Health & Place 65 (2020) 102395

Contents lists available at ScienceDirect

Health and Place

journal homepage: http://www.elsevier.com/locate/healthplace

Area-level differences in the prices of tobacco and electronic nicotine delivery systems — A systematic review

G. Emmanuel Guindon [a,b,c,*], Tooba Fatima [a,b], Bipandeep Abbat [a], Prabhnoor Bhons [a], Sophiya Garasia [a,b]

[a] Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, ON, Canada
[b] Department of Health Research Methods, Evidence, and Impact (HEI), McMaster University, Hamilton, ON, Canada
[c] Department of Economics, McMaster University, Hamilton, ON, Canada

ARTICLE INFO

Keywords:
Tobacco
Cigarette
Electronic nicotine delivery systems
Price
Neighbourhood
Area-level

ABSTRACT

Objective: To examine associations between area-level characteristics (socioeconomic status, racial or ethnic characteristics, age, and any other characteristics that may be associated with vulnerability) and the prices of tobacco products and electronic nicotine delivery systems (ENDS).
Data sources: We searched MEDLINE, EconLit and Scopus, unpublished and grey literature, hand-searched four specialty journals, examined references of relevant studies, and contacted key informants.
Study selection: We considered all studies that quantitatively examined area-level variations in the prices of tobacco products and ENDS. We included all studies that examined any area-level measures regardless of the geographic location, language or time of publication. At least two reviewers independently screened the articles. We identified 20 studies.
Data extraction: At least two reviewers independently extracted the characteristics, methods, and main results and assessed the quality of each included study.
Data synthesis: Overall, cigarette prices were found to be lower in lower socioeconomic status neighbourhoods, and in neighbourhoods with a higher percentage of youth, and Blacks or African Americans. We identified too few studies that examined price differences for cigarillos, chewing tobacco, roll-your-own, and ENDS to reach any conclusions.
Conclusions: Our findings are in keeping with tobacco industry documents that detailed how manufacturers used race, class, and geography to target vulnerable populations and suggest that regulations that can limit industry price manipulation such as minimum, maximum, and uniform prices, and high specific excise taxes should be considered. More frequent and systematic monitoring of tobacco prices and ENDS is warranted.

1. Introduction

There is overwhelming evidence that higher tobacco prices reduce tobacco use and that young people and those from more socioeconomically disadvantaged groups tend to be more sensitive to price changes (International Agency for Research on Cancer, 2011; US National Cancer Institute and World Health Organization, 2016). Consequently, vulnerable groups such as the young and the poor may be more susceptible to strategies that make tobacco products more affordable. Associations between individual socioeconomic status (SES) and smoking are well documented (Hiscock et al., 2012). There is also ample research that suggests area-level characteristics, such as household income, have an independent effect on individual smoking even after taking into account individual-level characteristics such as SES (Duncan et al., 1998; Reijneveld, 1998, 2002; Ross, 2000; Chuang et al., 2005; Cohen et al., 2011; Corsi et al., 2012; Karriker-Jaffe, 2013). While overall smoking prevalence has fallen over time in high-income countries, SES differences in smoking uptake, smoking prevalence and cessation have remained the same or even increased (Bosdriesz et al., 2015; Green et al., 2016; Drope et al., 2018; Tabuchi et al., 2018).

A comprehensive review of smoking and SES concluded that increasing the price of tobacco products was likely the tobacco control intervention with the greatest potential to reduce health inequalities from tobacco use (Hiscock et al., 2012). As a response to more

* Corresponding author. Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, ON, Canada.
E-mail address: emmanuel.guindon@mcmaster.ca (G.E. Guindon).

https://doi.org/10.1016/j.healthplace.2020.102395
Received 26 March 2020; Received in revised form 30 June 2020; Accepted 9 July 2020
Available online 25 August 2020

comprehensive marketing restrictions (e.g., prohibition of all tobacco advertising, promotion, and sponsorship, including point-of-sale and plain/standardized packaging), the tobacco industry has increasingly focused its attention on the use of price as a marketing tool (Henriksen, 2012). Surprisingly, little seems to be known about area-level (i.e., neighbourhood) variation in the price of tobacco products. A broader 2015 systematic review of neighbourhood disparities in point-of-sale tobacco marketing identified eight studies (Toomey et al., 2009; Seidenberg et al., 2010; McCarthy et al., 2011; Henriksen et al., 2012; Cantrell et al., 2013; Dalglish et al., 2013; Burton et al., 2014; Lipperman-Kreda et al., 2014) that specifically studied area-level differences in the prices of tobacco; results specific to prices, however, were not disaggregated from the other types of marketing (outside of the appendix evidence table)[1] (Lee et al., 2015a).

To fill this research gap, we systematically searched for and critically reviewed studies that examined associations between area-level characteristics and the prices of tobacco products. Additionally, given the rapid increase in the use of electronic nicotine delivery systems (ENDS)[2] which can provide a pathway to the cessation of tobacco use, but can also increase the risk of young non-smokers becoming addicted to nicotine, we also searched for and critically reviewed studies that examined associations between area-level characteristics and the prices of ENDS (McNeill et al., 2018; Yoong et al., 2018; Livingston et al., 2019).

2. Methods

We used an 'a priori' design but were unable to register our review to PROSPERO (an international database of prospectively registered systematic reviews) because our review does not have any health-related outcomes. Key information about our 'a priori' design which closely follows PROSPERO's template is presented in the appendix.

Search. We searched MEDLINE, EconLit and Scopus (see appendix for more details). We searched unpublished and grey literature via the New York Academy of Medicine Grey Literature Report, Open Grey, Google, and Google Scholar, and hand-searched four specialty journals (*Addiction, Health & Place, Nicotine & Tobacco Research and Tobacco Control*). We examined reference lists of relevant reviews and individual studies that we identified and examined studies that cited key papers using Thomson Reuters Web of Science and Google Scholar. Finally, we contacted four key informants to ensure that our search strategy captured all relevant studies. The database search was last updated on 12 May 2020. At least two reviewers, using distillerSR, screened titles and abstract of citations to determine relevance, followed by full text if relevance was unclear.

Inclusion and exclusion criteria. Types of studies: we considered all studies that quantitatively examined area-level variations in prices of tobacco products and of ENDS. Type of publication: we included all publication type including, but not limited to, peer-reviewed journal articles, working papers, research reports, and briefs in order to reduce the risk of publication bias and to identify as much relevant research as possible (Higgins et al., 2019). Time period: we included all studies regardless of date of publication or data collection. Geographic location: we included all studies regardless of the geographic location. Geographic coverage: we defined area-level loosely, as a single area-unit was defined differently across studies, but excluded studies that compared prices across larger areas such as countries, US states, and Canadian provinces. Language: we included all studies regardless of the language of publication. Types of outcome measures: we included all studies that examined price variations across any area-level measures that may be related to: 1) socioeconomic status (e.g., income, education); 2) racial or ethnic characteristics; 3) age (e.g., youth); and, 4) any other characteristics that may be associated with vulnerability.

Quality assessment and data extraction. Existing quality assessment tools for observational studies were not designed to assess the quality of methodological approaches used in studies that examine neighbourhood disparities in pricing or marketing strategies (Shamliyan et al., 2010; Waddington et al., 2017). In the development and operation of our review, we used Lee, Henriksen et al. (Lee et al., 2015a) who systematically reviewed neighbourhood disparities in point-of-sale tobacco marketing, as a guide. At least two of us independently extracted the following study characteristics: type of publication; location; time of data collection; area unit, sample strategy; sample size; retailer sampling frame and sampling strategy; data collection method; retailers' response rate; neighbourhood characteristics (measures, data sources); tobacco products/ENDS description; store/school density per area unit; statistical approach (and variables adjusted for in regression models); results; implications for policy development (as stated by authors); authors' efforts to identify and address potential biases; authors' assessment of the scientific quality and/or limitations; reporting of conflicts of interest and funding sources. In assessing the quality of the included studies, we focused on seven components: 1) the number of area units; 2) the number of retailers/stores; 3) spatial dependence; 4) probability-based sampling of area units and of retailers/stores; 5) inter-rater reliability; 6) collection of relative prices; and, 7) the interpretation and discussion of effect sizes. We did not compute total scores as empirical evidence does not support their use (Higgins et al., 2019; Greenland and O'Rourke, 2001; Lundh and Gotzsche, 2008).

3. Results

The database search produced 2438 records after the removal of duplicate citations, from which 2286 were excluded based on the title/abstract screen and 135 were subsequently removed after a full-text screen, yielding 16 studies that met all inclusion criteria. An additional three studies were identified after contacting key informants and one after searching reference lists of included studies (Fig. 1). Out of the 20 studies, three were from Australia (McCarthy et al., 2011; Dalglish et al., 2013; Burton et al., 2014), one from Scotland (Shortt et al., 2020) and 16 were from the United States (Toomey et al., 2009; Seidenberg et al., 2010; Henriksen et al., 2012, 2016, 2017; Cantrell et al., 2013, 2015; Lipperman-Kreda et al., 2014; Resnick et al., 2012; Lee et al., 2015b; Schleicher et al., 2015; Laestadius et al., 2018; Mills et al., 2018, 2019; Epperson et al., 2019; Kephart et al., 2019), of which four were conducted nationally, (Resnick et al., 2012; Lee et al., 2015b; Mills et al., 2018, 2019), one both nationally and in California (Henriksen et al., 2016), five in California (Henriksen et al., 2012, 2017; Lipperman-Kreda et al., 2014; Schleicher et al., 2015; Epperson et al., 2019), two in Washington DC (Cantrell et al., 2013, 2015), one in Wisconsin (Laestadius et al., 2018), one in Minnesota (Toomey et al., 2009) and two in Massachusetts (Seidenberg et al., 2010; Kephart et al., 2019). The first study was published in 2009 and presented data from the Minneapolis-St. Paul metropolitan area collected in 2002 (Toomey et al., 2009). The most recent study was published in 2020 and presented Scottish data from April 2018 (Shortt et al., 2020). A list of excluded studies and reasons for exclusion is provided in the appendix.

Among the 20 studies, six assessed area-level variation at the neighbourhood level, four in census blocks, four in census tracts, two using postcodes, and the remaining using suburbs (n = 1), city (n = 1), communities (n = 1), or geopolitics units (n = 1) as the area unit. We

[1] Main results were synthesized graphically and presented by neighbourhood characteristics for all four components (grouped together) of point-of-sale tobacco marketing: price (advertised price, price discounts, or price promotions), promotion, product, and placement.

[2] ENDS are battery-powered portable electronic devices that heat liquid (known as e-liquid or e-juice) containing nicotine or heat real tobacco leaves (heat-not-burn products) and generates vapour that is inhaled by the user (vaping). The experience simulates smoking a cigarette and the ENDS may or may not look like a cigarette (e-cigarette) (Glasser et al., 2017; National Academies of Sciences et al., 2018).

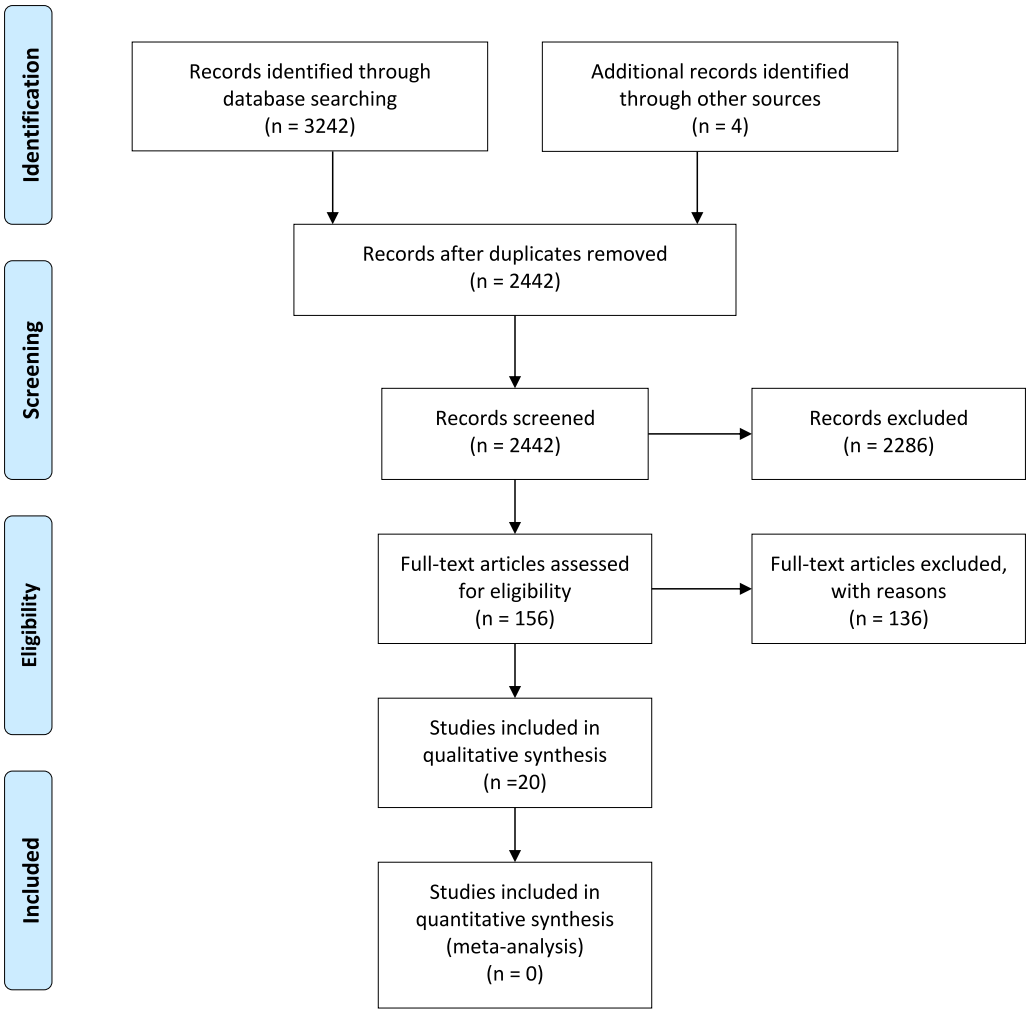


Fig. 1. Prisma flow diagram.

identified 19 studies that reported area-level differences in cigarette prices. Most studies (18 of 19) reported on cigarette pack price (single and/or multipack, premium and/or menthol, and/or cheapest pack). We also identified five studies that examined area-level differences in the prices of other tobacco products (little cigars/cigarillos [n = 3], chewing tobacco [n = 1], and roll-your-own [n = 1]), and two studies that examined electronic nicotine delivery systems (ENDS). Table 1 presents a summary of study characteristics and limitations (last column). eTables 1-3 presents a synthesis of main findings organized by area-level characteristics: SES, race/ethnicity, and youth. Detailed data extracted for each study are presented in the appendix.

Most studies did not examine area-level SES, racial/ethnic, and youth compositions in isolation. Consequently, correlation between area-level variables such as SES and racial/ethnic composition can affect both the magnitude and statistical significance of estimated associations (i.e., when explanatory variables are highly correlated, most of their variation is common to both variables, leaving little variation unique to each variable) (Kennedy, 2003). Fig. 2 presents results that, when applicable, included multiple area-level measures such as SES, racial/ethnic, and youth compositions while adjusting for other variables such as type of stores and retailer density.

Fig. 2 shows the count of results that showed a negative, unclear, and positive association between neighbourhood characteristics (SES, racial/ethnic composition, youth composition) and cigarette prices. The top panel uses an individual study as the unit of analysis while the bottom panel uses an association between one area-level characteristic and one product as the unit of analysis. In Fig. 2, and in the discussion below, we treat a study that both explored US (2012) and California (2014) as two independent studies (Henriksen et al., 2016). We first discuss associations between cigarette prices and SES characteristics and, racial/ethnic and youth composition of the area unit. We then discuss area-level differences in the prices of little cigars/cigarillos, chewing tobacco, roll-your-own, and ENDS.

3.1. Cigarettes

Socioeconomic status. 17 studies reported on the association between cigarette prices and SES characteristics of the area unit (Seidenberg et al., 2010; McCarthy et al., 2011; Henriksen et al., 2012, 2016, 2017; Dalglish et al., 2013; Burton et al., 2014; Lipperman-Kreda et al., 2014; Shortt et al., 2020; Cantrell et al., 2015; Lee et al., 2015b; Schleicher et al., 2015; Mills et al., 2018, 2019; Epperson et al., 2019; Kephart et al., 2019). SES was primarily measured using median household income; one study utilized the proportion of students eligible to receive free or reduced priced lunches as a measure of school SES (Henriksen et al., 2012), and four studies used indices for socioeconomic advantages and/or disadvantages (McCarthy et al., 2011; Dalglish et al., 2013; Burton et al., 2014; Shortt et al., 2020). Amongst the 17 studies, 15 found that prices were generally lower in lower-SES areas (11 of which were statistically significantly different at the 5% level). Two studies found unclear associations between tobacco prices and SES, while no study concluded that prices were higher in lower-SES areas. The 17 studies examined 65 associations between SES and cigarette prices, 57 of which suggested that prices were generally lower in lower-SES areas (28

Table 1
Study characteristics.

Study/location/period	Area units/sampling approach	Neighbourhood characteristics	Tobacco/ENDS products	Statistical approach, covariates	Limitations/risk of bias
Australia					
Burton, Williams et al., 2013 - New South Wales, Australia - Nov 2012 to Feb 2013	Postcodes for audit were randomly selected within each region until predefined sampling targets were reached for both the percentage of retailers and the percentage of postcodes.	SES, youth composition, racial/ethnic composition, remoteness	Winfield, pack and twin-pack	Generalized estimating equation (GEE) with a linear link, and exchangeable working correlation structure; *Additional covariates*: outlet type, legislation breach and listing with Ministry of Health.	1. # of area units: 95 2. # of stores: 1579 3. addressed spatial dependence: yes 4. used probability-based sampling of: area units: yes; of stores: n/a, 1579 of 1739 retailers were audited 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
McCarthy et al., 2011 - Australia - Victorian metropolitan areas with a population of 100,000 or more (Melbourne and Geelong) - Jul to Dec 2008	Neighbourhoods (in 1 km radius of selected milk bars); Closest two milk bars per school.	SES	Peter Jackson, pack Winfield, pack Longbeach, pack Benson & Hedges, pack Horizon, pack	Exact logistic regressions; *Additional covariates*: presence of a supermarket within 500 m of the school.	1. # of area units: 36 2. # of stores: 62 3. addressed spatial dependence: no 4. used probability-based sampling of area units: unclear; of stores: no 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no
Dalglish et al., 2013 - South-East Queensland, Australia - 30 Sep, Oct 1, 2010	Suburbs from the lowest and highest SES deciles were selected if the suburb contained a moderate-sized shopping centre (<100 retail outlets) and a 1 km radius from the main shopping centre did not include the Brisbane river; all retail outlets within a 1 km radius of a shopping centre were surveyed.	SES, racial/ethnic composition	Winfield Blue 25s, pack Longbeach Original 30s, pack Peter Jackson Original 30s, pack Horizon Purple 30s, pack	Two sample *t*-test; 2 factor-ANOVA; *Additional covariates*: none.	1. # of area units: 4 2. # of stores: unclear 3. addressed spatial dependence: no 4. used probability-based sampling of area units: no; of stores: all stores were sampled 5. inter-rater reliability: no 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no
United Kingdom					
Shortt et al., 2020 - Scotland - Apr 2018	Unclear; electronic point-of-sale data were obtained from convenience stores.	SES	Cigarettes (11 brands), roll-your-own (3 brands)	Linear regression models; *Additional covariates*: tobacco outlet density, urban/rural status.	1. # of area units: unclear 2. # of stores: 274 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: unclear; of stores: no 5. inter-rater reliability: n/a 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
United States, national					

(*continued on next page*)

Table 1 (*continued*)

Study/location/period	Area units/sampling approach	Neighbourhood characteristics	Tobacco/ENDS products	Statistical approach, covariates	Limitations/risk of bias
Mills et al., 2019 - United States - May 2015 to Aug 2015	Area unit: census tract;97 unique counties were randomly selected from all 3109 US counties.	SES, racial/ethnic composition, youth composition	Cheapest cigarette, pack	Linear mixed-effects/multilevel models; *Additional covariates*: store type, US region.	1. # of area units: 97 2. # of stores: 2069 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
Mills et al., 2018 - United States - May to Aug 2015	Area units: census tracts;97 unique counties selected from all 3109 counties. In the majority of counties, 24 tobacco retailers were randomly selected.	SES, racial/ethnic composition, youth composition	Marlboro Red, pack Newport, pack	Linear mixed-effects/multilevel models; *Additional covariates*: store type, US region.	1. # of area units: 97 2. # of stores: 2124 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
Henriksen et al., 2016 - Aug to Sep 2014, California - May to Jul 2012, United States	California, 2014: 0.5 mile roadway network service area around each store; US, 2012: census block groups Area units were randomly selected.	SES, racial/ethnic composition, youth composition, population density	- US/California: Marlboro Red, pack Newport, pack Cheapest cigarette, pack Pall Mall Red, pack - California: Pall Mall Red, pack - US Camel, pack	Ordinary least squares regressions; *Additional covariates*: store type.	1. # of area units: not reported 2. # of stores: 579 and 2603 3. addressed spatial dependence: unclear 4. used probability-based sampling of area units: unclear; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: yes 7. provided interpretation and discussed effect sizes: yes
Lee, Goldstein, et al., 2015 - United States - Jun to Oct 2012	Area units: census tracts;Census tracts in 97 counties across the US. 100 counties were randomly selected with minimal replacement and with probability proportionate to population size; For each selection of a county, up to 24 phone-verified stores were selected.	SES, racial/ethnic composition, youth composition, concentration of same-sex couples, rurality	Marlboro, pack Newport, pack	Linear mixed-effects/multilevel models; *Additional covariates*: store type.	1. # of area units: 1696 2. # of stores: 2231 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: to some extent

(*continued on next page*)

Table 1 (*continued*)

Study/location/period	Area units/sampling approach	Neighbourhood characteristics	Tobacco/ENDS products	Statistical approach, covariates	Limitations/risk of bias
Resnick et al., 2012 - United States - 2011 (months not reported)	Area units: census block groups;Sampling strategy not reported.	Racial/ethnic composition	Marlboro Red, pack Newport, pack Cheapest cigarette, pack	Not reported; *Additional covariates*: none.	1. # of area units: 1373 2. # of stores: 2387 3. addressed spatial dependence: no 4. used probability-based sampling of area units: not reported; of stores: not reported 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no
United States, states, cities					
Henriksen et al., 2017 - California - Jun to Sep 2013	Area units: census tracts;All retail outlets designated as licensed to sell tobacco.	SES, racial/ethnic composition, youth composition, population density	Cheapest cigarette, pack Swisher Sweets cigarillo, single	Linear mixed-effects/multilevel models, spatial regressions; *Additional covariates*: store type, distance to nearest competitor.	1. # of area units: 616 2. # of stores: 7393 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: no 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
Schleicher et al., 2015 - California - 2011 (months not reported) - Aug to Sep 2014	0.5 mile service areas around each store 2011: random sample; 2014: all 2011 stores still operating and selling tobacco were sampled; replacement stores randomly selected from the 2013 retailer licensing list.	SES, racial/ethnic composition, youth composition	Marlboro Red, pack Newport, pack Pall Mall, pack Cheapest cigarettes, pack Disposable e-cigarette: Blu NJOY Chewing tobacco: Grizzly Copenhagen	Least squares regression models for cross-sectional analysis; linear mixed-effects/multilevel models for longitudinal analysis; *Additional covariates*: store type.	1. # of area units: same as # of stores; 2. # of stores: n = 691 for longitudinal and n = 579 for cross-sectional 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: yes 7. provided interpretation and discussed effect sizes: to very little extent
Henriksen et al., 2012 - California; - Sep to Oct 2006	School neighbourhoods;All school neighbourhoods with six or fewer tobacco retailers were selected; in 31 neighbourhoods with more than 6 retailers, 6 or 50%, whichever yielded the larger number, were selected.	SES, racial/ethnic composition, youth composition, population density	Marlboro Red, pack Newport, pack Camel, pack Pall Mall, pack Cheapest cigarettes, pack	Linear mixed-effects/multilevel models; *Additional covariates*: store type, retailer density, discounted prices.	1. # of area units: 91 2. # of stores: 407 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: partially 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes

(*continued on next page*)

Table 1 (*continued*)

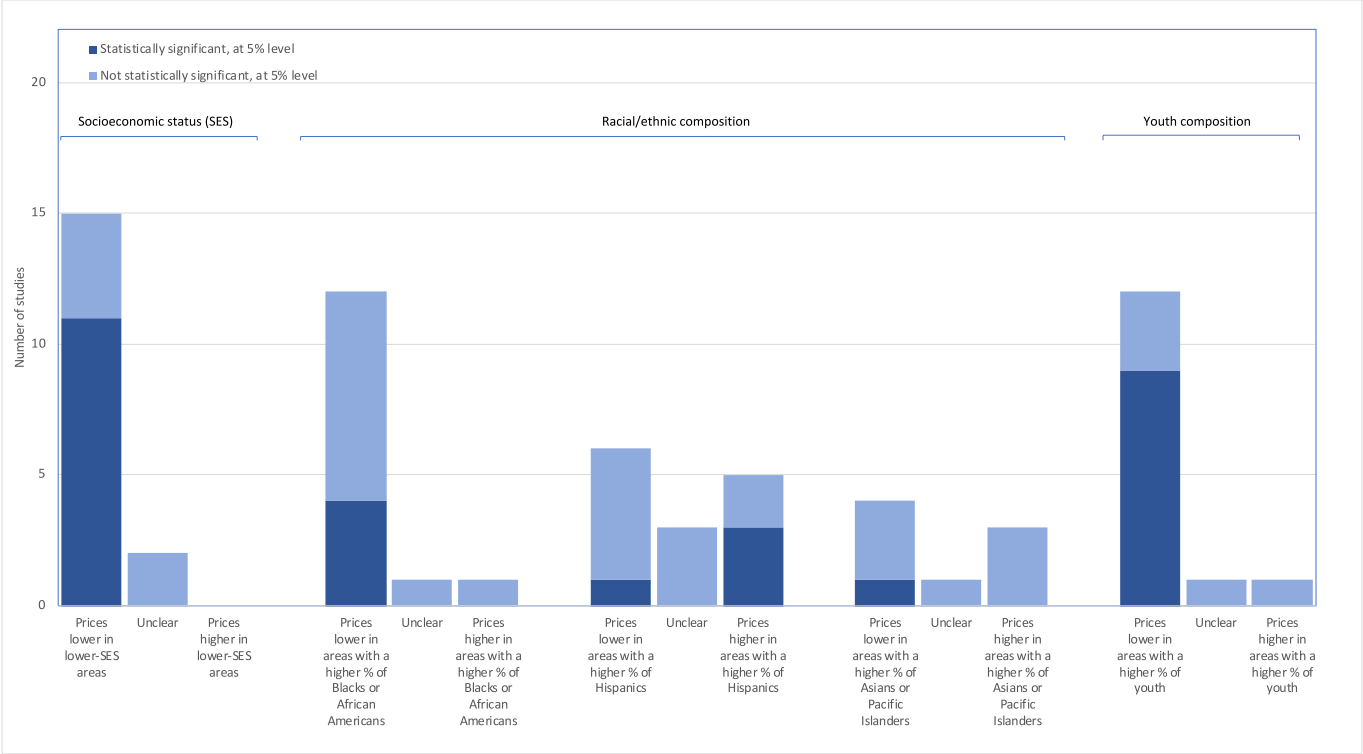
Study/location/period	Area units/sampling approach	Neighbourhood characteristics	Tobacco/ENDS products	Statistical approach, covariates	Limitations/risk of bias
Lipperman-Kreda, Grube, Friend, 2012 - California - time of data collection not reported.	City;Outlets were randomly sampled from lists created specifically for the study.	SES, racial/ethnic composition, youth composition, population density	Marlboro Red, pack Newport, pack	Linear mixed-effects/multilevel models; *Additional covariates*: store type, prevalence of adult smokers, retailer density, local tobacco retailer licensing, cigarette tax.	1. # of area units: 50 2. # of stores: 997 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no
Epperson et al., 2019 - California; - Jan to Mar 2017	0.5 mile service areas around each store; Random sample.	SES, racial/ethnic composition, youth composition	American Spirit, pack Pall Mall, pack Newport, pack Marlboro, pack Cheapest cigarettes, pack	Least squares regression models; *Additional covariates*: store type.	1. # of area units: 1182 2. # of stores: 1182 3. addressed spatial dependence: n/a 4. used probability-based sampling of area units: n/a; of stores: yes 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: yes
Cantrell et al., 2015 Cantrell et al., 2013 - Washington, DC - Sep 2011 to Mar 2012	Census block groups;All licensed tobacco retail outlets were surveyed.	SES, racial/ethnic composition, youth composition	Newport, pack Cheapest cigarettes, pack Black & Mild cigarillo, single	Linear mixed-effects/multilevel models; *Additional covariates*: store type, closest school type, schools within 1 mile buffer, lowest price on exterior, brand category, special price status, menthol status, lowest Newport menthol price, # registers, zoning, retailer density.	1. # of area units: 265 2. # of stores: 750 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: no; of stores: no 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: to some extent. Unclear why regression model differs between Cantrell et al., 2013 and Cantrell et al., 2015.
Kephart et al., 2019 - Boston, Massachusetts - Jul 2015 to Jun 2016	Census block groups;All tobacco retailers were surveyed.	SES, racial/ethnic composition, youth composition, retail density	Marlboro Red, pack Camel, pack Pall Mall Red, pack	Generalized linear mixed models (GLMM) with a normal distribution; *Additional covariates*: retailer density, % of independent retailers.	1. # of area units: 325 2. # of stores: 689 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: no; of stores: no 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: to some extent

(*continued on next page*)

Table 1 (*continued*)

Study/location/period	Area units/sampling approach	Neighbourhood characteristics	Tobacco/ENDS products	Statistical approach, covariates	Limitations/risk of bias
Seidenberg et al., 2010 - Boston, Massachusetts - Two communities: Dorchester and Brookline - Nov 2007 to Feb 2008	Each community (Dorchester and Brookline) was treated as an area unit;All identified tobacco retailers were visited.	SES, racial/ethnic composition, youth composition	Advertised cigarette pack price	t-tests; *Additional covariates*: none.	1. # of area units: 2; 2. # of stores: 56 Dorchester and 42 Brookline; 3. addressed spatial dependence: n/a 4. used probability-based sampling of area units: no; of stores: no 5. inter-rater reliability: yes 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: to some extent; The statistical analysis performed did not examine associations between prices and community characteristics.
Laestadius et al., 2018 - Milwaukee, Wisconsin - Jul to Sep 2016	Zip codes;A random sample of retailers.	Racial/ethnic composition	Newport, pack Cheapest cigarettes, pack Blu disposable e-cigarette	Anova F-test (p-values adjusted to correct for multiple comparisons using the Bonferroni procedure); *Additional covariates*: none.	1. # of area units: 9 2. # of stores: 195 3. addressed spatial dependence: unclear 4. used probability-based sampling of area units: no; of stores: yes 5. inter-rater reliability: no 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no
Toomey et al., 2009 - Minneapolis—St. Paul metropolitan area - Oct 2002	Geopolitical units (GPU);Max of 8 stores randomly selected from each of the GPUs.	Racial/ethnic composition, youth composition	Light premium brand that youth often buy, pack Menthol brand often smoked by minority racial/ethnic groups, pack Discount brand, pack Brand names not reported	Generalized linear model (link function not reported); *Additional covariates*: store type, # of schools, # of stores.	1. # of area units: 29 2. # of stores: 214 3. addressed spatial dependence: yes 4. used probability-based sampling of area units: yes; of stores: yes 5. inter-rater reliability: not reported 6. collected relative prices: no 7. provided interpretation and discussed effect sizes: no

A. Number of studies



B. Number of associations

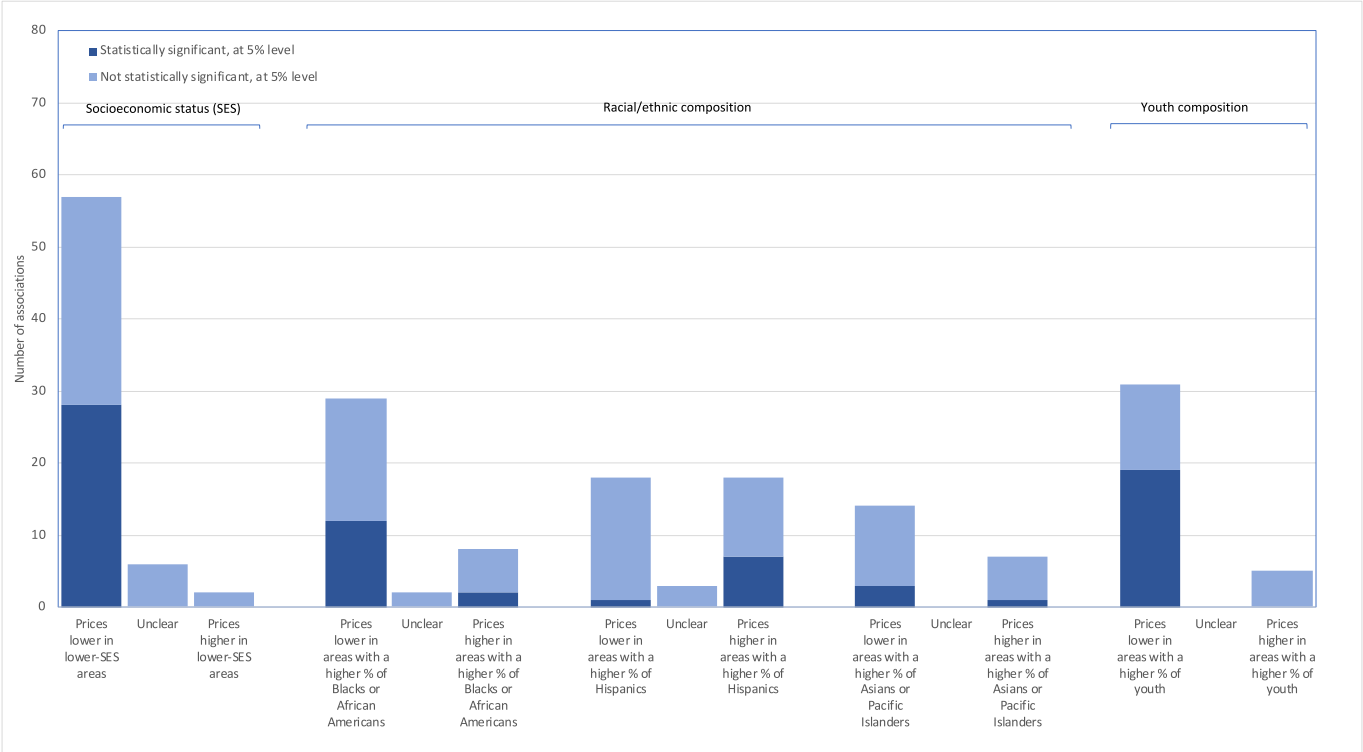


Fig. 2. Count of results for cigarette price differences by direction of association and neighbourhood characteristics of socioeconomic status, ethnic/racial composition and youth composition.

of which found that price differences were statistically significantly different at the 5% level).

In Australia, price differences between high and low-SES areas ranged between 0.35 to AU$0.75, or a 2–5% difference (McCarthy et al., 2011; Dalglish et al., 2013; Burton et al., 2014). In Scotland, prices of all sales of packs of 20 cigarettes were £0.20, £0.40, £0.56, and £0.50 cheaper in quintiles 2–5, compared to quintile 1 (lowest income deprivation). There were, however, negligible differences in the prices of specific brands between SES categories. In the US, at the national level, price differences were either negligible or ranged from about 0.10 to $0.15 a pack between lower- and higher-SES areas, or about $0.20 less with each standard deviation decrease in median area-level income. In California, price differences were similar: either negligible or about 0.10 to $0.20 less with each standard deviation decrease in median area-level income. Lastly, comparable price differences were also observed in Boston and Washington, DC.

Racial or ethnic composition. 18 studies investigated the association between cigarette pricing and the racial or ethnic compositions of the area units (Toomey et al., 2009; Seidenberg et al., 2010; Henriksen et al., 2012, 2016, 2017; Burton et al., 2014; Lipperman-Kreda et al., 2014; Resnick et al., 2012; Cantrell et al., 2015; Lee et al., 2015b; Schleicher et al., 2015 Laestadius et al., 2018; Mills et al., 2018, 2019; Epperson et al., 2019; Kephart et al., 2019). 14 studies examined associations between cigarette prices and the proportion of Blacks or African Americans. 12 studies found that prices were generally lower in areas with a higher % of Blacks or African Americans (four of which found that price differences were, on the whole, statistically significantly different at the 5% level), one study found unclear associations, and another study found that prices were generally higher in areas with a greater proportion of Blacks or African Americans. 14 studies examined associations between prices and the proportion of Hispanics. Six studies found that prices were lower in areas with a higher proportion of Hispanics (one of which found that price differences were generally statistically significantly different at the 5% level), three studies found unclear associations and five studies found that prices were higher in areas with a higher proportion of Hispanics (three of which found that price differences were statistically significantly different at the 5% level). The eight studies that examined associations between prices and the proportion of Asians/Pacific Islanders reported conflicting results. Lastly, one study examined price differences between white and non-white (Toomey et al., 2009) and one study looked at differences between neighbourhoods' proportion of Australian-born (Burton et al., 2014). Both studies found that prices tended to be higher in areas with a higher proportion of the population born in Australia or areas with a higher proportion of whites. Examining the number of associations instead of the number of studies suggests similar associations between area-level racial or ethnic composition and cigarette prices.

The heterogeneity in how measures of racial or ethnic composition were operationalized and reported makes it difficult to compare effect sizes between studies or synthesize effect sizes across studies. The most recent national US study reported modest to substantive price differences: a pack of 20 Newport cigarettes cost $0.09, $0.08, and $0.18 less in neighbourhoods in the second, third, and highest quartiles of Black residents respectively as compared to the lowest quartile; and, a pack of Marlboro cigarettes cost $0.08, $0.04, and $0.05 less in neighbourhoods in the second, third, and fourth quartiles of Black residents respectively as compared to the lowest quartile (Mills et al., 2018).

In the US, menthol cigarettes have been predominately used by African American smokers (Gardiner, 2004; Giovino et al., 2004, 2015 Weinberger et al., 2019). The prices of Newport, the most popular brand of menthol cigarettes in the US, was observed in several studies. Newport cigarettes were consistently found to cost less in areas with a greater proportion of Blacks or African Americans (Henriksen et al., 2012, 2016; Lipperman-Kreda et al., 2014; Resnick et al., 2012; Cantrell et al., 2015; Lee et al., 2015b; Schleicher et al., 2015; Laestadius et al., 2018; Mills et al., 2018; Kephart et al., 2019).

Youth composition. 14 studies examined the association between cigarette pricing and the youth composition of the neighbourhoods (Toomey et al., 2009; Seidenberg et al., 2010; Henriksen et al., 2012, 2016, 2017; Burton et al., 2014; Lipperman-Kreda et al., 2014; Cantrell et al., 2015; Schleicher et al., 2015; Mills et al., 2018, 2019; Epperson et al., 2019; Kephart et al., 2019). Among the studies, youth generally referred to individuals between the ages of five and 17 or younger than 18 years of age. 12 studies (Toomey et al., 2009; Seidenberg et al., 2010; Henriksen et al., 2012, 2017; Burton et al., 2014; Lipperman-Kreda et al., 2014; Schleicher et al., 2015; Mills et al., 2018, 2019; Epperson et al., 2019; Kephart et al., 2019) found that prices were generally lower in areas with a higher % of youth (nine of which found that price differences were, on the whole, statistically significantly different at the 5% level), while one study found unclear associations between cigarette prices and neighbourhoods' youth composition and one study found that cigarette prices were higher (although not statistically significantly) in areas with a higher proportion of youth (Cantrell et al., 2015; Henriksen et al., 2016).

In Australia, relative to areas with a youth composition (≤18 years old) of less than 16%, prices were lower by AU$0.24, AU$0.45, and AU $0.62 in areas with 16–22%, 22–25%, and 25+% of youth (Lipperman-Kreda et al., 2014). In the US in 2015, Newport cigarettes cost $0.12 and $0.09 less in the third and highest quartiles of youth (5–17 years) as compared to the lowest quartile while Marlboro cigarettes cost $0.11 less in neighbourhoods with the highest quartiles of youth as compared to the lowest quartiles of youth. (Mills et al., 2018). For each 5% points increase in the % of youth, the cheapest pack cost $0.04 less (Mills et al., 2019).

Temporal changes in the difference in area-level cigarette prices. One study collected prices of Marlboro and Newport cigarettes in 2011 and 2014 in California. Although cigarette prices only changed marginally between 2011 and 2014, significant changes were observed by neighbourhood demography (Schleicher et al., 2015). In areas with higher proportions of school-age youth, the price of Marlboro decreased significantly and in areas with higher proportions of African American and Asian/Pacific Islander residents, the price of Newport cigarettes significantly decreased by more than in areas with fewer of these residents (Schleicher et al., 2015).

Proportion of same-sex couples. One study examined the association between the rate of same-sex couples per 1000 coupled households and Newport and Marlboro prices in 1696 census tracts in 97 US counties in 2012 and found that prices were generally higher in areas that had a higher proportion of same-sex couples. Three of the four associations examined were statistically significantly different at the 5% level but differences were fairly small (Lee et al., 2015b).

3.2. Cigarillos, chewing tobacco, roll-your-own tobacco and ENDS

In addition to cigarettes, area-level differences in the prices of little cigars, cigarillos, chewing tobacco, roll-your-own, and e-cigarettes were studied. Two studies examined the association between the prices of little cigars and cigarillos and area-level SES and youth and found that prices were generally lower in lower-SES areas and in areas with a higher proportion of youth (Schleicher et al., 2015; Henriksen et al., 2017). There was conflicting evidence among the three studies that examined the associations between the prices of little cigars and cigarillos and the racial/ethnic composition of neighbourhoods (Cantrell et al., 2013; Schleicher et al., 2015; Henriksen et al., 2017). Two studies did not find any substantial associations between little cigar/cigarillo prices and the racial/ethnic compositions of neighbourhoods (Schleicher et al., 2015; Henriksen et al., 2017), while the other found strong negative associations, with prices decreasing with increasing quartiles of African American residents (Cantrell et al., 2013). One study examined the association between chewing tobacco prices and area-level measures of income, and racial/ethnic and youth compositions and found no clear associations between prices of chewing tobacco

and any area-level characteristics (Schleicher et al., 2015). One study examined roll-your-own tobacco in Scotland and found that prices were prices were generally lower in more deprived areas (Shortt et al., 2020).

Lastly, we identified two studies that examined the association between e-cigarette prices and neighbourhoods' racial/ethnic compositions. In the summer of 2016 in Milwaukee, Wisconsin, Blu e-cigarettes cost less (about $2) in neighbourhoods with a greater percentage of African Americans relative to neighbourhoods with a greater proportion of Hispanics or whites (Laestadius et al., 2018). One study collected e-cigarette prices in California and found that unlike cigarette prices, there was little variation in the prices of e-cigarettes: prices of Blu and NJOY e-cigarettes were the same in 79% and 84% of stores, respectively (Schleicher et al., 2015).

4. Discussion

Main findings. On the whole, we found consistent evidence that cigarette prices were lower in lower SES neighbourhoods, and in neighbourhoods with a higher percentage of youth, and of Blacks or African Americans. These findings are in keeping with tobacco industry documents that detailed how manufacturers used race, class, and geography to target vulnerable populations (Yerger et al., 2007). Although we are confident about the direction of price differences between neighbourhoods, the heterogeneity between studies made it difficult to assess the overall magnitude of price differences. Some studies documented statistically significant but modest price differences between neighbourhoods, while others documented fairly large statistically significant differences. One study assessed temporal changes in the difference in area-level cigarette prices and found that modest changes in average prices overtime concealed significant changes in prices between neighbourhood characteristics (Schleicher et al., 2015). We identified too few studies that examined price differences between neighbourhoods for cigarillos, chewing tobacco, roll-your-own, and ENDS to reach any conclusions.

We assessed the quality of each included study using seven criteria (Table 1, last column). First, area unit sample sizes were adequate in all studies with, perhaps, three exceptions that compared two, four, and nine area units (Seidenberg et al., 2010; Dalglish et al., 2013; Laestadius et al., 2018). Second, the total number of retailers and the number of retailers per area unit varied considerably between studies. For example, some studies collected data from one or two stores per area (McCarthy et al., 2011; Schleicher et al., 2015; Mills et al., 2018) while others collected data from about 20 stores per area (Lipperman-Kreda et al., 2014; Lee et al., 2015b; Laestadius et al., 2018). Additionally, one study did not clearly report the number of retailers[3] (Dalglish et al., 2013). Third, because prices collected in stores from the same area may be correlated, it is preferable not to assume that observations/areas are independent of one another (LeSage, 2008). Spatial dependence was not clearly addressed in five studies. Fourth, only eight studies reported having used probability-based sampling for both area units and retailers (Toomey et al., 2009; Lipperman-Kreda et al., 2014; Lee et al., 2015b; Schleicher et al., 2015; Henriksen et al., 2017; Mills et al., 2018, 2019); one study sampled all retailers in all areas (Kephart et al., 2019). Fifth, only two studies collected prices for products other than tobacco or ENDS (Schleicher et al., 2015; Henriksen et al., 2016). One study found that bottled water generally cost more in pharmacies where cigarettes cost less; on the whole, however, the price of bottled water did not vary by area-level characteristics (Henriksen et al., 2016). Another study also collected prices of bottled water but did not report any results. Collecting prices for products other than tobacco or ENDS can allow researchers to more insightfully comment on industry pricing strategies and affordability of tobacco and ENDS products (Schleicher et al., 2015). Sixth, only eight studies provided an intuitive interpretation and clear discussion of the magnitude of price differences between areas (Henriksen et al., 2012, 2016, 2017; Burton et al., 2014; Lee et al., 2015b; Mills et al., 2018, 2019; Epperson et al., 2019). Additionally, we examined whether each study discussed their scientific quality and/or limitations. A common limitation that was self-reported by many authors was that the cross-sectional nature of most studies impeded any sort of temporal inferences from being made.

Strengths and limitations. We extracted detailed characteristics for all studies that investigated price variations across SES, racial or ethnic characteristics, age and other characteristics that may be associated with vulnerability and used seven components to assess the quality of included studies. Nonetheless, our paper has some inherent limitations. First we were unable to conduct a meta-analysis due to the heterogeneity in the methods and measures used in different studies, hence impeding us from providing adequate summary measures. Second, as all the studies were conducted in the US, Scotland or Australia, the generalizability of our findings is limited. Moreover, the studies conducted in the US were predominately focused on states that already had relatively strict tobacco control policies in place (e.g., California, Massachusetts, Minnesota), thus further limiting their applicability to other regions with less comprehensive tobacco control measures. Third, it was, on occasion, unclear how price data were collected and what they represented (e.g., indoor/outdoor advertised prices, prices obtained from retailers in face-to-face interactions or actual purchase prices). Advertised prices may not represent actual retail prices but nevertheless represent an important promotion channel, especially for youth in jurisdictions with point-of-sale restrictions. One study found good concordance between advertised cigarette prices with purchase receipts in the US. (Schleicher et al., 2018) We found that the most popular brand of menthol cigarettes in the US, Newport cigarettes, consistently cost less in areas with a greater proportion of Blacks or African Americans. This finding, however, does not necessarily extend to other brands of menthol cigarettes. Lastly, our review suffers from limitations identified by Lee, Henriksen et al. (Lee et al., 2015a) in their review of neighbourhood disparities in point-of-sale tobacco marketing: 1) the relationship between area-level characteristics and prices may be nonlinear (e.g., there might be household income thresholds that are more relevant to the pricing strategy of manufacturers); and, 2) area-level characteristics such as SES and racial/ethnic or youth compositions may be correlated which can make it difficult to disentangle independent effects.

Implications for policy and research. Our findings suggest that regulations that can limit industry price manipulation such as minimum, maximum, and uniform prices, and high specific excise taxes should be considered. There is emerging evidence that price-promotion restrictions and minimum-price laws can be useful approaches to reduce price disparities and lower tobacco consumption (Golden et al., 2016). Additionally, there is fairly robust evidence that price-based alcohol policy interventions such as minimum pricing of alcohol can reduce alcohol consumption (Boniface et al., 2017).

Given the importance of prices in increasing cessation and reducing tobacco use onset and disparities in tobacco use (International Agency for Research on Cancer, 2011; US National Cancer Institute and World Health Organization, 2016), it is surprising that so little research in so few jurisdictions has examined area-level differences in prices. More frequent and systematic monitoring of tobacco prices is warranted. In particular, additional research in geographic locations with high tobacco use prevalence and in low- and middle-income countries has the potential to make important contributions to tobacco control research. Given the rapid increase in the use of ENDS in many jurisdictions (Kmietowicz, 2014; Filippidis et al., 2017; Cantrell et al., 2018; Hammond et al., 2019), close price monitoring is also warranted. Because area-level characteristics such as SES and racial/ethnic or youth compositions may be correlated, we recommend that key neighbourhood

[3] An adequate number of area units and adequate number of stores inherently depends on context. Table 1 presents the number of areas and the number stores for each study to facilitate assessment.

characteristics be examined individually and jointly and that preferences for a particular specification be clearly discussed and reported. Lastly, as suggested by Lee, Henriksen et al. (Seidenberg et al., 2010) there is a need to try to identify if particular thresholds of SES, youth or racial/ethnic compositions trigger price changes.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This study builds on work conducted as part of a larger project funded by the Canadian Cancer Society that examined area-level differences in the prices of tobacco and electronic nicotine delivery systems in Ontario and Québec. GEG holds the Centre for Health Economics and Policy Analysis (CHEPA)/Ontario Ministry of Health and Long-Term Care (MOHLTC) Chair in Health Equity, an endowed Chair funded in part by the MOHLTC and an Ontario Ministry of Research, Innovation and Science, Early Researcher Award. The views expressed are the views of the authors and should not be taken to represent the views of the Government of Ontario.

Authors' contributions

GEG conceptualized the study. GEG and TF wrote the article. TF and SG led the design and operationalized the search strategy. GEG, TF, BA, PB, and SG screened studies for inclusion and extracted data from included studies. BA, PB, and SG contributed to the interpretation of the findings and revised the article critically for important intellectual content.

Declaration of competing interest

None.

Acknowledgements

We thank Pranipa Ernest, Selene Miller, and Kevin Zhao for their research assistance, Bruce Baskerville and Annie Montreuil for their comments and discussion, and Lisa Henriksen for providing a list of studies our initial search strategy had missed.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2020.102395.

References

Boniface, S., Scannell, J.W., Marlow, S., 2017. Evidence for the effectiveness of minimum pricing of alcohol: a systematic review and assessment using the Bradford Hill criteria for causality. BMJ Open 7 (5), e013497.
Bosdriesz, J.R., Willemsen, M.C., Stronks, K., Kunst, A.E., 2015. Socioeconomic inequalities in smoking cessation in 11 European countries from 1987 to 2012. J. Epidemiol. Community Health 69 (9), 886–892.
Burton, S., Williams, K., Fry, R., et al., 2014. Marketing cigarettes when all else is unavailable: evidence of discounting in price-sensitive neighbourhoods. Tobac. Contr. 23 (e1), e24–e29.
Cantrell, J., Kreslake, J.M., Ganz, O., et al., 2013. Marketing little cigars and cigarillos: advertising, price, and associations with neighborhood demographics. Am. J. Publ. Health 103 (10), 1902–1909.
Cantrell, J., Ganz, O., Anesetti-Rothermel, A., et al., 2015. Cigarette price variation around high schools: evidence from Washington DC. Health Place 31, 193–198.
Cantrell, J., Huang, J., Greenberg, M., Willett, J., Hair, E., Vallone, D., 2018. History and Current Trends in the Electronic Cigarette Retail Marketplace in the United States: 2010–2016. Nicotine & Tobacco Research.
Chuang, Y.-C., Cubbin, C., Ahn, D., Winkleby, M.A., 2005. Effects of neighbourhood socioeconomic status and convenience store concentration on individual level smoking. J. Epidemiol. Community Health 59 (7), 568–573.
Cohen, S.S., Sonderman, J.S., Mumma, M.T., Signorello, L.B., Blot, W.J., 2011. Individual and neighborhood-level socioeconomic characteristics in relation to smoking prevalence among black and white adults in the Southeastern United States: a cross-sectional study. BMC Publ. Health 11 (1), 877.
Corsi, D.J., Chow, C.K., Lear, S.A., Subramanian, S.V., Teo, K.K., Boyle, M.H., 2012. Smoking in context: a multilevel analysis of 49,088 communities in Canada. Am. J. Prev. Med. 43 (6), 601–610.
Dalglish, E., McLaughlin, D., Dobson, A., Gartner, C., 2013. Cigarette availability and price in low and high socioeconomic areas. Aust. N. Z. J. Publ. Health 37 (4), 371–376.
Drope, J., Liber, A.C., Cahn, Z., et al., 2018. Who's still smoking? Disparities in adult cigarette smoking prevalence in the United States. Ca - Cancer J. Clin. 68 (2), 106–115.
Duncan, C., Jones, K., Moon, G., 1998. Context, composition and heterogeneity: using multilevel models in health research. Soc. Sci. Med. 46 (1), 97–117.
Epperson, A.E., Johnson, T.O., Schleicher, N.C., Henriksen, L., 2019. The price of natural American spirit relative to other cigarette brands. Nicotine Tob. Res. 21 (12), 1715–1720.
Filippidis, F.T., Laverty, A.A., Gerovasili, V., Vardavas, C.I., 2017. Two-year trends and predictors of e-cigarette use in 27 European Union member states. Tobac. Contr. 26 (1), 98.
Gardiner, P.S., 2004. The African Americanization of menthol cigarette use in the United States. Nicotine Tob. Res. 6 (Suppl. l_1), S55–S65.
Giovino, G.A., Sidney, S., Gfroerer, J.C., et al., 2004. Epidemiology of menthol cigarette use. Nicotine Tob. Res. 6 (Suppl. l_1), S67–S81.
Giovino, G.A., Villanti, A.C., Mowery, P.D., et al., 2015. Differential trends in cigarette smoking in the USA: is menthol slowing progress? Tobac. Contr. 24 (1), 28.
Glasser, A.M., Collins, L., Pearson, J.L., et al., 2017. Overview of electronic nicotine delivery systems: a systematic review. Am. J. Prev. Med. 52 (2), e33–e66.
Golden, S.D., Smith, M.H., Feighery, E.C., Roeseler, A., Rogers, T., Ribisl, K.M., 2016. Beyond excise taxes: a systematic review of literature on non-tax policy approaches to raising tobacco product prices. Tobac. Contr. 25 (4), 377.
Green, M.J., Leyland, A.H., Sweeting, H., Benzeval, M., 2016. Socioeconomic position and early adolescent smoking development: evidence from the British Youth Panel Survey (1994-2008). Tobac. Contr. 25 (2), 203–210.
Greenland, S., O'Rourke, K., 2001. On the bias produced by quality scores in meta-analysis, and a hierarchical view of proposed solutions. Biostatistics 2 (4), 463–471.
Hammond, D., Reid, J.L., Rynard, V.L., et al., 2019. Prevalence of vaping and smoking among adolescents in Canada, England, and the United States: repeat national cross sectional surveys. BMJ 365, l2219.
Henriksen, L., 2012. Comprehensive tobacco marketing restrictions: promotion, packaging, price and place. Tobac. Contr. 21 (2), 147–153.
Henriksen, L., Schleicher, N.C., Dauphinee, A.L., Fortmann, S.P., 2012. Targeted advertising, promotion, and price for menthol cigarettes in California high school neighborhoods. Nicotine Tob. Res. 14 (1), 116–121.
Henriksen, L., Schleicher, N.C., Barker, D.C., Liu, Y., Chaloupka, F.J., 2016. Prices for tobacco and nontobacco products in pharmacies versus other stores: results from retail marketing surveillance in California and in the United States. Am. J. Publ. Health 106 (10), 1858–1864.
Henriksen, L., Andersen-Rodgers, E., Zhang, X., et al., 2017. Neighborhood variation in the price of cheap tobacco products in California: results from healthy stores for a healthy community. Nicotine Tob. Res. 19 (11), 1330–1337.
Higgins, J., Thomas, J., Chandler, J., et al., 2019. Cochrane Handbook for Systematic Reviews of Interventions Version 6.0 (Updated July 2019). Cochrane. Available from: www.training.cochrane.org/handbook, 2019.
Hiscock, R., Bauld, L., Amos, A., Fidler, J.A., Munafo, M., 2012. Socioeconomic status and smoking: a review. Ann. N. Y. Acad. Sci. 1248, 107–123.
International Agency for Research on Cancer, 2011. IARC Handbooks of Cancer Prevention: Tobacco Control. Volume 14. Effectiveness of Price and Tax Policies for Control of Tobacco. International Agency for Research on Cancer, Lyon.
Karriker-Jaffe, K.J., 2013. Neighborhood socioeconomic status and substance use by U.S. adults. Drug Alcohol Depend. 133 (1), 212–221.
Kennedy, P., 2003. A Guide to Econometrics, fifth ed. MIT Press, Cambridge, Mass.
Kephart, L., Song, G., Henley, P., Ursprung, W.W.S., 2019. The association between neighborhood racial composition and menthol cigarette pricing in Boston, MA. Health Place 58, 102144.
Kmietowicz, Z., 2014. Use of e-cigarettes in UK has tripled in two years, finds survey. BMJ Br. Med. J. (Clin. Res. Ed.) 348, g2987.
Laestadius, L., Sebero, H., Myers, A., Mendez, E., Auer, P., 2018. Identifying disparities and policy needs with the STARS surveillance tool. Tobacco Regulatory Science 4 (4), 12–21.
Lee, J.G.L., Henriksen, L., Rose, S.W., Moreland-Russell, S., Ribisl, K.M., 2015a. A systematic review of neighborhood disparities in point-of-sale tobacco marketing. Am. J. Publ. Health 105 (9), e8–18.
Lee, J.G.L., Goldstein, A.O., Pan, W.K., Ribisl, K.M., 2015b. Relationship between tobacco retailers' point-of-sale marketing and the density of same-sex couples, 97 U. S. Counties, 2012. Int. J. Environ. Res. Publ. Health 12 (8), 8790–8810.
LeSage, J.P., 2008. An introduction to spatial econometrics. Rev. d'Écon. Ind. 123 (3), 19–44.
Lipperman-Kreda, S., Grube, J.W., Friend, K.B., 2014. Contextual and community factors associated with youth access to cigarettes through commercial sources. Tobac. Contr. 23 (1), 39–44.
Livingston, C.J., Freeman, R.J., Costales, V.C., et al., 2019. Electronic nicotine delivery systems or E-cigarettes: American college of preventive medicine's practice statement. Am. J. Prev. Med. 56 (1), 167–178.
Lundh, A., Gotzsche, P.C., 2008. Recommendations by Cochrane Review Groups for assessment of the risk of bias in studies. BMC Med. Res. Methodol. 8, 22.

McCarthy, M., Scully, M., Wakefield, M., 2011. Price discounting of cigarettes in milk bars near secondary schools occurs more frequently in areas with greater socioeconomic disadvantage. Aust. N. Z. J. Publ. Health 35 (1), 71–74.
McNeill, A., Brose, L.S., Calder, R., Bauld, L., Robson, D., 2018. Evidence Review of E-Cigarettes and Heated Tobacco Products 2018. A Report Commissioned by Public Health England. Public Health England, London.
Mills, S.D., Henriksen, L., Golden, S.D., et al., 2018. Disparities in retail marketing for menthol cigarettes in the United States, 2015. Health Place 53, 62–70.
Mills, S.D., Golden, S.D., Henriksen, L., Kong, A.Y., Queen, T.L., Ribisl, K.M., 2019. Neighbourhood disparities in the price of the cheapest cigarettes in the USA. J. Epidemiol. Community Health 73 (9), 894–896.
National Academies of Sciences, Engineering, and Medicine, 2018. Public Health Consequences of E-Cigarettes. The National Academies Press, Washington, DC.
Reijneveld, S.A., 1998. The impact of individual and area characteristics on urban socioeconomic differences in health and smoking. Int. J. Epidemiol. 27 (1), 33–40.
Reijneveld, S.A., 2002. Neighbourhood socioeconomic context and self reported health and smoking: a secondary analysis of data on seven cities. J. Epidemiol. Community Health 56 (12), 935.
Resnick, E.A., Jackson, K.L., Barker, D.C., Chaloupka, F.J., 2012. Cigarette Pricing Differs by U.S. Neighborhoods – A BTG Research Brief. Chicago, IL: Bridging the Gap Program, Health Policy Center. Institute for Health Research and Policy, University of Illinois at Chicago.
Ross, C.E., 2000. Walking, exercising, and smoking: does neighborhood matter? Soc. Sci. Med. 51 (2), 265–274.
Schleicher, N.C., Johnson, T., Ahmad, I., Henriksen, L., 2015. Tobacco Marketing in California's Retail Environment (2011-2014). Final Report for the California Tobacco Advertising Survey (2014). California Tobacco Control Program, California Department of Public Health. Stanford Prevention Research Center, Stanford University School of Medicine, Palo Alto, CA.
Schleicher, N.C., Johnson, T.O., D'Angelo, H., Luke, D.A., Ribisl, K.M., Henriksen, L., 2018. Concordance of advertised cigarette prices with purchase receipts in the United States. Tob Regul Sci 4 (3), 3–9.
Seidenberg, A.B., Caughey, R.W., Rees, V.W., Connolly, G.N., 2010. Storefront cigarette advertising differs by community demographic profile. Am. J. Health Promot. 24 (6), e26–31.
Shamliyan, T., Kane, R.L., Dickinson, S., 2010. A systematic review of tools used to assess the quality of observational studies that examine incidence or prevalence and risk factors for diseases. J. Clin. Epidemiol. 63 (10), 1061–1070.
Shortt, N.K., Tunstall, H., Mitchell, R., et al., 2020. Using point-of-sale data to examine tobacco pricing across neighbourhoods in Scotland. Tobac. Contr. https://tobaccocontrol.bmj.com/content/tobaccocontrol/early/2020/03/19/tobaccocontrol-2019-055484.full.pdf.
Tabuchi, T., Iso, H., Brunner, E., 2018. Tobacco control measures to reduce socioeconomic inequality in smoking: the necessity, time-course perspective, and future implications. J. Epidemiol. 28 (4), 170–175.
Toomey, T.L., Chen, V., Forster, J.L., Van Coevering, P., Lenk, K.M., 2009. Do cigarette prices vary by brand, neighborhood, and store characteristics? Publ. Health Rep. 124 (4), 535–540.
US National Cancer Institute, World Health Organization, 2016. The Economics of Tobacco and Tobacco Control. National Cancer Institute Tobacco Control Monograph 21. NIH Publication No. 16-CA-8029A. National Institutes of Health, National Cancer Institute; and World Health Organization, Bethesda, MD; Geneva, CH.
Waddington, H., Aloe, A.M., Becker, B.J., et al., 2017. Quasi-experimental study designs series-paper 6: risk of bias assessment. J. Clin. Epidemiol. 89, 43–52.
Weinberger, A.H., Giovenco, D.P., Zhu, J., Lee, J., Kashan, R.S., Goodwin, R.D., 2019. Racial/ethnic differences in daily, nondaily, and menthol cigarette use and smoking quit ratios in the United States: 2002 to 2016. Prev. Med. 125, 32–39.
Yerger, V.B., Przewoznik, J., Malone, R.E., 2007. Racialized geography, corporate activity, and health disparities: tobacco industry targeting of inner cities. J. Health Care Poor Underserved 18 (4 Suppl. l), 10–38.
Yoong, S.L., Stockings, E., Chai, L.K., et al., 2018. Prevalence of electronic nicotine delivery systems (ENDS) use among youth globally: a systematic review and meta-analysis of country level data. Aust. N. Z. J. Publ. Health 42 (3), 303–308.