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Area-level sociodemographic differences in tobacco availability examined with nationwide tobacco product retail licence data in Finland

Salla-Maaria Pätsi ![ORCID],[1] Arho Toikka,[2] Hanna Ollila ![ORCID],[1] Otto Ruokolainen ![ORCID][1]

ABSTRACT

Background Differences in tobacco retailer density between areas by sociodemographic composition have been observed. However, little research comes from European jurisdictions and from countries with a tobacco retail licensing system. In Finland, the system consists of criteria for retailers and supervision fees.

Methods The tobacco product retail licence data and sociodemographic data were retrieved from corresponding Finnish authorities. Area-level tobacco availability was measured as the presence of a retailer and as the number of retailers per 1000 inhabitants by postcode area. Sociodemographic indicators included median income, percentage of inhabitants in the lowest income tertile, percentage of adults with higher education and unemployment rate. Analyses were based on logistic regression and Ordinary Least Squares regression with log-transformed density.

Results Lower area-level sociodemographic composition was mainly associated with higher tobacco availability. Income was the strongest correlate of the tobacco retailer availability: areas with higher median income had lower odds of having a tobacco retailer (OR 0.54, 95% CI 0.48 to 0.61 per €1000) and lower retailer density (−4.4% per €1000, Cohen's f=0.51). Areas with a greater proportion of people in the lowest income category had higher densities of tobacco retailers (+2.8% per percentage point, Cohen's f=0.07). Other sociodemographic indicators showed inconsistent associations with retailer presence and density.

Conclusion Tobacco availability can be higher in areas with lower sociodemographic composition also in a country with a comprehensive tobacco retail licensing system and small income inequalities. Retailing policies should be further developed to reduce tobacco availability and narrow inequalities in tobacco use.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ International research has shown that lower area-level sociodemographic composition is associated with higher tobacco retailer densities.
⇒ Less affluent areas have higher tobacco retailer densities.

WHAT THIS STUDY ADDS

⇒ There are sociodemographic differences in area-level tobacco availability in Finland, a country with low income inequalities and where tobacco retailing is already controlled by the state.
⇒ An area-level income measure showed consistent negative association with retailer density in postcodes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides evidence that controlling tobacco retail sales with a nationwide licensing system with supervisory fees is not sufficient as such to prevent sociodemographic differences in area-level tobacco availability.
⇒ Restricting the number and density of tobacco sales points, with potential area-level criteria, could be one way to decrease tobacco-related inequalities.

INTRODUCTION

Smoking is a significant cause of inequalities in health.[1 2] There is a well-documented social gradient at the smoking rates in the Western countries, where smoking is more common among population groups with lower socioeconomic position.[3] That is the case also in Finland, both among adults and adolescents.[4 5] The socioeconomic differences originate in the interplay between individual and societal determinants,[6] where area-level tobacco availability may play a role.

Among adults, higher retailer density is associated with a higher smoking prevalence and lower cessation outcomes,[7] while lower density of tobacco retailers is associated with a lower risk of tobacco use behaviours such as smoking and relapse.[8] Among adolescents, there is evidence of a positive association between tobacco retailer density and lifetime and current smoking.[7 9]

A number of investigations have shown that areas with lower sociodemographic composition have higher densities of tobacco retailers.[10–15] The current evidence is predominantly from the USA, Australia and New Zealand. From Europe, Scottish[16] and German[17] investigations suggest that, according to income, the most deprived areas have the highest densities of tobacco retailers. Studies with licensing or registry system in different local areas, such as states, have been published,[12–14 16] but, to our knowledge, no earlier study has investigated countrywide associations in jurisdictions with a retail licensing system. Compared with jurisdictions included in earlier studies, Finland has relatively small income inequalities (Gini coefficient for Finland 0.265, for Australia 0.318, for New Zealand 0.320 and for the USA 0.370)[18] and low residential segregation.[19]

Most countries do not control the density and supply of tobacco retailers by applying a tobacco retail licensing scheme[20] even though such policy is recommended in the WHO Framework Convention on Tobacco Control[21] and in the Protocol to Eliminate Illicit Trade in Tobacco Products.[22] A retail licensing scheme has potential to curb smoking by reducing the density of tobacco retailers by increasing the cost of selling tobacco and defining criteria for acquiring and retaining a licence.[20] Advantage of licensing over registration is the better ability to restrict and supervise tobacco sales.[23]

Since April 2009, there has been a tobacco product retail licensing system in Finland. The retail sale of tobacco products and nicotine-containing liquids is subject to a licence and the wholesale to a notification. The Tobacco Act sets criteria through preconditions and impediments for granting the licence. Retailers are required to sustain a self-monitoring plan, and the local authority charges an annual supervisory fee per point of sale according to an annually agreed tariff: a maximum of €500 per point of sale, and for operators who sell both tobacco products and nicotine-containing liquids, a maximum of €1000 per point of sale.[24] The licensing system in Finland was initially designed to control the availability of tobacco but not directly reduce it, as the licence is granted to all applicants who meet the set preconditions. However, the introduction of supervisory fees and the specification of maximum fees in the 2016 revision of the Tobacco Act decreased retailers from over 10 000 to approximately 7250 by 2018.[25] In 2016, new impediments were also defined to prevent granting licences to outlets that are located in premises used predominantly by children and adolescents.

In 2010, the goal of the Finnish Tobacco Act was to end tobacco use, defined as no more than 5% prevalence of daily tobacco use by 2040. In 2016, the goal was updated to include non-medicinal nicotine products and to be achieved by 2030. However, no new measures have been taken or proposed after 2016 to reduce the supply of tobacco in order to meet the endgame goal. Modelling studies indicate that reductions in the availability of tobacco would be effective tobacco endgame strategies, especially combined with other policies.[26 27]

A shortage of evidence on the association between sociodemographic factors and tobacco retail sales from countries with nationwide retail licensing system is evident. Thus, the aim of this ecological study was to examine the association between area-level sociodemographic characteristics and tobacco retailing in Finland. Our research questions were as follows: (1) are the area-level sociodemographic factors associated with the presence of a tobacco retailer? (2) are the area-level sociodemographic factors associated with tobacco retailer density?

DATA AND METHODS
Study population
Finland is divided into circa 3000 postcodes, which are the unit of analysis. Statistics Finland maintains so-called statistical postcodes from address-level postal delivery codes for statistical purposes. Postcodes are the smallest area unit where sociodemographic indicators are collected, and they can be interpreted as 'neighbourhoods'[28]: areas were assigned to postcode areas for the purpose of postal delivery and correspond to areas where the inhabitants are likely to find and use services too. Postcode areas with fewer than 500 inhabitants were excluded, resulting in 1441 areas (average 3580 inhabitants, range 503–28 449). These cover 94.3% of the population in Finland. Both tobacco product retail licence and sociodemographic data were available for all included postcodes, and there were no missing data.

Variables
Data were combined from two sources. The National Supervisory Authority for Welfare and Health (Valvira) maintains the register of tobacco product retail sales licences in Finland and provided the proprietary retail licence data. Postcode-level retailer information can also be accessed from Valvira's public register.[29] All tobacco product retail sales licences valid on the last day of 2020 were considered, with locations not available for public shopping excluded (eg, wholesale, airport airside locations and ferries). Additionally, retail licences granted to specialist retailers for only the sales of nicotine liquids were excluded, as the prevalence of e-cigarette use in the general population is very low.[30] This resulted in 5263 retail licences granted to businesses in 1441 included postcode areas. Statistics Finland open data PAAVO API[31] was used for the collection of postcode area data (year 2020 or the latest available). The code used to collect and transform this is available in online supplemental files 1 and 2.

Two outcome variables are (1) the presence of any tobacco retailer (dichotomous, 1=yes) and (2) the density of tobacco retailers (continuous, the number of retailers per 1000 people). The following sociodemographic indicators are the independent variables: median income in the postcode area (in €1000), the proportion of inhabitants belonging to the lowest income tertile, unemployment rate (people registered as job seekers out of the workforce, ie, job seekers plus employed), and the proportion of adults with a higher (tertiary) education. In addition, the multivariable models control for population density (1000 people/km^2).

Statistical analysis
The number of retail locations was right-skewed with a high number of zeros. Thus, the modelling proceeded in two parts: first, whether a postcode is predicted to have a sales location present, and second, provided that there was at least one sales location, the density of sales locations was predicted. The first was done with logistic regression models and the second with an Ordinary Least Squares linear regression with log-transformed density. The overall approach is similar to earlier area-level retail availability studies, closely matching the approach of Kong et al.[32] A similar log-normal model has been used in multiple studies,[11 33 34] though Craigmile et al[34] addressed zero density by adding one to the retailer count before taking the logarithm. Two types of results are presented: univariable models with each predictor in turn, and a multivariable model with all predictors used. All estimates were exponentiated, so they can be interpreted as per cent changes in the odds of having a retail location or in the density of locations. All the analyses were carried out with the language R V.4.1.3. The analysis code is available in online supplemental file 3.

A number of sensitivity analyses were run, and the code and results are available in online supplemental file 4. Regression model assumptions were checked, and the minor deviations were cleared with sensitivity analyses that removed potentially problematic data points (sensitivity #1) or collinear predictors with high variance inflation factor (sensitivity #2). To further confirm the reliability of the results, general linear models with a log-link for >0 locations (sensitivity #3) and with a zero-inflated gamma log link for the whole data were run (sensitivity #4). The results from all sensitivity analyses are substantially similar with the main results.

Table 1 Descriptive statistics for tobacco retail presence/density and population demographics: Finland, 2020

Variable	Mean	SD	Min	Max
Postcodes with 0 sales locations (n=330)				
Tobacco retailer density (per 1000 people)	0.0	0.0	0.0	0.0
Median income, €1000	24.2	2.9	16.9	40.2
% in lowest income category	18.5	4.3	10.7	36.1
% unemployed	7.8	3.5	0.5	24.3
% with higher education	19.9	8.6	6.6	59.4
Population per square kilometre, 1000 s	0.1	0.4	0.0	3.2
Postcodes with at least one sales location (n=1111)				
Tobacco retailer density (per 1000 people)	1.3	1.3	0.1	26.3
Median income, €1000	22.6	3.3	11.4	36.4
% in lowest income category	19.9	4.9	8.2	61.0
% unemployed	10.1	4.2	2.1	35.9
% with higher education	21.9	10.9	4.6	60.2
Population per square kilometre, 1000 s	0.8	1.7	0.0	20.5
All postcodes (N=1441)				
Tobacco retailer density (per 1000 people)	1.0	1.3	0.0	26.3
Median income, €1000	23.0	3.3	11.4	40.2
% in lowest income category	19.6	4.8	8.2	61.0
% unemployed	9.6	4.1	0.5	35.9
% with higher education	21.4	10.4	4.6	60.2
Population per square km, 1000 s	0.7	1.5	0.0	20.5

RESULTS

Descriptive statistics are provided in table 1. Overall, the mean tobacco retailer density was 1.0 per 1000 inhabitants (SD=1.3). Of the retailers with licence (n=5263), 27% were grocery stores; 18% were restaurants or nightclubs; 14% were kiosks or gas stations; 2% were other businesses; and 0.3% were specialist tobacco stores. As informing the retailer type was voluntary, 39% of the retailers had not reported the type of business.

Regression lines and scatter plots for the association between sociodemographic indicators and tobacco retailer presence and density are presented in figure 1. Areas with inhabitants with higher median income and higher education had lower tobacco retailer availability. In contrast, areas with higher percentage of unemployed inhabitants and inhabitants in the lowest income category had higher availability of tobacco retailers.

Presence of tobacco retailers

All sociodemographic indicators were significantly (p<0.05) associated with the presence of tobacco retailers in the univariable regression models (table 2, model 1). Areas with higher median income were associated with lower odds of presence of retailers. On the contrary, areas with greater percentage of inhabitants in the lowest income category, unemployed or inhabitants with higher education had higher odds of having a tobacco retailer.

All variables remained significant in multivariable regression models (table 2, model 3, adjusted R^2=22.7%). Median income continued to be negatively associated with the presence of tobacco retailers. When median income of postcode area was €1000 higher, the odds of having a tobacco retailer were 45.8% lower. Compared with univariable models, the effect of inhabitants in the lowest income category changed direction. When the share of inhabitants in the lowest income category was 1 percentage point higher, the odds of having a tobacco retailer were 11.6% lower. The percentage of unemployed inhabitants

and inhabitants with higher education was positively associated with the presence of tobacco retailers.

Tobacco retailer density

All sociodemographic indicators showed a significant association with the tobacco retailer density in the univariable regression models (table 2, model 2). Median income and percentage of inhabitants with higher education were negatively associated with tobacco retailer density. In contrast, the proportion of inhabitants in the lowest income category and proportion unemployed was positively associated with retailer density.

In multivariable analyses, income variables and education continued to show consistent significant associations with retailer density, but the association of unemployment changed direction (table 2, model 4). When the median income was €1000 higher, retailer density was 4.4% lower, while 1 percentage point higher proportion of inhabitants in the lowest income category was associated with 2.8% more retailers in the area. One percentage point higher proportion of unemployed inhabitants or inhabitants with higher education was associated with 2.4% or 1.8% lower retailer density, respectively.

DISCUSSION

The aim of this study was to investigate the association between area-level sociodemographic composition and tobacco retailing in Finland, where a retail licensing system with retailer criteria and annual supervision fees are in place and enforced. Our results show that tobacco retailer density is associated with area-level sociodemographic indicators for postcodes. Income was the strongest correlate of tobacco retailer density: areas with lower median income and greater proportion of people in the lowest income category had higher densities of tobacco retailers. Additionally, median income correlated negatively with the presence of tobacco retailers. Areas with higher proportion of inhabitants

N=1,438 of 1,441 postcode areas shown in figure.
Y-axis is tobacco retail locations per 1,000 people in all plots.
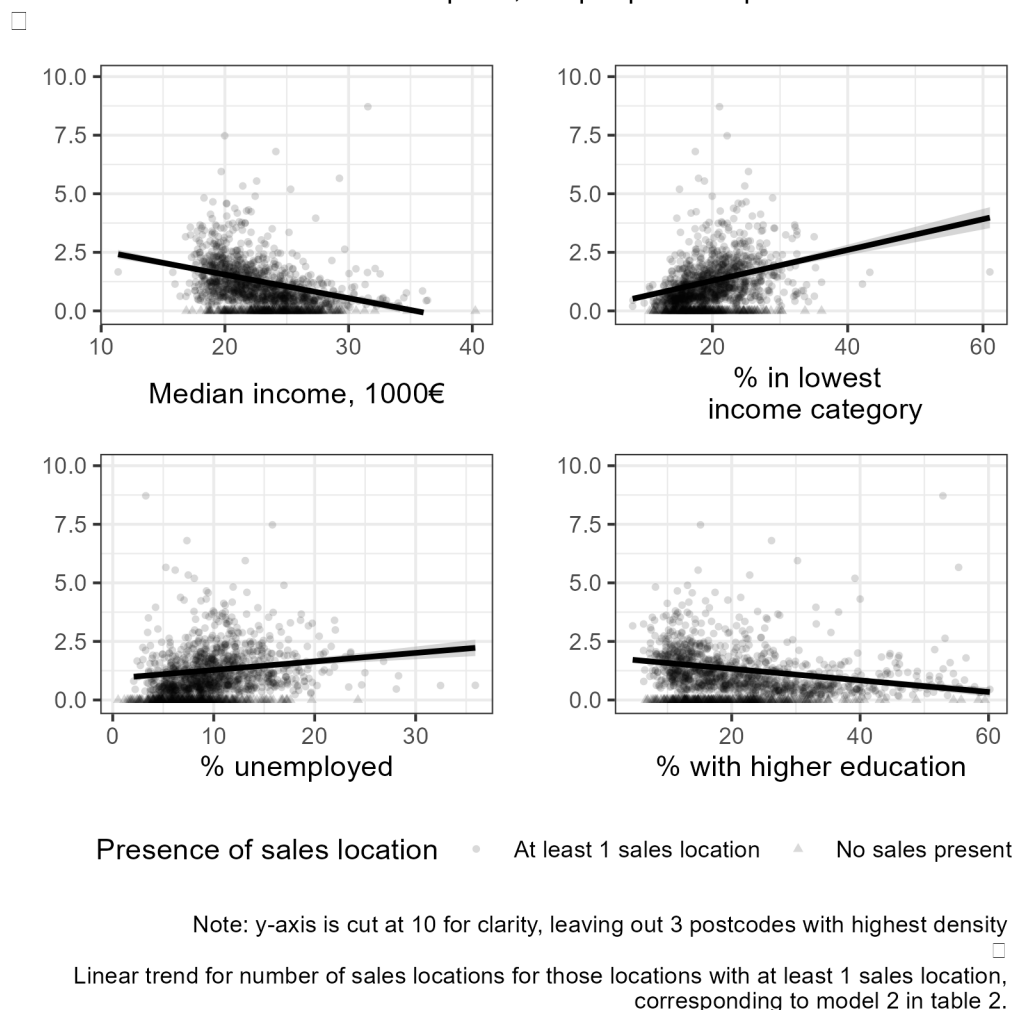

Note: y-axis is cut at 10 for clarity, leaving out 3 postcodes with highest density

Linear trend for number of sales locations for those locations with at least 1 sales location, corresponding to model 2 in table 2.

Figure 1 Tobacco retail availability and sociodemographic indicators: Finland, 2020.

with a higher education had higher odds of having a tobacco retailer yet lower retailer density.

The results on income and tobacco retailer density are consistent with previous research. Higher median household income has been associated with lower tobacco retailer density in the USA[10 11 33] and Scotland.[16] Further, areas with a higher percentage of residents living in poverty have higher density of tobacco retailers in the USA.[11 32] In Australia and New Zealand, area-level deprivation and density of tobacco retailers have been positively associated when income has been measured as a part of an index.[13–15] Large income inequalities could explain some findings of these investigations. Compared with several countries, Finland has relatively small income inequalities.[18] Thus, our results indicate that higher area-level income is also associated with lower tobacco retailer density in a country with relatively little income inequality.

Little research is available on the association between educational level and tobacco retailer density. Earlier investigation of adolescents aged 13–17 years indicated that students aiming at vocational education had around 50% higher exposure to tobacco outlets than students aiming at university.[35] Education has been measured primarily as a part of an index so its independent association remains unclear.[13 15] Our results on education were somewhat inconsistent proposing that income could be a

more reliable indicator of area-level tobacco availability. Overall, differences in smoking by educational level have widened in Finland[5] and to narrow these inequalities, further research on the association between education and tobacco availability could provide useful insights.

The observation that tobacco retailer density is associated with area-level sociodemographic indicators in a country with a retail licensing system indicates that supply control has not been used to its full capacity in the prevention of tobacco-related harms. Several studies provide evidence for retailer reduction policies from the health benefit, health equality and cost-savings perspectives.[36–38] Retailer restrictions can also facilitate quitting. A study from Finland observed that increased proximity to the closest tobacco retailer increased the odds of quitting.[39] Additionally, the likelihood of smoking cessation among Finnish men who are heavy smokers is reduced when living in close proximity to a tobacco retailer.[40] Some studies have found evidence of an association of proximity to a tobacco retailer and tobacco use behaviours[7 8] yet this warrants further research.

Tobacco retail policies could be one of the strategies for reaching the goal of a tobacco- and nicotine-free Finland by 2030. This approach is supported by modelling studies that place retailer reduction strategies among effective tobacco endgame strategies.[26 27] Several approaches have been proposed,

Table 2 Univariable and multivariable associations for presence of retailer and retailer density by sociodemographic indicators

Variable	Model 1 Univariable logistic regression for presence of retailer			Model 2 Univariable linear regression for log of retailer density				Model 3 Multivariable logistic regression for presence of retailer			Model 4 Multivariable linear regression for log of retailer density			
	Estimate	95% CI	P value	Estimate	95% CI	P value	Cohens f	Estimate	95% CI	P value	Estimate	95% CI	P value	Cohens f
Median income, €1000	0.866	0.834 to 0.9	<0.001	0.907	0.896 to 0.918	<0.001	0.496	0.542	0.481 to 0.608	<0.001	0.956	0.929 to 0.984	0.002	0.506
% in lowest income category	1.071	1.041 to 1.103	<0.001	1.059	1.051 to 1.068	<0.001	0.422	0.884	0.836 to 0.933	<0.001	1.028	1.014 to 1.042	<0.001	0.068
% unemployed	1.186	1.142 to 1.234	<0.001	1.037	1.027 to 1.047	<0.001	0.214	1.063	1.01 to 1.12	0.020	0.976	0.964 to 0.987	<0.001	0.117
% with higher education	1.020	1.007 to 1.033	0.002	0.974	0.971 to 0.978	<0.001	0.433	1.139	1.102 to 1.178	<0.001	0.982	0.976 to 0.989	<0.001	0.144
Population density, 1000 s per square kilometre								2.903	1.843 to 4.909	<0.001	1.033	1.004 to 1.063	0.023	0.068

Estimates are exponentiated and can be interpreted as multiplicative differences in OR and density, given 1 unit change in predictor.

including limiting the number, location and opening hours of tobacco retailers; prohibiting new outlets; barring outlets near schools or limiting sales to non-school hours; restricting all sales to government-controlled outlets or to one type of outlet; raising the cost of licences along with the cost of violating licencure provisions; and providing incentives for retailers to give up tobacco licences.[41] Only a few of these have yet been implemented in different countries,[42] warranting the close consideration of the feasibility and potential impact on the prevention of tobacco use initiation and supporting cessation in each national context.

Reducing inequalities in tobacco retailer density has been investigated. Craigmile *et al*[34] suggest that by licensing-law strategies, vulnerable communities could remove over 20% of their tobacco retailers. Effective ways to decrease inequalities could be to: (1) cap the number of retailers in an area based on population size or (2) decluster retailers by prohibiting them from being in close proximity to one another.[34 43] Several studies have proposed that removing tobacco sales near child spaces and schools could be a proequity measures.[34 43 44] Since 2016, granting licences to outlets that are in premises used predominantly by children and adolescents, such as school canteens, has been prohibited in Finland. However, the criteria do not address the proximity of other tobacco sales points near these premises. Since tobacco control policies aimed at protecting children have strong support in Finland[45] and socioeconomic differences in tobacco use emerge in adolescence,[4] planning and framing retailer reduction policies from this perspective could be beneficial. Prohibiting sales near schools could be supported and potentially decrease the inequalities in adolescent smoking.

When restricting the availability of tobacco, incentives could be provided for retailers to transition away from tobacco sales, potentially as part of their corporate social responsibility strategies. Although retailers have shown to be concerned about how declines in tobacco sales will affect the profits of their store, they are also worried about the well-being of the customers and the whole neighbourhood.[46] Contrary to tobacco industry's claims, tobacco seems not to be essential for viability of businesses.[47] Underlining this, some large chains have quit selling cigarettes, for example CVS pharmacy in the USA[48] and Lidl in the Netherlands.[49] Also in Finland, some retailers have ceased selling tobacco products but it is still an uncommon practice.[50 51]

The licensing system in Finland provides possibilities to consider different retailer reduction strategies, for example capping and declustering. Feasible strategies could be further increases in the retail and supervisory fees and limiting the types of retail outlets that can apply for the licence to move the sales to specialist shops. The introduction of a licensing scheme with supervision fees decreased the number of tobacco retailers in Finland.[25] Based on our data, the decrease has further continued, but the number is still relatively high with over 5000 sales points in 2020. To compare, New Zealand, with a similar population size as Finland, recently passed legislation that will reduce the number of tobacco retailers from over 6000 to 600.[52] Concerning increased fees, more than a 16-fold fee increase decreased the number of retailers by 24% in South Australia.[53] To limit the type of outlets, one additional option could be to grant licences only to adult stores, namely tobacco or vape stores. For example, in the Netherlands, tobacco sales will be prohibited at supermarkets in 2024 and at petrol stations and small outlets after 2030, leaving tobacco sales allowed only for specialist tobacco shops.[54] One further option could be to restrict tobacco sales to liquor stores, but a simulation model has indicated that this policy could increase socioeconomic inequalities.[43] A similar

result was found for restricting tobacco sales to pharmacies.[43] In Finland, this measure could additionally give mixed messages to the general public as nicotine replacement therapy products have been allowed to be sold over-the-counter in retail outlets since 2006.

In the Finnish context, some controversy can be observed in granting tobacco product retail licences to bars, restaurants and public outdoor events such as festivals where smoking is fully or partially prohibited. Since alcohol consumption is known to be associated with impulsive smoking and relapse in cessation,[55 56] the availability of tobacco sales in these premises might prompt impulse purchasing. In recent years, retail sale licences have also been granted to temporary pop-up sales points. These types of sales points could be seen contradicting the full tobacco advertising and promotion ban, including point-of-sale advertising and display ban in force in Finland since 2012. Examples of these include promotional e-cigarette pop-up stores, often placed in centrally located places, for example, in shopping malls.[57]

Strengths and limitations

A limitation is that this study observed the characteristics of postcode areas people inhabit, while people obviously move outside that limited area for work and leisure and the area-level densities might underestimate real total exposure.[58] Still, exposure near housing should affect inhabitants in a fairly similar manner (ie, practically everyone will have to move about in the area they inhabit, while activities outside that area are more varied). Future studies could use geolocation tracking by smartphones to give accurate individual-level information about exposure. Second, we were not able to consider sales place, size or opening hours. Third, there is lack of individual-level data on smoking prevalence at the equivalent area-level so the effects of tobacco availability on smoking rates cannot be estimated. Future studies should use data triangulation to investigate differences in tobacco use behaviour and tobacco availability in Finland.

To our knowledge, this is one of the few studies about area-level sociodemographic differences in tobacco availability in jurisdictions with a nationwide licensing system which increases accuracy of location data. Both the tobacco retailer and sociodemographic data are based on the latest available information from the same time point and gathered from reliable national authorities. The data encompasses 94.3% of the population living in Finland and is thus highly representative of the total population. Missing information is viewed as negligible. To further confirm this, additional sensitivity analyses were run which showed similar results as the main analyses.

CONCLUSION

There are sociodemographic differences in the area-level tobacco retailer density in Finland showing higher availability in less affluent areas. Hence, controlling tobacco sales with licensing system and supervision fees is likely insufficient to reduce tobacco-related sociodemographic differences if the retailer criteria do not address the number and density of the sales points. If no policy measures to change this distribution are enacted in the future, tobacco availability will likely remain more concentrated in more disadvantaged areas. Supply side policies and reduction of retail density should be integrated into the measures aiming at achieving tobacco or nicotine endgame.

ORCID iDs
Salla-Maaria Pätsi http://orcid.org/0000-0003-1626-1400
Hanna Ollila http://orcid.org/0000-0002-8814-1021
Otto Ruokolainen http://orcid.org/0000-0001-9601-7330

REFERENCES

1 Petrovic D, de Mestral C, Bochud M, et al. The contribution of health behaviors to socioeconomic inequalities in health: a systematic review. *Prev Med* 2018;113:15–31.
2 Härkänen T, Kuulasmaa K, Sares-Jäske L, et al. Estimating expected life-years and risk factor associations with mortality in Finland: cohort study. *BMJ Open* 2020;10:e033741.
3 Hiscock R, Bauld L, Amos A, et al. Socioeconomic status and smoking: a review. *Ann N Y Acad Sci* 2012;1248:107–23.
4 Ruokolainen O, Ollila H, Lahti J, et al. Intergenerational social mobility, smoking and smokeless tobacco (snus) use among adolescents during 2008-2017. *Addict Behav* 2019;98:106022.
5 Ruokolainen O, Heloma A, Jousilahti P, et al. Thirty-eight-year trends of educational differences in smoking in Finland. *Int J Public Health* 2019;64:853–60.
6 Lahelma E. Health and social stratification. In: W.C C, ed. *The New Blackwell Companion to Medical Sociology*. John Wiley & Sons Ltd, 2016.
7 Travis N, Levy DT, McDaniel PA, et al. Tobacco retail availability and cigarette and e-cigarette use among youth and adults: a scoping review. *Tob Control* 2022;31:e175–88.
8 Lee JGL, Kong AY, Sewell KB, et al. Associations of tobacco retailer density and proximity with adult tobacco use behaviours and health outcomes: a meta-analysis. *Tob Control* 2022;31:e189–200.
9 Marsh L, Vaneckova P, Robertson L, et al. Association between density and proximity of tobacco retail outlets with smoking: a systematic review of youth studies. *Health Place* 2021;67.
10 Mills SD, Kong AY, Reimold AE, et al. Sociodemographic disparities in tobacco retailer density in the United States, 2000-2017. *Nicotine Tob Res* 2022;24:1291–9.
11 Kong AY, Delamater PL, Gottfredson NC, et al. Sociodemographic inequities in tobacco retailer density: do neighboring places matter? *Health Place* 2021;71.

12 Fakunle DO, Thorpe RJ, Furr-Holden CDM, *et al*. Does tobacco outlet inequality extend to high-white Mid-Atlantic jurisdictions? A study of socioeconomic status and density. *J Racial Ethn Health Disparities* 2019;6:409–18.

13 Marashi-Pour S, Cretikos M, Lyons C, *et al*. The association between the density of retail tobacco outlets, individual smoking status, neighbourhood socioeconomic status and school locations in new south wales, australia. *Spat Spatiotemporal Epidemiol* 2015;12:1–7.

14 Melody SM, Martin-Gall V, Harding B, *et al*. The retail availability of tobacco in tasmania: evidence for a socio-economic and geographical gradient. *Med J Aust* 2018;208:205–8.

15 Marsh L, Doscher C, Robertson LA. Characteristics of tobacco retailers in new zealand. *Health Place* 2013;23:165–70.

16 Shortt NK, Tisch C, Pearce J, *et al*. A cross-sectional analysis of the relationship between tobacco and alcohol outlet density and neighbourhood deprivation. *BMC Public Health* 2015;15:1014.

17 Schneider S, Gruber J. Neighbourhood deprivation and outlet density for tobacco, alcohol and fast food: first hints of obesogenic and addictive environments in Germany. *Public Health Nutr* 2013;16:1168–77.

18 the OECD. Inequality - income inequality - OECD data. Available: http://data.oecd.org/inequality/income-inequality.htm [Accessed 3 Jun 2022].

19 Tammaru T, Marcin'czak S, Aunap R, *et al*. Relationship between income inequality and residential segregation of socioeconomic groups. *Regional Studies* 2020;54:450–61.

20 Kuipers MAG, Nuyts PAW, Willemsen MC, *et al*. Tobacco retail licencing systems in Europe. *Tob Control* 2022;31:784–8.

21 WHO. WHO framework convention on tobacco control overview. 2003. Available: https://fctc.who.int/who-fctc/overview [Accessed 12 Jul 2022].

22 WHO. Protocol to eliminate illicit trade in tobacco products. 2013. Available: https://fctc.who.int/protocol/overview [Accessed 12 Jul 2022].

23 Robertson L, Marsh L, Hoek J, *et al*. New zealand tobacco control experts' views towards policies to reduce tobacco availability. *N Z Med J* 2017;130:27–35.

24 Valvira. Tobacco - sales. 2018. Available: http://www.valvira.fi/web/en/tobacco/-myynti [Accessed 3 Jun 2022].

25 Timberlake DS, Laitinen U, Kinnunen JM, *et al*. Strategies and barriers to achieving the goal of finland's tobacco endgame. *Tob Control* 2020;29:398–404.

26 van der Deen FS, Wilson N, Cleghorn CL, *et al*. Impact of five tobacco endgame strategies on future smoking prevalence, population health and health system costs: two modelling studies to inform the tobacco endgame. *Tob Control* 2018;27:278–86.

27 Chaiton M, Dubray J, Guindon GE, *et al*. Tobacco endgame simulation modelling: assessing the impact of policy changes on smoking prevalence in 2035. *Forecasting* 2021;3:267–75.

28 Toivakka M, Pihlapuro A, Tykkyläinen M, *et al*. The usefulness of small-area-based socioeconomic characteristics in assessing the treatment outcomes of type 2 diabetes patients: a register-based mixed-effect study. *BMC Public Health* 2018;18:1258.

29 Valvira. Julkinen lupa- ja ilmoitusasioiden rekisteri. n.d. Available: http://www.valvira.fi/tupakka/myynti/vahittaismyynti/julkinen-lupa-ja-ilmoitusasioiden-rekisteri

30 Ruokolainen O, Ollila H, Karjalainen K. Correlates of e-cigarette use before and after comprehensive regulatory changes and e-liquid flavour ban among general population. *Drug Alcohol Rev* 2022;41:1174–83.

31 Tilastokeskus. Paavo postal code area statistics. Available: https://www.stat.fi/tup/paavo/index_en.html [Accessed Jul 2022].

32 Kong AY, Delamater PL, Gottfredson NC, *et al*. Neighborhood inequities in tobacco retailer density and the presence of tobacco-selling pharmacies and tobacco shops. *Health Educ Behav* 2022;49:478–87.

33 Siahpush M, Jones PR, Singh GK, *et al*. Association of availability of tobacco products with socio-economic and racial/ethnic characteristics of neighbourhoods. *Public Health* 2010;124:525–9.

34 Craigmile PF, Onnen N, Schwartz E, *et al*. Evaluating how licensing-law strategies will impact disparities in tobacco retailer density: a simulation in ohio. *Tob Control* 2021;30:e96–103.

35 Zijp A, van Deelen TRD, van den Putte B, *et al*. Educational inequalities in exposure to tobacco promotion at the point of sale among adolescents in four dutch cities. *Health Place* 2022;76.

36 Kaviany P, Senter JP, Collaco JM, *et al*. Spatial analysis of tobacco outlet density on secondhand smoke exposure and asthma health among children in Baltimore City. *Tob Control* 2022:tobaccocontrol-2021-056878.

37 Kong AY, Baggett CD, Gottfredson NC, *et al*. Associations of tobacco retailer availability with chronic obstructive pulmonary disease related hospital outcomes, united states, 2014. *Health Place* 2021;67.

38 Pearson AL, Cleghorn CL, van der Deen FS, *et al*. Tobacco retail outlet restrictions: health and cost impacts from multistate life-table modelling in a national population. *Tob Control* 2016;26:579–85.

39 Pulakka A, Halonen JI, Kawachi I, *et al*. Association between distance from home to tobacco outlet and smoking cessation and relapse. *JAMA Intern Med* 2016;176:1512–9.

40 Halonen JI, Kivimäki M, Kouvonen A, *et al*. Proximity to a tobacco store and smoking cessation: a cohort study. *Tob Control* 2014;23:146–51.

41 McDaniel PA, Smith EA, Malone RE. The tobacco endgame: a qualitative review and synthesis. *Tob Control* 2016;25:594–604.

42 Valiente R, Sureda X, Bilal U, *et al*. Regulating the local availability of tobacco retailing in Madrid, Spain: a GIS study to evaluate compliance. *Tob Control* 2019;28:325–33.

43 Caryl FM, Pearce J, Reid G, *et al*. Simulating the density reduction and equity impact of potential tobacco retail control policies. *Tob Control* 2021;30:e138–43.

44 Ribisl KM, Luke DA, Bohannon DL, *et al*. Reducing disparities in tobacco retailer density by banning tobacco product sales near schools. *Nicotine Tob Res* 2017;19:239–44.

45 Ruokolainen O, Ollila H, Patja K, *et al*. Social climate on tobacco control in an advanced tobacco control country: a population-based study in Finland. *Nordisk Alkohol Nark* 2018;35:152–64.

46 Chavez G, Minkler M, McDaniel PA, *et al*. Retailers' perspectives on selling tobacco in a low-income San Francisco neighbourhood after California's $ 2 tobacco Tax increase. *Tob Control* 2019;28:657–62.

47 Tunstall H, Shortt NK, Kong AY, *et al*. Is tobacco A driver of footfall among small retailers? A geographical analysis of tobacco purchasing using electronic point of sale data. *Tob Control* 2022.

48 Glasser AM, Roberts ME. Retailer density reduction approaches to tobacco control: a review. *Health Place* 2021;67.

49 NL Times. Lidl stops selling cigarettes, tobacco with immediate effect. Available: https://nltimes.nl/2021/10/01/lidl-stops-selling-cigarettes-tobacco-immediate-effect [Accessed 12 Jul 2022].

50 Ilta-Sanomat. Kauppaketju halpa-halli ei myy ollenkaan olutta tai tupakkaa – näin periaatepäätöksellä tienaa. 2019. Available: https://www.is.fi/taloussanomat/art-2000006298455.html [Accessed 23 Aug 2022].

51 Karjalainen. Jari-pekan toimitusjohtaja perustelee: tämän takia emme myy alkoholia ja tupakkaa. n.d. Available: https://www.karjalainen.fi/kotimaa/58027

52 New Zealand Health Committee. Final report: smokefree environments and regulated products (smoked tobacco) amendment bill. Available: https://www.parliament.nz/en/pb/sc/reports/document/SCR_130048/smokefree-environments-and-regulated-products-smoked-tobacco [Accessed 27 Dec 2022].

53 Bowden JA, Dono J, John DL, *et al*. What happens when the price of a tobacco retailer licence increases? *Tob Control* 2014;23:178–80.

54 van Deelen TRD, Kunst AE, van den Putte B, *et al*. Ex ante evaluation of the impact of tobacco control policy measures aimed at the point of sale in the Netherlands. *Tob Control* 2022:tobaccocontrol-2021-057205.

55 Tomko RL, Saladin ME, McClure EA, *et al*. Alcohol consumption as a predictor of reactivity to smoking and stress cues presented in the natural environment of smokers. *Psychopharmacology (Berl)* 2017;234:427–35.

56 Krall EA, Garvey AJ, Garcia RI. Smoking relapse after 2 years of abstinence: findings from the Va normative aging study. *Nicotine Tob Res* 2002;4:95–100.

57 Siippainen A. Tupakkajätti ja R-kioski avasivat huomiota herättävän myymälän triplaan – tätä mieltä kaupunki ja valvira ovat sen laillisuudesta. *Helsingin Uutiset* 2021. Available: https://www.helsinginuutiset.fi/paikalliset/4141724

58 Caryl F, Shortt NK, Pearce J, *et al*. Socioeconomic inequalities in children's exposure to tobacco retailing based on individual-level GPS data in scotland. *Tob Control* 2020;29:367–73.