* packages were used to create marginal effect plots (Bates et al., 2007; Wickham, 2011).

Results

Objective 1: The association between neighbourhood SES and grocery store alcohol sales

A total of 1062 eligible urban grocery stores were identified, of which 336 began selling alcohol between 2015 and 2020. Descriptive statistics of the eligible stores, stratified by whether they started selling alcohol following sales deregulation, are presented in Table 1. The modeled associations between material deprivation and whether a store started selling alcohol post-deregulation are presented in Table 2. In both the unadjusted and adjusted models, grocery stores in neighbourhoods in the lowest SES quintile had a lower odds of starting to sell alcohol than those in neighbourhoods in the highest SES quintile (*unadjusted* odds ratio (OR): 0.61, 95% confidence interval (CI): 0.39–0.94; *adjusted* OR (aOR): 0.67, 95% CI: 0.45–0.99). Similar results were observed when grocery stores that were previously associated with a wine retailer were included in the analytic sample (Supplementary Table 2).

Objective 2: The association between neighbourhood SES and alcohol availability following partial sales deregulation

In total, 17,096 urban neighbourhoods were included in the analysis. The average road-network distance to the closest 1, 3, and 5 off-premise alcohol outlets from the geographic centre of these neighbourhoods for each year between 2014 and 2020 is presented in Fig. 1a. This illustrated a significant decrease in the distance to the closest off-premise alcohol outlet(s) between 2014 and 2020, as gauged by a 1-way ANOVA for the time trends (Fig. 1a). Grocery store alcohol outlets represented 82% of new off-premise alcohol outlets in urban Ontario between 2015 and 2020 (Fig. 1b).

Table 1 Neighbourhood characteristics of eligible grocery stores, stratified by whether or not they started selling alcohol following partial sales deregulation in 2015

Variable	Overall (*n* = 1062)	Started selling alcohol		SD
		No (*n* = 726)	Yes (*n* = 336)	
Material deprivation quintile				
1 (lowest)	205 (19.3%)	129 (17.8%)	76 (22.6%)	0.27
2	193 (18.2%)	132 (18.2%)	61 (18.2%)	
3	175 (16.5%)	104 (14.3%)	71 (21.1%)	
4	220 (20.7%)	164 (22.6%)	56 (16.7%)	
5 (highest)	269 (25.3%)	197 (27.1%)	72 (21.4%)	
Closest off-premise outlet (m) — median (IQR)	559.1 (150.1–887.5)	531.8 (142.4–1399.0)	633.0 (180.3–1215.9)	0.06
Population density (pop./km^2) — median (IQR)	1848 (648–3354)	1935 (716–3532)	1708 (593–3064)	0.10
% immigrant population — median (IQR)	22.9 (11.8–40.3)	20.2 (11.0–39.0)	29.1 (15.3–42.1)	0.26
% ages 20–29 — median (IQR)	12.7 (10.2–15.3)	12.6 (9.9–15.2)	12.8 (10.6–15.5)	0.08

SD, standardized difference

The results of the linear mixed model for the association between SES quintile and the distance to the closest off-premise alcohol outlet are presented in Table 3. The modeled distance to the closest outlet decreased by an average of 51.85 m each year between 2014 and 2020 (95% CI: 48.76–54.94, *p* < 0.01). Across the entire study timeframe, lower SES was associated with a shorter distance to the closest outlet, with neighbourhoods in the lowest SES quintile being on average 454.81 m (95% CI: 389.99–519.62, *p* < 0.01) closer to an off-premise alcohol outlet than neighbourhoods in the highest SES quintile.

A significant interaction was observed between year and SES quintile, such that the annual reduction in the distance to the closest outlet was smaller in neighbourhoods in lower, relative to higher, SES quintiles (Table 3). For example, in neighbourhoods with the lowest SES, the annual reduction in distance to the closest off-premise alcohol outlet was 39.34 m (95% CI: 34.92–43.77, *p* < 0.01) less than the reduction observed among neighbourhoods with the highest SES (Table 3). This interaction is visualized in Fig. 2, which shows that the annual reduction in the distance to the closest off-premise alcohol outlet is more pronounced in neighbourhoods with higher versus lower SES. The net result of this interaction is that the difference in the average distance to the closest off-premise alcohol outlet between low- and high-SES neighbourhoods became smaller over time (Fig. 2).

Similar results were obtained from the sensitivity analyses where we considered the average distance to either the closest

Table 2 Modeled association between neighbourhood socioeconomic status (SES) and whether or not an eligible grocery store started selling alcohol

Variable	OR†	95% CI	*p*	aOR†	95% CI	*p*
Material deprivation quintile (ref. 1, high SES)						
2	0.80	0.51–1.24	0.32	0.81	0.53–1.24	0.33
3	1.28	0.82–2.00	0.27	1.10	0.72–1.69	0.66
4	0.61	0.39–0.97	0.04	0.56	0.37–0.87	0.01
5 (low SES)	0.61	0.39–0.94	0.02	0.67	0.45–0.99	0.04
Distance to nearest off-premise outlet (m)*				1.08	0.94–1.23	0.29
Population density				0.69	0.57–0.83	< 0.01
Population density^2				0.83	0.75–0.93	< 0.01
% immigrant population				1.42	1.23–1.64	< 0.01
% ages 20–29				1.21	1.05–1.40	0.01

OR, odds ratio; *aOR*, adjusted odds ratio; *CI*, confidence interval

*Log transformed prior to analysis due to right skew

† Odds ratios for continuous variables represent the change in odds of the outcome associated with a 1 standard deviation increase in the variable
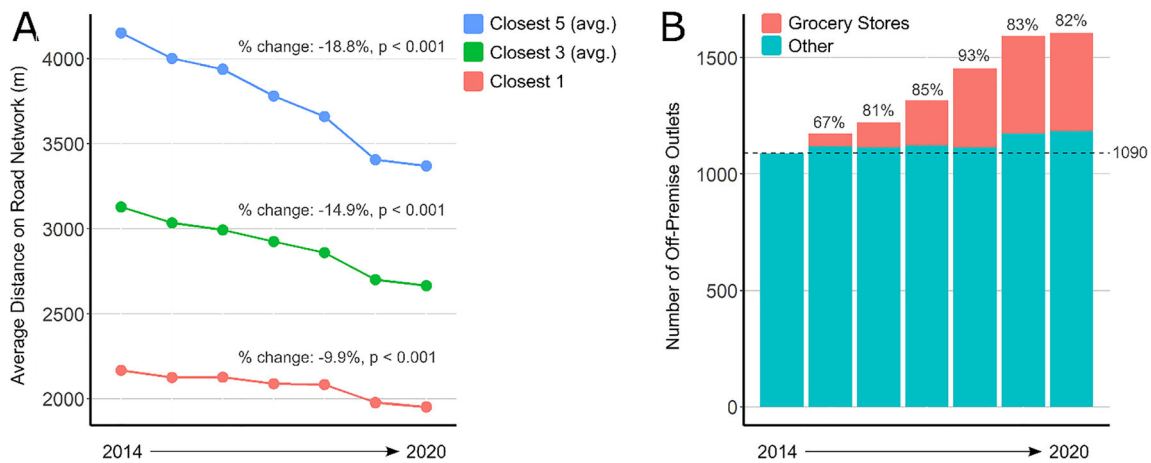
Fig. 1 Descriptive statistics for off-premise alcohol availability in urban Ontario between 2014 and 2020. **a** The average drive-distance to the closest 1 (red), 3 (green), and 5 (blue) off-premise alcohol outlets from neighbourhood centres for each year between 2014 and 2020. The (1) percent change between 2014 and 2020 and (2) p-value from a 1-way analysis of variance (ANOVA) used to assess the significance of the annual change are provided above each line. **b** The count of off-premise

alcohol outlets (grocery stores [red] and LCBO outlets, The Beer Store, The Wine Rack, and The Wine Store [blue]) in urban Ontario for each year between 2014 and 2020. The percentages above each bar indicate the annual percentage of new off-premise alcohol outlets (relative to 2014) that are grocery stores. Urban Ontario defined as neighbourhoods in Census Agglomerations (>10,000 population) or Census Metropolitan Areas (>100,000 population)

three or five outlets (Supplementary Table 3) or when we considered the drive-time to the closest outlet instead of drive-distance (Supplementary Table 4). In both cases, the increase in alcohol availability over time was significantly smaller in the lowest, relative to the highest, SES quintile, resulting in a reduction in the SES-related disparity in alcohol availability over the study timeframe (Supplementary Fig. 1).

Discussion

Main findings

Following a 2015 policy change that allowed for beer, wine, and cider to be sold in grocery stores, grocery stores in neighbourhoods with higher SES were more likely to start

	Estimate†	95% CI	p
(Intercept)	2183.48	2012.87–2354.09	< 0.01
Year (per 1-year increase)	−51.85	−54.94 to −48.76	< 0.01
Material deprivation quintile (ref. 1, high SES)			
2	−114.76	−203.46 to −86.05	< 0.01
3	−277.85	−338.68 to −217.02	< 0.01
4	−328.89	−391.85 to −265.94	< 0.01
5 (low SES)	−454.81	−519.62 to −389.99	< 0.01
Population density	−720.66	−755.59 to −685.74	< 0.01
Population density^2	462.24	447.59 to 476.90	< 0.01
% ages 20–29	−131.13	−151.07 to −111.19	< 0.01
% immigrant population	266.05	233.96 to 298.14	< 0.01
Interaction (ref. year * material deprivation quintile 1)			
Year * material deprivation quintile 2	7.17	2.71–11.63	< 0.01
Year * material deprivation quintile 3	12.91	8.42–17.40	< 0.01
Year * material deprivation quintile 4	25.39	20.90–29.87	< 0.01
Year * material deprivation quintile 5	39.34	34.92–43.77	< 0.01

Table 3 Modeled association between neighbourhood socioeconomic status (SES) and the road-network distance from a neighbourhood centre to the closest off-premise alcohol outlet between 2014 and 2020

CI, confidence interval

† Estimates for continuous variables represent the change in the outcome associated with a 1 standard deviation increase in the variable

Fig. 2 Marginal effect plot to visualize interaction between time (year between 2014 and 2020, *x*-axis) and material deprivation (grouping variable) on the distance to the closest off-premise alcohol outlet (*y*-axis). This interaction was statistically significant as demonstrated by the results of the linear mixed model presented in Table 3
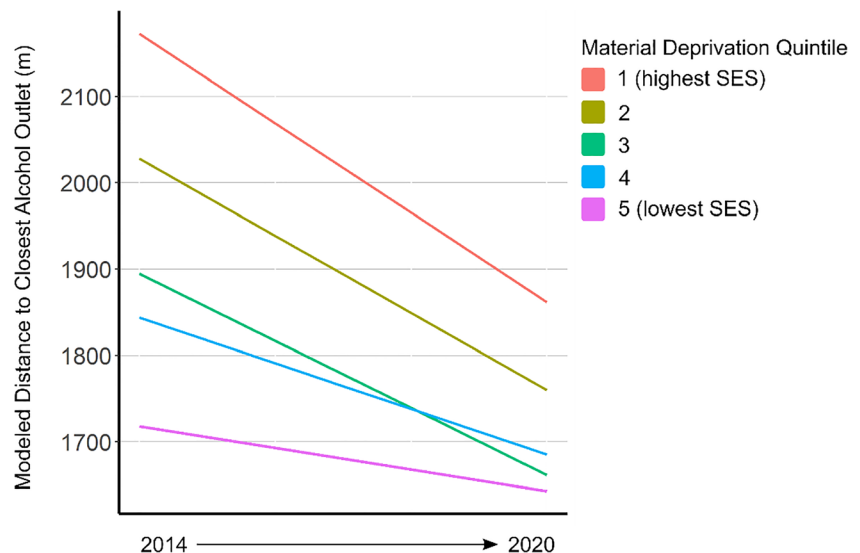
selling alcohol than grocery stores in neighbourhoods with lower SES. As grocery store alcohol sales expanded, the availability of off-premise alcohol outlets increased province-wide; however, this increase in alcohol availability was larger in neighbourhoods with higher versus lower SES. This attenuated a previously existing disparity in the availability of off-premise alcohol outlets, which has been historically higher in low-income neighbourhoods.

Relevance to existing literature

Previous studies exploring the impact of alcohol sales deregulation have consistently indicated that deregulation results in an increase in alcohol availability, alcohol sales, and alcohol use in Canada (Myran et al., 2019a; Stockwell et al., 2009) and internationally (Hahn et al., 2012; Wagenaar & Langley, 1995). These increases have been associated with an elevated risk of alcohol-related harms including alcohol-related emergency department (ED) visits and mortality (Myran et al., 2019b; Stockwell et al., 2013). Our results align with this previous literature, insofar as the expansion of grocery alcohol sales in Ontario following partial sales deregulation significantly increased the neighbourhood-level availability of alcohol between 2015 and 2020.

The second finding, pertaining to the shift in SES-related disparities in off-premise alcohol availability, builds on this previous knowledge by demonstrating that sales deregulation can influence the socioeconomic landscape of alcohol availability. Previous work has demonstrated that off-premise alcohol outlets tend to cluster in lower-SES neighbourhoods, despite the fact that lower-SES populations consume less alcohol than higher-SES populations (Lee et al., 2020; Myran et al., 2019a). The reasons for this phenomenon are complex and not fully understood; however, one consideration is that an alcohol outlet can maximize profit by situating itself in a low-income neighbourhood that borders a high-income neighbourhood, such that it can capitalize

on both low rent and consumer demand (Morrison et al., 2015). Another consideration is the history of racist and otherwise discriminatory financial and zoning practices ('redlining') that have contributed to a colocation of low-income, racialized populations and clusters of off-premise alcohol outlets in the United States (Lee et al., 2020; Trangenstein et al., 2020). While parallel research is not available in the Canadian context, socioeconomic disparities in the spatial distribution of other industries have been documented. For example, in Winnipeg, mainstream financial institutions tend to locate in higher- versus lower-income neighbourhoods, whereas the opposite is true of payday loan outlets (Brennan et al., 2011). In turn, discriminatory policies and processes may have similarly contributed to the clustering of off-premise alcohol outlets in low-income Canadian neighbourhoods, although additional research is required on this topic due to the differences in alcohol regulation between Canada and the USA.

Given this context, it is interesting that the expansion of beer, wine, and cider sales into Ontario grocery stores resulted in a partial attenuation of this historic trend. The reasons why this happened were not directly investigated, but merit discussion. First, there is a complex relationship between the location of grocery stores and area-level SES. Substantial research has been done on the concept of 'food deserts' in North America, which broadly refer to a lower access to healthy food retail in low-SES neighbourhoods (Luan et al., 2016; Minaker et al., 2016). Despite this attention, there is little evidence that they exist in Canada, with most research finding equal or greater access to grocery stores selling healthy foods in lower- relative to higher-income neighbourhoods (Minaker et al., 2016). Therefore, disparate access to grocery stores that were eligible to start selling alcohol between low- and high-income neighbourhoods likely did not influence the trends observed in this study.

What may be more important is brand-specific decision-making. If (1) the brands of grocery store that were eligible to

start selling alcohol in Ontario were unevenly distributed between low- and high-income neighbourhoods, and (2) brands located in higher-income neighbourhoods were more likely to begin selling alcohol, then alcohol availability would have disproportionately increased in high- versus low-income neighbourhoods during the expansion of grocery store alcohol sales. While there are no publicly available data to evaluate the decision-making processes of private grocery retailers in Ontario, there are multiple discount grocery store brands (e.g., No Frills, Food Basics) that were eligible to start selling alcohol but (1) may have been less likely to start selling alcohol due to low profit margins (White, 2022) and (2) may preferentially locate near lower-income populations, which, in turn, supports the plausibility of this hypothesis. Last, because the grocery stores that began selling alcohol were existing retail outlets, land cost or rent may have had less influence on the placement of alcohol sales outlets, allowing for the market to respond more freely to the higher demand for alcohol in higher-income neighbourhoods.

While this study did not evaluate area-level alcohol use or alcohol-related harms, it will be important to understand how uneven changes in alcohol availability in high- versus low-SES neighbourhoods following the deregulation of grocery store alcohol sales influenced socioeconomic disparities in these outcomes. Given that higher alcohol availability is associated with increased rates of alcohol-related harm (Sherk et al., 2018), it is possible that the rapid increase in off-premise alcohol availability in high-income neighbourhoods resulted in a disproportionate increase in alcohol-related harm among higher- versus lower-income populations following the policy change. However, as described in the Introduction section, there is complex relationship between SES, alcohol use, and alcohol-related harm, and caution must be taken in assuming that a narrowing of socioeconomic disparities in alcohol availability would have resulted in a proportional narrowing of socioeconomic disparities in alcohol-related harm (Smith & Foster, 2014). Future research is required to understand the complex associations among SES, alcohol availability, and alcohol-related harm in Ontario and how they have been impacted by the expansion of private grocery store alcohol sales.

Limitations

There are several limitations to this study. First, while grocery stores represented most new outlets in Ontario between 2015 and 2020, other government-run off-premise alcohol outlets were also established in this timeframe. If these alcohol outlets were preferentially opened in high-SES neighbourhoods, this would have contributed to the larger increase in alcohol availability observed in higher- versus lower-SES neighbourhoods. However, government-run alcohol outlets have historically gravitated towards lower-income neighbourhoods, which

may reduce the impact of this limitation (Myran et al., 2019a). Second, independent grocery stores that did not begin selling alcohol were not included in the analytic sample for objective one, which biases the results of this analysis to be representative of patterns of alcohol sales in large chain grocery stores. This is not particularly problematic in the context of this study, given that virtually all grocery stores that began selling alcohol were chains (see Supplementary Methods); however, this should be considered when extrapolating the results of this study to other jurisdictions with different types of grocery retail environments. Finally, this study only focused on off-premise alcohol availability given that grocery stores fall into this category of alcohol sales. Nonetheless, there are also known socioeconomic disparities in on-premise alcohol availability (Livingston, 2012), which contribute to socioeconomic differences in alcohol use and alcohol-related harm (Livingston, 2011; Treno et al., 2001). Therefore, future studies on how alcohol sales deregulation impacts socioeconomic disparities in alcohol availability should consider the relative impacts of both on- and off-premise alcohol outlets.

Conclusion

Following a partial deregulation of alcohol sales that allowed for alcohol to be sold in grocery stores, alcohol availability increased across Ontario. Grocery stores in neighbourhoods with higher SES were more likely to start selling alcohol than grocery stores in neighbourhoods with lower SES. This corresponded with a proportionately larger increase in alcohol availability in high- versus low-SES neighbourhoods, resulting in a narrowing of SES-related disparities in off-premise alcohol availability. Future research is required to understand how this shift in alcohol availability in low- and high-SES neighbourhoods impacted socioeconomic disparities in alcohol use and alcohol-related harm.

Contributions to knowledge

What does this study add to existing knowledge?

- Off-premise alcohol outlets have historically concentrated in neighbourhoods with low, relative to high, socioeconomic status (SES).
- We found that after a policy change allowed grocery stores to sell alcohol, grocery stores in high-SES neighbourhoods were more likely to begin selling alcohol than grocery stores in low-SES neighbourhoods.
- In turn, this policy change resulted in a larger increase in off-premise alcohol availability in high- relative to low-

SES neighbourhoods and a narrowing of pre-existing socioeconomic disparities in alcohol availability.

What are the key implications for public health interventions, practice, or policy?

- Alcohol sales deregulation significantly increases the physical availability of off-premise alcohol outlets, which is a known environmental risk factor for hazardous and harmful alcohol use.
- Alcohol sales deregulation can change existing socioeconomic disparities in the physical availability of off-premise alcohol outlets.
- More research is required to understand how expanding grocery store alcohol sales in Ontario have impacted socioeconomic disparities in alcohol use and alcohol-related harm.

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Code availability Available on request.

Author contributions EF and DM conceptualized the study. EF, ES, and DM collected and analyzed the data. EF and ES wrote the first draft of the manuscript. All authors approved the final version of the manuscript.

Data availability A portion of the data used in this study is publicly available.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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