Vape stores in Western Australia: growth, proximity to schools and socio-economic gradient of density

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Submitted: 6 October 2023; Revision requested: 7 December 2023; Accepted: 10 December 2023

Abstract

Objective: To audit the number and location of dedicated e-cigarette retailers ("vape stores") in Western Australian (WA), measure proximity to schools and model the association between vape store density and socio-economic disadvantage.

Methods: Vape stores were identified via internet search and geocoded. Proximity to schools was measured. Regression modelling was used to investigate the association between vape store density and socio-economic disadvantage.

Results: 194 stores were identified, with 88% located within one kilometre of a school. In metropolitan WA, vape store density was nearly seven times higher in the most socio-economically disadvantaged areas than in the least disadvantaged areas (rate ratio 6.9, 95% confidence interval 3.4–15.5).

Conclusions: There has been rapid, recent growth in the number of vape stores in WA, with most located within walking distance of schools. In metropolitan WA, vape store density is strongly associated with socio-economic disadvantage, mirroring the pattern observed globally for tobacco outlets.

Implications for Public Health: This is the first Australian study demonstrating that vape stores are more densely located in socio-economically disadvantaged areas. Vape stores' proximity to schools may increase young people's access and exposure to promotional signage. There is a need to address ready e-cigarette availability through strong regulatory and compliance measures.

Key words: vape stores, density, proximity to schools, legislation, socio-economic disadvantage

Introduction

E-cigarettes, also known as 'vapes', have become increasingly used and available internationally in recent years. In Australia, vaping prevalence has increased rapidly, with 8.9% of Australians aged 14+ being current vapers in 2023.[1]

There is substantial evidence that using nicotine-containing e-cigarettes can lead to a range of short-term health effects, including nicotine poisoning and toxicity.[2] While the long-term health effects of vaping are still emerging, evidence shows that use of nicotine-containing e-cigarettes leads to dependence on e-cigarettes.[2] Further, a recent study found that non-smokers who vape are three times more likely to initiate tobacco smoking than those who do not, suggestive of a gateway effect.[3] Although tobacco use in the Australian population has been declining over the last two decades, reaching approximately 10% in 2021–22,[4] smoking rates among children aged 14–17 years more than tripled between 2019 and 2022,[1] and there was a more than tenfold increase in the prevalence of vaping in that age group over the same period.[1]

Against a backdrop of widely held public health concerns about vaping in Australia, the Australian government recently announced substantial vaping reforms[5] and released the Australian National Tobacco Strategy 2023–2030,[6] both of which target reductions in recreational, or non-prescription, vaping, especially amongst young people. To this end, in 2023, the Australian government announced plans to stop the importation, manufacture, and supply of non-therapeutic vapes and to implement an absolute ban on all single-use, disposable vapes. Non-therapeutic vapes are vapes that are used

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Aust NZ J Public Health. 2024; Online; https://doi.org/10.1016/j.anzjph.2023.100118

without a medical prescription and not for a therapeutic purpose such as smoking cessation or treatment of nicotine dependence.

Both nicotine-containing e-cigarettes and e-cigarettes purported to be nicotine-free are sold in Australia, with Australian research showing that vaping products available for sale frequently contain nicotine, even when marketed and labelled as nicotine-free.[7] While nicotine-containing e-cigarettes can currently be legally accessed in Australia only from licensed pharmacies and with a medical prescription, they are nonetheless widely available in a range of physical and online settings. Currently, nicotine vaping products that are imported into or supplied in Australia must meet current minimum safety and quality standards set out in the Australian government Therapeutic Goods Administration's Therapeutic Goods (Standard for Nicotine Vaping Products) (TGO 110) Order 2021,[8] which specifies a nicotine base form concentration limit of no more than 100mg/mL and, for nicotine salt form products, an equivalent base form concentration of no more than 100mg/mL. However, there is no restriction on the volume of container, and the Therapeutic Goods Administration has proposed lowering the maximum allowable nicotine concentration to 20mg/mL to align with limits in the EU, UK, and Canada.

'Brick and mortar' vape stores have proliferated in Australia in recent years. For example, one study reported 'exponential growth' in vape stores in Western Australia (WA) between 2017 and 2019.[9] Australian vape stores commonly have sales of e-cigarette products as a main source of business, in contrast to stores like supermarkets and convenience stores, which, when they do sell such products, do so only alongside various other non-smoking- or vaping-related items. Often, vape store names and visible advertising directly refer to vaping or related terminology, as depicted in Figure 1. This overt display of vaping language and imagery has contributed to the normalisation of vaping, particularly amongst youth.[10–12] Physical stores represent a unique environment where both new and existing users can sample products and receive advice from staff.[9] Further, evidence shows that first-time exposure to vape products often occurs in a physical retailer setting,[13] where the ability to sample products, for example, may prompt initiation. Given this situation, it is important to monitor the number and locations of physical vape stores in communities, to guide policy and intervention.

Understanding the relationship between vape store density and socio-economic disadvantage is important for guiding public health policy and interventions, particularly those targeting priority populations who are at higher risk of initiation. However, existing evidence of an association between vape store density and socio-economics is mixed,[9,11,14–16] in contrast to abundant evidence of a consistent, positive correlation between socio-economic disadvantage and tobacco retailer density.[17–20] Therefore, additional studies are needed in different geographic regions, including in Australia, to improve the evidence base in this area.

Previous tobacco research has shown that the proximity of tobacco retailers to people's schools or homes can influence smoking

Figure 1: Examples of vape stores and their advertising in Perth, Western Australia in 2023.

behaviours, and similar relationships have been reported for e-cigarettes.[21] Recent Australian research found that 14% of children aged 14-17 years currently vape, and that vaping rates were highest among people aged under 35 years.[1] Given the rapid rise of vaping amongst youth and the potential for associated health harms, it is important to consider the proximity of vape stores to places where young people gather, particularly schools.

Given this background, this study aimed to:

1. update existing data on the number of vape stores in WA[9] and expand these data to include both regional and metropolitan areas,
2. measure the proximity of vape stores to schools, and
3. model the association between vape store density and socio-economic disadvantage.

Methods

Data

Geographical boundary data (Environmental Systems Research Institute (ESRI) shapefiles) for Australian Bureau of Statistics (ABS) Suburbs and Localities (SALs; n=1,699, mean population 1,561[22]), Urban Centres and Localities (UCLs), and Greater Capital City Statistical Areas (GCCSAs) from the 2021 Australian Census (hereafter the 'Census') were obtained for WA from the ABS,[22] and the following sub-regions of WA were defined.

i. **metropolitan WA** (or 'Perth'), corresponding to the GCCSA of 'Greater Perth' (395 SALs, population 2,043,762[23]),
ii. **regional WA,** comprising all SALs outside of Perth (1,304 SALs, population 616,264[23]) and divided into:
   a. **major regional centres in WA,** following Wood et al. (2013)[17] and based on the relevant UCL boundaries: Bunbury (15 SALs, population 75,196[23]), Geraldton (18 SALs, population 32,717[23]), Albany (24 SALs, population 31,128[23]), Kalgoorlie – Boulder (13 SALs, population 29,068[23]), and Busselton (6 SALs, population 27,233[23]). These towns are the five largest in regional WA, each with a population > 25,000. Together, they comprised 76 SALs.
   b. **remainder of regional WA**, comprising all regional WA SALs outside the major regional centres (1,228 SALs).

SAL-resolution Census population counts and socio-economic status (SES) data were also obtained from the ABS.[24,25] For the latter, following previous work,[9,17] ABS Socio-Economic Indexes for Areas data, and specifically the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD), were used.

Data for 1,144 government, independent, and Catholic schools in WA, current as of Semester 1, 2023, were obtained from the WA Department of Education.[26] Two schools located on islands off the coast of WA were excluded, leaving 1,142 for analysis.

Vape store audit

There is no public registry of vape stores in WA, unlike for tobacco retailers for which there is a positive licensing scheme.[27] Therefore, an audit of WA vape stores was undertaken manually in January 2023 using a desktop-via-internet search strategy[9,28] that itself was based on previous approaches.[29,30] This approach involved manually searching Google, Google Maps and Facebook for a variety of terms including 'vape shop', 'vape store', 'e-cigarettes', 'e-cigarette retailer', 'Perth', and 'Western Australia'. Only stores that had sales of e-cigarette products as a main source of business were included; thus, tobacconists and smoke shops were included but outlets such as convenience stores and independent supermarkets which sold vaping products were excluded. The audited stores were geocoded manually via Google Maps.

Statistical analysis

The number of vape stores and their proximity to schools was measured in each region. A negative binomial model was fitted to investigate the association between the density of vape stores (SAL-level counts of vape stores per 10,000 population) and SES group in Perth, with the model incorporating an offset to account for population size. Only Perth was examined for this analysis due to relatively few stores being located outside that region. SALs with no measured IRSAD (n=23), which comprised parks, airports and industrial areas, were excluded. Based on the IRSAD, SES categories of 'low', 'medium' and 'high' were defined to aid interpretability, congruent with how many smoking prevalence and tobacco control findings are presented and the common usage of such groups in other Australian statistical and policy reports and in the literature. To obtain these categories, a percentile distribution of IRSAD for Perth was derived and subsequently categorised as low SES (0–24%, i.e., high levels of socio-economic disadvantage), medium SES (25–74%) and high SES (75–100%, i.e., low levels of socio-economic disadvantage). The high SES group was used as the reference in the model.

Table 1: Number of vape stores in Western Australia, by geographic region.

Region	Number of SALs (% of all WA SALs)	Number of vape stores (% of all WA stores)	Number (%) of SALs with 1+ store	Mean (range) number of stores per SAL among SALs with 1+ store
Metropolitan WA (Perth)	395 (23)	159 (82)	88 (22)	1.8 (1 - 7)
Regional WA[a]	1,304 (77)	35 (18)	24 (2)	1.5 (1 - 4)
Regional WA centres	76 (4)	23 (12)	13 (17)	1.8 (1 - 4)
Remainder of regional WA	1,228 (72)	12 (6)	11 (1)	1 (1 - 2)
All of WA	**1,699 (100)**	**194 (100)**	**112 (7)**	**1.7 (1 - 7)**

[a]Regional WA comprises regional WA centres and remainder of regional WA.
WA = Western Australia; **SALs** = Suburbs and Localities.

Table 2: Proximity of vape stores to schools in Western Australia (WA), by geographic region.

Region	Total number of stores	Number (%) of stores			
		Within 250 m of a school	Within 500 m of a school	Within 1 km of a school	Further than 1 km from a school
Metropolitan WA (Perth)	159	19 (12)	64 (40)	140 (88)	19 (12)
Regional WA[a]	35	6 (17)	12 (34)	30 (86)	5 (14)
Regional WA Centres	23	4 (17)	7 (30)	19 (83)	4 (17)
Remainder of regional WA	12	2 (17)	5 (42)	11 (92)	1 (8)
All of WA	**194**	**25 (13)**	**76 (39)**	**170 (88)**	**24 (12)**
Region	**Total number of schools**	**Number (%) of schools with at least 1 vape store located nearby**			
		1+ vape store within 250 m	1+ vape store within 500 m	1+ vape store within 1 km	No vape stores within 1 km
Metropolitan WA (Perth)	733	20 (3)	71 (10)	214 (29)	519 (71)
Regional WAa	409	7 (2)	15 (4)	52 (13)	357 (87)
Regional WA Centres	91	5 (5)	9 (10)	32 (35)	59 (65)
Remainder of regional WA	318	2 (1)	6 (2)	20 (6)	298 (94)
All of WA	**1,142**	**27 (2)**	**86 (8)**	**266 (23)**	**876 (77)**

[a]Regional WA comprises regional WA centres and remainder of regional WA.
m = metres; **km** = kilometres; **1 km** = 1,000 m.

Results

In total, 194 vape stores were identified in WA, most of which (82%, n=159) were in Perth (Table 1). Most stores in regional WA were located in major regional WA centres (23 of 35 stores, 66%). In Perth, 22% (n=88) of SALs had at least one vape store, compared to 17% of regional WA centre SALs and just 1% of SALs in the remainder of regional WA. Amongst SALs with at least one store, the number of stores ranged between one and seven in Perth, one and four in the regional WA centres and one and two in the remainder of regional WA.

Approximately one in three vape stores in each region were located within 500 metres of a school (39% overall, range 30% – 40% between regions), and most were located within one kilometre of a school (88% overall, range 83% – 92% between regions) (Table 2). Meanwhile, 29% of schools in Perth (n=214) and 35% of schools in regional WA centres (n=32) had at least one store located within one kilometre.

A strong, positive association was observed between the density of vape stores and socio-economic disadvantage amongst SALs in Perth, with the mean number of retailers per 10,000 population being 1.2 amongst the most disadvantaged SALs and just 0.1 amongst the least disadvantaged SALs (Table 3). The negative binomial model estimated the density of vape stores in the most disadvantaged SALs to be, on average, almost seven times higher than that in the least disadvantaged SALs (RR 6.9, 95% confidence interval 3.4–15.5).

Discussion

This paper has provided up-to-date figures on the number of vape stores in Perth, and extended these data to capture regional WA, including major regional WA centres. Further, it has contributed to the evidence base for a strong, positive association between the density of vape stores and socio-economic disadvantage and provided striking evidence of the proximity of stores to schools.

The growth in the number of vape stores in Perth and WA over the last few years mirrors that seen internationally (e.g., in New Zealand[31]). Particularly, the finding of 159 vape stores in Perth represents an increase of over 120% in the space of just under 3.5 years, that is, since the audit undertaken by Scott et al., in 2019 which identified 72 retailers that were vape shops, tobacconists, or smoke shops.[9] This is despite it currently being illegal in WA under the *Tobacco Products Control Act 2006* (WA) to sell any food, toy or other product that is not a tobacco product but is designed to resemble a tobacco product or package.[32] Currently, the WA Department of Health website states "It is the Department of Health's view that e-cigarette devices and their components, and whether (in the case of the components) they are sold separately or not, constitute products that are designed to resemble tobacco products".[33] In May 2022, the

Table 3: Density of vape stores in metropolitan WA (Perth), by socio-economic group.

Socio-economic status (SES) group	IRSAD score range	Number of SALs (% of all Perth SALs[a])	Mean number of stores per 10,000 population (among SALs with 1+ store[a])	Rate ratio (95% confidence interval)[b]
Low (most disadvantaged)	821 - 974	83 (54)	1.2	6.9 (3.4 - 15.5)
Medium SES	974 - 1075	61 (40)	0.6	3.3 (1.6 - 7.6)
High SES (least disadvantaged)	1075 - 1192	9 (6)	0.1	Reference

[a]Excluding SALs with no measured IRSAD (n=23), which comprised parks, airports and industrial areas (see Methods).
[b]Based on a negative binomial regression model.
IRSAD = Index of Relative Socio-economic Advantage and Disadvantage; **SALs** = Suburbs and Localities; **SES** = socio-economic status

WA Department of Health publicly stated it had, "put 3,000 retailers on notice reminding them of the ongoing restrictions regarding the sale of e-cigarette devices and vaporiser nicotine products under WA's *Tobacco Products Control Act 2006* and *Medicines and Poisons Act 2014*".[34] More recently, the WA Government announced in June 2023 that it had seized $1 million worth of vapes in transit to Perth,[35] and in August 2023 that it had seized 15 tonnes of vapes worth $10 million.[36] In June 2023, in response to a question on notice, the WA Minister for Police confirmed that, between 2019 and 17 May 2023, only twelve individuals and/or entities were successfully prosecuted for "offences relating to the sale, supply or possession of e-cigarette devices and/or their components or vaping products containing nicotine".[37]

Importantly, the audit findings consider only vape stores, and therefore underestimate the total number of e-cigarette retailers in Perth and WA, which is known to include some other retailers such as convenience stores and independent supermarkets.[9] As it was not feasible to include such retailers in the audit, this paper focused on vape stores due to the overt advertising of vaping products by those stores. Further, the findings underestimate the overall availability of e-cigarette products and the rise in vaping prevalence in WA and Australia more broadly, part of which is driven by the online market and sales facilitated by social media. To curb access to non-prescription vaping products, the proposed legislative reforms in Australia must prioritise visible enforcement to deter retailers and suppliers outside the pharmacy sector.

The role that 'brick and mortar' vape stores play in normalising e-cigarette use, particularly amongst youth,[10–12] cannot be overstated. As noted, this normalisation plays out through stores explicitly referring to vaping in their names, promotions and prominent signage on shop fronts (e.g., Figure 1). Similarities in other sectors include the noted normalising effects of tobacco, alcohol, gambling, and junk food advertising.[38–41] Counteracting this, evidence from tobacco research shows that banning advertising can have a de-normalising effect, with bans leading to reduced awareness of tobacco industry promotional activity, smoking prevalence, and initiation of smoking.[38]

Given that many students walk to and from school or pass nearby retail outlets en route to school, the finding that most WA vape stores audited are located within one kilometre of a school amplifies community concerns about youth vaping. This finding is consistent with similar figures reported by other studies internationally, such as Hahn et al.[42] who found that 68% of schools in two central Kentucky Counties (US) had an e-cigarette retailer within one mile (~1.6 kilometres). Similarly, Chido-Amajuoyi et al.[43] found that 40% of vape shops in central Texas (US) were located within half a mile (~0.8 kilometres) of a middle or high school, and Widiantari et al.[44] reported that 28% of schools in Denpasar (Indonesia) had at least one vape store within 250 metres. In Perth, the proximity of vape stores to schools has been the subject of public outcry and media coverage at least once to date, with the store in question closing as a result.[45,46] However, before closing, the store had a large, neon sign reading "*Stop smoking*, *start vaping*" immediately adjacent to a primary school crossing. More broadly, the proximity of vape stores to schools, while a cause for concern, is also a potential angle for advocacy for stronger enforcement action at both a state and national level.

The finding of a strong, positive relationship between the density of vape stores and socio-economic disadvantage in Perth mirrors the corresponding relationship observed both in Australia and internationally for tobacco,[17–20] and the findings of some, but not all, existing studies on e-cigarette retailers.[9,47,48] For example, a national US study reported that vape shop density was associated with lower levels of college education and owner-occupied housing,[11] while other US studies have reported mixed or contradictory findings. Giovenco et al.[16] noted that vape shop density is highest among low- and middle-income areas, while Bostean et al.[15] reported higher density among moderately impoverished but not highly impoverished areas. However, it should be noted that these studies were undertaken in different settings: one in largely suburban Orange County (Giovenco et al.) and the other in urban New Jersey (Bostean et al.). Additionally, discrepancies in the association between vape store density and socio-demographic characteristics across jurisdictions may be partly attributable to the method of vape store identification.[49,50] Given the inconsistency in the literature to date, further examination of the relationship between vape store density and socio-economic disadvantage is needed, particularly in other Australian jurisdictions but also globally, to characterise potential differences both within and between countries and thereby guide effective policy. The higher density of vape stores in socio-economically disadvantaged areas observed in this study may lead to unequal impacts of, for example, advertising exposure and access to vapes among populations who are at higher risk of e-cigarette initiation and dependence.

The generalisability of this paper's findings to other Australian states and territories may be affected by WA's distinct regulatory approach to non-nicotine e-cigarette products. Elsewhere in Australia (i.e., outside of WA), sales of non-nicotine e-cigarette products are currently regulated in a similar way to tobacco products, with general retail stores legally able to sell these products to adults.

The analysis of the relationship between vape store density and SES is subject to the modifiable areal unit problem (MAUP) due to depending on the SAL boundaries. However, given the strength of the relationship observed, it is unlikely that using alternative units, such as ABS Statistical Areas Level 2 (SA2s), would change its direction.

Conclusions

There has been rapid, recent growth in the number of vape stores in WA. This study has demonstrated that WA vape stores are more densely located in areas of socio-economic disadvantage, mirroring the pattern observed globally in relation to tobacco outlets. Most vape stores in both metropolitan and regional WA are located within one kilometre of a school, meaning that young people may be exposed to promotional signage and have increased access to e-cigarette products. There is a need to take early action to reduce e-cigarette availability through strong regulatory and compliance measures that target the supply of non-therapeutic vapes.

Funding

This research was partially funded by CCWA. However, the funder had no role in the study design or in the collection, analysis or interpretation of the data.

Ethical statement

Ethics approval for this research was granted by the University of Western Australia (UWA) Human Research Ethics Committee (HREC) on 15 February 2022 (2021/ET001076), with cross-institutional HREC approval from the University of Notre Dame Australia (UNDA) granted in April 2022.

Author contributions

MT, AG and LW designed the study. MT obtained the data, wrote the first draft, undertook the data analysis and coordinated subsequent revisions. NL and CK provided expert policy advice. MT, AG, LW and NL provided expert research advice. All authors contributed to reviewing the manuscript and approved submission to the journal.

Conflicts of interest

The authors have no competing interests to declare.

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