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Article

Fast food restaurant locations according to socioeconomic disadvantage, urban–regional locality, and schools within Victoria, Australia

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ABSTRACT

Features of the built environment provide opportunities to engage in both healthy and unhealthy behaviours. Access to a high number of fast food restaurants may encourage greater consumption of fast food products. The distribution of fast food restaurants at a state-level has not previously been reported in Australia. Using the location of 537 fast food restaurants from four major chains (McDonald's, KFC, Hungry Jacks, and Red Rooster), this study examined fast food restaurant locations across the state of Victoria relative to area-level disadvantage, urban–regional locality (classified as Major Cities, Inner Regional, or Outer Regional), and around schools. Findings revealed greater locational access to fast food restaurants in more socioeconomically disadvantaged areas (compared to areas with lower levels of disadvantage), nearby to secondary schools (compared to primary schools), and nearby to primary and secondary schools within the most disadvantaged areas of the major city region (compared to primary and secondary schools in areas with lower levels of disadvantage). Adjusted models showed no significant difference in location according to urban–regional locality. Knowledge of the distribution of fast food restaurants in Australia will assist local authorities to target potential policy mechanisms, such as planning regulations, where they are most needed.

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Background

In recent years, there has been growing attention paid by researchers, land-use planners and policymakers to the number and types of food stores within neighbourhoods (Caspi, Sorensen, Subramanian & Kawachi, 2012; Fraser, Edwards, Cade & Clarke, 2010; Kent & Thompson, 2014; Ni Mhurchu et al., 2013; Story, Kaphingst, Robinson-O'Brien & Glanz, 2008). Environmental justice theories posit that communities experiencing greater levels of disadvantage have a disproportionate distribution of "good" and "bad" environmental features (Schlosberg, 2007). To understand the impact of these contextual injustices, epidemiological studies have sought to understand how neighbourhood-level food access may contribute to individuals' diet and health (Caspi et al., 2012; Giskes, van Lenthe, Avendano-Pabon & Brug, 2011; Ni Mhurchu et al., 2013).

Two recent reviews point to a number of studies that have focused specifically on the location of fast food restaurants, and identified characteristics of areas with high exposure to the expanding fast food industry (Fleischhacker, Evenson, Rodriguez & Ammerman, 2011; Fraser et al., 2010). Whilst definitions of a fast food restaurant have varied, with few exceptions, large-scale studies on fast food restaurant locations by socioeconomic characteristics have shown that these restaurants are more accessible in areas with greater socioeconomic disadvantage (Cummins, McKay & Macintyre, 2005; Macdonald, Cummins & Macintyre, 2007; Pearce, Blakely, Witten & Bartie, 2007; Powell, Chaloupka & Bao, 2007).

Only ten of the forty previously reviewed studies of fast food restaurant locations considered both urban and rural areas, again noting that the definition of what constitutes an urban or rural area varies (Fleischhacker et al., 2011). A nationwide study in the US found that compared to urban areas, fast food chains were more abundant in suburban areas but were less prevalent in rural regions (Powell et al., 2007). In New Zealand, meshblocks (small geographic unit with approximately 100 people) within the urban setting were located a median distance of 2 km from the nearest multinational fast food restaurant compared to a median distance of 31 km from meshblocks located in rural locations (Pearce et al., 2007).

Fast food restaurant access around schools has been examined in a number of studies, particularly in the US (Austin et al., 2005; Simon, Kwan, Angelescu, Shih & Fielding, 2008; Sturm, 2008;

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Walker, Block & Kawachi, 2014; Zenk & Powell, 2008). Secondary schools are generally reported to have greater access to fast food restaurants than schools with younger children attending (Simon et al., 2008; Sturm, 2008; Zenk & Powell, 2008). Similar to findings from studies focused on neighbourhood-level access, larger-scale studies have found fast food restaurants to be more accessible to schools located in lower income neighbourhoods and in urban areas, compared with higher income or rural neighbourhoods (Pearce et al., 2007; Zenk & Powell, 2008).

Studies previously conducted in Australia have also demonstrated greater access to fast food restaurants in more disadvantaged areas (Burns & Inglis, 2007; Reidpath, Burns, Garrard, Mahoney & Townsend, 2002). Reidpath and colleagues undertook the first study that investigated fast food restaurant locations within an Australian context, exploring the distribution across Melbourne (Australia's second largest city) (Reidpath et al., 2002). Data were collected at the postcode level on the number of fast food franchises from Australia's five largest chains (McDonald's, Pizza Hut, Kentucky Fried Chicken, Red Rooster, and Hungry Jack's). Results showed that the lowest income postcodes had 2.5 times more fast food restaurants per person compared to the highest income postcodes (Reidpath et al., 2002). In another study undertaken in the outer fringe of Melbourne, Burns and Inglis (2007) reported shorter travel times to the nearest fast food restaurant for those living in the most disadvantaged areas; however this study was limited to a single Local Government Area (LGA) and edge effects (i.e. stores outside of the LGA boundary) were not considered. Another Victorian study found a greater number of fast food restaurants in urban compared to rural areas (Thornton et al., 2012a), but that study focused only on areas with higher levels of socioeconomic disadvantage. Elsewhere in Australia, Turrell and Giskes (2008) found that residents of the most disadvantaged neighbourhoods tend to live more proximally to major fast food chains, but the number of stores per population did not differ by area-level disadvantage. To our knowledge, fast food restaurant location around schools has yet to be investigated in Australia.

Greater access to fast food chains translates into an environment with increased opportunities to purchase and consume such items (Brug, 2008; Thornton, Bentley & Kavanagh, 2009). As governments at the Federal, state, and local levels strive to find new ways to improve population health outcomes, a growing amount of attention has been directed towards potential environmental-level factors that may contribute to detrimental health. Whilst a number of other countries have produced large scale investigations on fast food restaurant distribution (Cummins et al., 2005; Macdonald et al., 2007; Maddock, 2004; Mehta & Chang, 2008; Pearce et al., 2007; Pearce, Hiscock, Blakely & Witten, 2009; Powell et al., 2007; Zenk & Powell, 2008), Australia to date has not. Given the current interest among researchers and policy makers in aspects of the built environment that potentially contribute to obesity, it is timely to update prior findings that have thus far been limited in scope. The present study includes a comprehensive assessment of the location of four of Australia's largest fast food chains across the whole state of Victoria, Australia. Fast food restaurant locations are considered at two geographic levels and assessed in relation to area-level disadvantage, urban/regional location, and around schools. This study concludes by offering insights into planning and policy mechanisms that may help control the proliferation of fast food restaurants within vulnerable communities.

Methods

Study area and geographic units

This study was conducted within the state of Victoria, Australia, the second most populous state (5,841,700 people as of June 2014; ~25% of the total Australian population (Australian Bureau of Statistics, 2014a)). Two geographic units were considered in this study: (1) Statistical Area Level 2 (SA2); and (2) Local Government Area (LGA). SA2s correspond to a boundary for which census data is released and therefore can be used to guide the provision of community services. LGAs relate to geographic areas that have the regulatory authority over local planning decisions. Population and geographic descriptors related to these two administrative units are presented in Table 1.

Fast food restaurant locations

Based on market research (Franchise Business, 2014), four leading fast food chains were chosen for this study: (1) McDonald's (ranked 1st for popularity; average of 2.7 visits per customer over 4 weeks; over 900 Australian stores); (2) KFC (ranked 2nd; average 1.9 visits; over 600 Australian stores); (3) Hungry Jacks (ranked 4th; average 2.2 visits; over 340 Australia stores); and (4) Red Rooster (ranked 6th; average 1.8 visits; over 360 Australian stores).

Reidpath et al. (2002) previously investigated these same four chains within Melbourne in addition to Pizza Hut. In the present study, Pizza Hut (ranked seventh) and Domino's Pizza (ranked fifth) were excluded since there are many other competing pizza outlets (chain and non-chain) in Victoria and as these stores often offer home delivery, location is of less relevance than for stores that can only be accessed by visiting. A further point of difference

Table 1
Description of study areas.

	Statistical Area Level 2 (SA2) ***n*=422**[a]				**Local Government Area (LGA)** ***n*=79**			
	Percentage of areas with FF restaurant present	**Mean (s.d.)**	**Median (IQR)**	**Min–max**	**Percentage of areas with FF restaurant present**	**Mean (s.d.)**	**Median (IQR)**	**Min–max**
Fast food (FF) restaurants	52.1	1.2 (1.6)	1 (0–7)	0–9	77.2	6.8 (7.6)	4 (0–26)	0–33
Population size		12,620 (6716)	11,466 (7201–17,248)	77–38,328		67,660 (60,410)	41,842 (15,953–111,312)	2995–252,347
Geographic area (km^2)		525.6 (1709.9)	18.3 (6.3–153.9)	1.3–21,570		2876 (3963)	1533 (114–4047)	8.6–22,083
Proportion of the population aged <25 years		31.5 (4.7)	31 (29–35)	15–51		30.7 (3.7)	31 (28–34)	21–38

[a] *n* based on areas without missing IRSD values and excluding Melbourne CBD and Melbourne Airport.

is these outlets don't have products that are available for immediate purchase and consumption. Subway (ranked third) was also excluded on the basis that they offer a substantially different product to the other chains and rarely have a drive-through service, which is an important factor that influences the location of the other chain stores.

Address information for each of the four chains were sourced in December 2013 through the companies' websites and hence minimal errors in locational data were anticipated. However when required, addresses were verified through other sources such as telephone directories, Google Maps, and field validation. These multiple approaches to address validation helped reduce possible errors associated with using secondary data sources (Fleischhacker, Evenson, Sharkey, Pitts & Rodriguez, 2013; Thornton, Pearce & Kavanagh, 2011). A total of 537 fast food restaurants from the four chains were identified in Victoria. All addresses were geocoded in ArcGIS 10.1 (ESRI, 2012).

Area-level socioeconomic disadvantage

The 2011 Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD) is an area-level index that measures levels of socioeconomic disadvantage based on data collected during the 2011 census (Australian Bureau of Statistics, 2013). The IRSD is calculated on a number of factors including education, employment status, occupation, English-speaking ability, car ownership, and income. A small percentage of areas where the population is too low or the data are not of sufficient quality do not have a SEIFA score. SEIFA data for the administrative units investigated were sourced from the Australian Bureau of Statistics (ABS) website (Australian Bureau of Statistics, 2013). State specific deciles are provided and were used for analysis as recommended by the ABS (Australian Bureau of Statistics, 2013).

Using the geocoded fast food data and digital geographic boundary data sourced from the ABS website (Australian Bureau of Statistics, 2011), a spatial join in ArcGIS 10.1 (ESRI, 2012) was used to determine the number of fast food restaurants that were located within boundaries of the geographic areas for each of the two levels.

Measure of urban–regional locality

The urban–regional classification was based on the Accessibility and Remoteness Index of Australia (ARIA) (Australian Bureau of Statistics, 2014b). The ARIA+ iteration of this measure was used as this is an ABS endorsed measure of "Remoteness Structure". Briefly, the index provides a relative measure of access to service centres from populated localities. Across Australia, six classes of remoteness exist: Major Cities of Australia, Inner Regional Australia, Outer Regional Australia, Remote Australia, Very Remote Australia and Migratory. The index is measured in grids of 1 km and was aggregated to SA2 level geographic units. SA2s were viewed as an appropriately-sized administrative unit at which to assess the distribution of fast food restaurants by urban–regional locality as they are small enough to reflect the urban–regional characteristics of an area but large enough to be a catchment area for fast food restaurant placement. As ARIA data are provided in 1 km grids, the average of the grid scores within an SA2 unit was used for classification. SA2s in this study fell into three of the six classes: Major Cities, Inner Regional, and Outer Regional.

School locations

School location data are managed by the Victorian Department of Education and Training and were sourced from the Victorian Government data website (www.data.vic.gov.au). The dataset contains attributes that allowed us to create three mutually exclusive categories of schools: primary school only (students aged ~5 to 12 years), schools that teach both primary/secondary, and secondary school (students aged ~13 to 18 years) only. Using ArcGIS 10.1 (ESRI, 2012), school location was matched to polygon data (school boundary) and this was converted to points at every 50 m. If a point was within 50 m of a road network it was considered an access point to the school. This method gives a more appropriate measure of distance to a school than a single point which can bias estimates by several hundred metres. Proximity data were based on the shortest path between a fast food restaurant and a school access point. Road network service areas were created from the school access points and merged for each school at distances of 0.5 km, 1 km and 2 km. Counts of fast food restaurants within these service areas were calculated. We have previously demonstrated that inferences related to the role of the food environment in influencing eating behaviours may be sensitive to the buffer measure chosen (Thornton et al., 2012b). The buffer distances for this study were chosen to reflect access within both a walkable distance and a short drive from the school as car drop-off/pick-up is a popular form of transport amongst Victorian school children (Carver, Watson, Shaw & Hillman, 2013).

The socioeconomic classification of a school was based on the IRSD score of the SA2 within which it was located. Analysis of the relationship between IRSD of schools and fast food restaurants was restricted to SA2s within the major cities classification and also to only schools classified as either primary or secondary. This was deemed appropriate as stores in regional areas may be more strongly influenced by the presence of major thoroughfares and population locality. SA2s within the major cities region had an average population of 14,545 and many students attend the nearest (or another nearby) school due to school zonings (which limit which public school students can attend based on their residential location). Therefore, the IRSD of the SA2 within which the school was located is likely to reasonably represent the neighbourhood socioeconomic status of families whose children attend that school. Limiting school type to those classified as only primary or secondary means the two major school types are represented and, more importantly, the school types used distinguish students by age (primary school ages 5–12 years; secondary school ages 13–18 years), something that we could not assess with combined primary/secondary schools. Analysis of fast food restaurant access by area-level disadvantage differs from the analysis of access by area-level disadvantage within administrative units as it considers proximity from schools to the nearest outlet and a count of outlets within 1 km rather than a count within the administrative unit boundary.

Covariates

Total population, geographic area in square kilometres, and the proportion of the population aged <25 years were sourced from the census data available from the ABS for each geographic unit included in this study. The size and number of people in an area could plausibly be associated with the distribution of fast food restaurants because these two factors would capture a larger geographic region and greater customer market base, respectively. The proportion of the population under 25 years was also included as it was posited that this is the age group likely to form the majority of the customer base for these chain fast food restaurants based on prior Australian work (on a sample aged 14 years and older) which found fast food consumption decreased with increasing age (Mohr et al., 2007).

Analysis

Descriptive statistics on the characteristics of the study areas are presented in Table 1. Included in this table are the SA2 areas that did not have missing IRSD values (missing=9/433) and all LGAs (no missing values). Also excluded from the analysis at the SA2 level were the SA2 that encompassed Melbourne Airport ($n=1$) and the SA2 that included the Melbourne Central Business District (CBD) ($n=1$). The airport was excluded because many of the listed stores are located within the airport terminals and are therefore not accessible to the public. Exclusion of the CBD area was based on the fact that this area mainly services visitors and the higher number of fast food restaurants ($n=18$; next highest=9) would bias findings. For the analysis at the LGA level, the LGAs that included the airport and CBD area were retained as they encompass a larger area around the airport and CBD, respectively. However, stores located inside the airport terminal were excluded on the basis they are inaccessible to anyone who is not using the airport on a given day. The final number of areas included was 422 SA2s and 79 LGAs.

To examine differences in fast food restaurant access by IRSD, logistic regression was used to model presence (no/yes) within each area and Poisson regression was used to model the number in each area, with IRSD (deciles) used as the predictor variable (Table 2). Separate models were fitted for access at the SA2 and LGA levels. Robust standard errors were used to account for mild violations of the underlying modelling assumptions since overdispersion was present in the distribution of the number of fast food restaurants. The estimated percentage of units with a fast food restaurant and mean number for each IRSD decile were calculated using estimated marginal means. Adjusted models accounted for the administrative units' geographic size, population and percentage of the population aged under 25 years. Statistically significant differences within predictor categories were based on comparison to the most disadvantaged decile. The odds ratios (ORs) and incidence rate ratios (IRRs) estimated from the logistic and Poisson regression models of the associations between fast food restaurant access (presence and number, respectively) and IRSD deciles are presented in Figs. 1 and 2, alongside corresponding 95% confidence intervals (CIs). These figures show the patterns in the associations, allowing comparison of the patterns at the different geographical unit levels.

Differences across major cities, inner regional and outer regional areas were only considered at the SA2 level due to the small number of LGAs. The modelling approach outlined above was repeated for subsequent analyses presented in Table 3 (with urban–regional locality used as the predictor variable). The approach was also used for Table 4 (with school type used as the predictor variable) and Table 5 (with IRSD decile used as the predictor and analysis restricted to the major city area and stratified by primary/secondary schools); however, as counts within buffers of the same size rather than administrative units were used in analyses for schools, the models were not adjusted. In Tables 4 and 5, tests for statistically significant differences in the median values (for proximity to fast food restaurant) were determined using the Wilcoxon–Mann–Whitney test.

Within the adjusted models (Tables 2 and 3), there was no evidence of spatial auto-correlation in the residuals. Therefore, it was not necessary to control for this in the analysis. All analyses were conducted using Stata 13.1 (StataCorp, 2013). Figures were created using R version 3.1.3 (R Core Team, 2015).

Results

SA2s had a median geographic size of 18 km^2 and a median population of ~11,500 people, with an average of 31% of the population aged 25 years or less (Table 1). Over half of the SA2s had at least one fast food restaurant. LGAs are larger administrative units with a median size and population of > 1500 km^2 and ~42,000 people, respectively, and again with an average of 31% aged 25 years or less. Just over three quarters of LGAs had at least one fast food restaurant, with an average of seven fast food restaurants per LGA.

Presence and number of fast food restaurants by area-level disadvantage

At the SA2 level, 80% of areas in the most disadvantaged decile had at least one fast food restaurant compared to only 29% in the

Table 2
Distribution of fast food restaurants by area-level disadvantage within Statistical Area Level 2 and Local Government Areas.

SEIFA IRSD	Statistical Area Level 2 (SA2)					Local Government Area (LGA)				
	n (%[a])	**Unadj. % with FF (s.e.)[b]**	**Adj. % with FF (s.e.)[b]**	**Unadj. mean no. FF (s.e.)[c]**	**Adj. mean no. FF (s.e.)[c]**	**n (%)**	**Unadj. % with FF (s.e.)[b]**	**Adj. % with FF (s.e.)[b]**	**Unadj. mean no. FF (s.e.)[c]**	**Adj. mean no. FF (s.e.)[c]**
Decile 1 (Most disadv.)	44 (10.4)	79.5 (6.1)	72.6 (5.8)	2.07 (0.27)	1.79 (0.22)	8 (10.1)	75.0 (15.4)	76.1 (12.3)	7.88 (3.46)	9.31 (0.72)
Decile 2	41 (9.7)	58.5 (7.7)*	65.1 (6.9)	1.27 (0.24)*	1.36 (0.23)	8 (10.1)	75.0 (15.4)	63.1 (16.9)	5.50 (2.91)	7.14 (0.92)
Decile 3	44 (10.4)	38.6 (7.3)***	48.3 (6.6)**	1.16 (0.27)*	1.57 (0.24)	9 (11.4)	77.8 (14.0)	75.1 (14.9)	2.78 (0.96)	9.93 (2.29)
Decile 4	41 (9.7)	48.8 (7.8)**	60.2 (5.9)	1.20 (0.23)*	1.50 (0.24)	7 (8.9)	71.4 (17.2)	68.1 (14.0)	5.00 (1.61)	7.71 (1.28)
Decile 5	41 (9.7)	46.3 (7.8)**	50.5 (6.6)*	1.15 (0.26)*	1.28 (0.23)	8 (10.1)	75.0 (15.4)	78.9 (16.6)	7.38 (2.89)	6.61 (0.52)***
Decile 6	43 (10.2)	60.4 (7.5)	60.2 (6.5)	1.53 (0.28)	1.47 (0.23)	8 (10.1)	62.5 (17.2)	61.4 (14.5)	4.63 (1.84)	7.07 (1.04)
Decile 7	42 (10.0)	50.0 (7.7)**	48.8 (6.5)**	0.98 (0.22)**	0.96 (0.21)*	8 (10.1)	75.0 (15.4)	66.6 (18.8)	8.25 (3.19)	3.88 (0.81)***
Decile 8	43 (10.2)	53.5 (7.6)*	46.7 (6.4)**	1.16 (0.25)*	0.99 (0.22)*	8 (10.1)	75.0 (15.4)	83.2 (11.0)	12.00 (3.17)	10.07 (2.56)
Decile 9	42 (10.0)	54.8 (7.7)*	49.8 (5.4)**	0.90 (0.18)***	0.84 (0.14)***	9 (11.4)	100 (0.0)	100 (0.0)	8.56 (2.51)	7.25 (1.22)
Decile 10 (Least disadv.)	41 (9.7)	29.3 (7.1)***	25.8 (5.8)***	0.66 (0.22)***	0.57 (0.18)***	6 (7.6)	83.3 (15.3)	89.7 (8.7)	5.83 (1.17)	4.56 (1.24)**
	n (%)	**% with FF restaurant**	**Mean (s.d.)**	**Min–max**		**n (%)**	**% with FF restaurant**	**Mean (s.d.)**	**Min–max**	
Missing IRSD	9 (2.1)	22.2	0.33 (0.71)	0–2		0	–	–	–	

FF=fast food restaurant; SEIFA IRSD=Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD).

[a] % of non-missing values.

[b] *p*-value of difference compared to the most disadvantaged decile determined by logistic regression: * < 0.05; ** < 0.01; *** < 0.001.

[c] *p*-value of difference compared to the most disadvantaged decile determined by Poisson regression: * < 0.05; ** < 0.01; *** < 0.001.

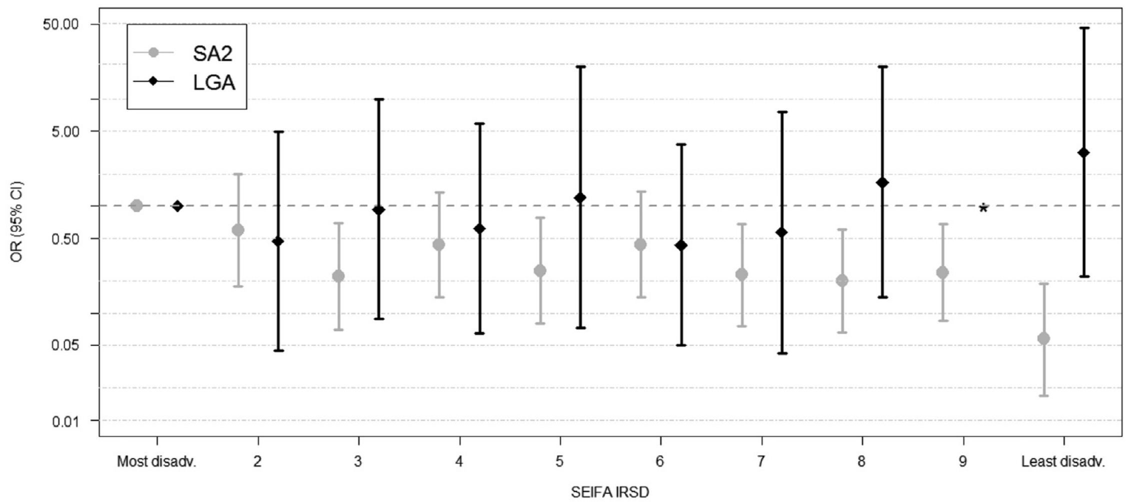

Fig. 1. Graph of odds ratios of having a fast food restaurants within a Statistical Area Level 2 (SA2) or Local Government Area (LGA) administrative unit by area-level disadvantage with 95% confidence intervals. *All LGAs in IRSD 9 had a fast food restaurant so OR not estimated.

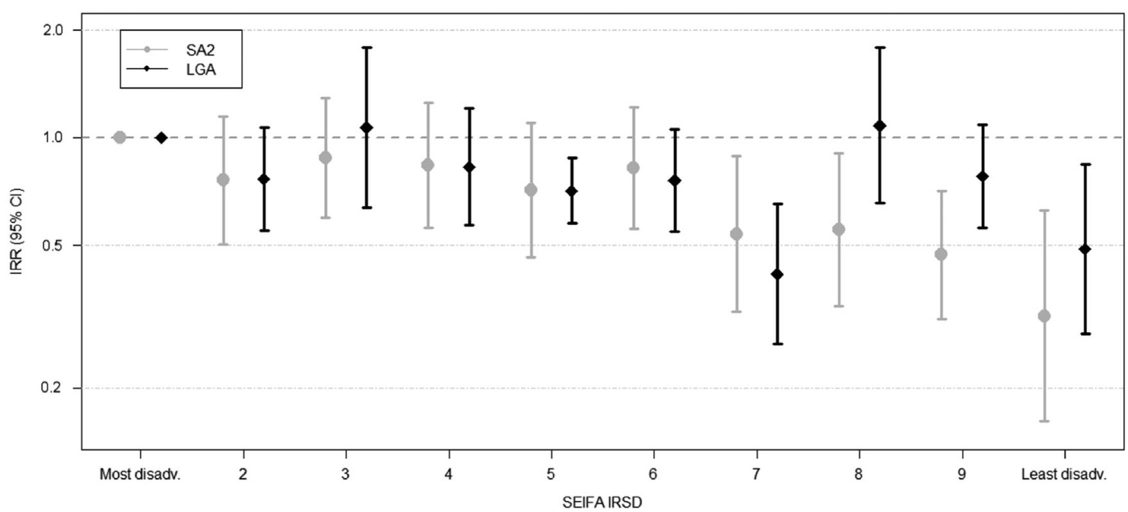

Fig. 2. Graph of incidence rate ratio (IRR) for count of fast food restaurants within a Statistical Area Level 2 (SA2) or Local Government Area (LGA) administrative unit by area-level disadvantage with 95% confidence intervals.

Table 3
Distribution of fast food restaurants within Statistical Area Level 2 by urban–regional locality.

	***n* (%)**	**Unadj. % with FF (s.e.)**[a]	**Adj. % with FF (s.e.)**[a]	**Unadj. mean no. FF (s.e.)**[b]	**Adj. mean no. FF (s.e)**[b]
Major city	277 (64.3)	62.1 (2.9)	50.4 (2.8)	1.45 (0.10)	1.14 (0.08)
Inner regional	119 (27.6)	37.0 (4.4)***	54.2 (3.8)	0.83 (0.13)***	1.48 (0.22)
Outer regional	35 (8.1)	17.1 (6.4)***	52.3 (8.2)	0.43 (0.17)**	1.29 (0.27)

FF = fast food restaurant.

[a] *p*-value of difference compared to major city areas determined by logistic regression: * < 0.05; ** < 0.01; *** < 0.001.
[b] *p*-value of difference compared to major city areas determined by Poisson regression: * < 0.05; ** < 0.01; *** < 0.001.

least disadvantaged areas (Table 2). However, the percentage did not consistently decrease with decreasing disadvantage. The most disadvantaged decile (decile 1) also had the highest mean number of fast food restaurants (mean = 2.07) with the lowest mean number observed in the two least disadvantaged deciles (decile 9: mean = 0.90; decile 10: mean = 0.66). These results held after adjustment for geographic size, population and percentage of the population under the age of 25 years (decile 1: mean = 1.79; decile 9: mean = 0.84; decile 10: mean = 0.57).

At the LGA level, there was no evidence of a difference between IRSD deciles in either the presence of a fast food restaurant or the mean number of fast food restaurants in unadjusted analyses (Table 2). However, after adjustment, there was evidence to suggest that compared to the most disadvantaged decile

Table 4
Access to fast food restaurants around schools by school type.

	n (%)	Proximity (km)	FF within 0.5 km		FF within 1 km		FF within 2 km	
		Median (IQR)[a]	% with FF (s.e.)[b]	Mean (s.e.)[c]	% with FF (s.e.)[b]	Mean (s.e.)[c]	% with FF (s.e.)[b]	Mean (s.e.)[c]
All schools	2343	2.07 (1.10–10.43)	7.1 (0.5)	0.09 (0.01)	25.3 (0.9)	0.35 (0.02)	49.1 (1.0)	1.21 (0.04)
Primary	1640 (70.0)	2.36 (1.20–14.08)	5.6 (0.6)	0.08 (0.01)	22.5 (1.0)	0.29 (0.02)	44.8 (1.2)	1.07 (0.04)
Combined	237 (10.1)	2.07 (1.21–4.74)	5.5 (1.5)	0.07 (0.02)	19.8 (2.6)	0.34 (0.05)	48.1 (3.2)	1.00 (0.09)
Secondary	466 (19.9)	1.49 (0.80–2.66)***	13.1 (1.6)***	0.17 (0.02)***	38.0 (2.2)***	0.56 (0.04)***	64.8 (2.2)***	1.79 (0.11)***

FF=fast food restaurant.

[a] *p* value of difference compared to primary schools determined using the Wilcoxon–Mann–Whitney test: * < 0.05; ** < 0.01; *** < 0.001.
[b] *p*-value of difference compared to primary schools determined by logistic regression: * < 0.05; ** < 0.01; *** < 0.001.
[c] *p*-value of difference compared to primary schools determined by Poisson regression: * < 0.05; ** < 0.01; *** < 0.001.

Table 5
Distribution of fast food restaurants around schools in major city areas by area-level disadvantage (based on Statistical Area Level 2 that school is within).

SA2 SEIFA IRSD	Major city							
	Primary schools *n*=901				Secondary schools *n*=296			
	n (%)	Proximity (median (IQR))[a]	% with FF outlet within 1 km (s.e.)[b]	Mean no. of outlets within 1 km (s.e.)[c]	*n* (%)	Proximity (median (IQR))[a]	% with FF outlet within 1 km (s.e.)[b]	Mean no. of outlets within 1 km (s.e.)[c]
Decile 1 (Most disadv.)	118 (13.1)	1.27 (0.87–1.85)	46.6 (4.6)	0.58 (0.09)	42 (14.2)	1.00 (0.61–1.49)	61.9 (7.5)	0.95 (0.18)
Decile 2	65 (7.2)	1.35 (0.75–1.84)	38.5 (6.0)	0.43 (0.08)	21 (7.1)	1.12 (0.91–1.70)	57.1 (10.8)	0.52 (0.13)
Decile 3	42 (4.7)	1.18 (0.75–1.88)	57.1 (7.6)	0.71 (0.16)	14 (4.7)	1.02 (0.55–1.38)	71.4 (12.1)	0.93 (0.33)
Decile 4	51 (5.7)	1.57 (0.83–2.24)	33.3 (6.6)	0.49 (0.12)	20 (6.8)	0.97 (0.53–1.43)	60.0 (11.0)	0.95 (0.23)
Decile 5	73 (8.1)	1.63 (1.01–2.28)*	27.4 (5.2)**	0.37 (0.09)	27 (9.1)	1.56 (0.87–1.97)*	40.7 (9.5)	0.37 (0.13)**
Decile 6	93 (10.3)	1.48 (1.00–2.21)	26.9 (4.6)**	0.38 (0.08)	30 (10.1)	0.99 (0.46–1.48)	56.7 (9.1)	0.83 (0.18)
Decile 7	101 (11.2)	1.61 (0.95–2.88)*	33.7 (4.7)	0.41 (0.08)	26 (8.8)	1.01 (0.50–1.89)	50.0 (9.8)	1.00 (0.23)
Decile 8	109 (12.1)	1.68 (1.06–2.78)***	27.5 (4.3)**	0.32 (0.07)*	36 (12.2)	1.51 (0.91–2.15)*	30.6 (7.7)**	0.42 (0.13)*
Decile 9	130 (14.4)	1.81 (1.17–2.61)***	23.8 (3.7)***	0.30 (0.07)*	35 (11.8)	1.42 (0.80–1.99)*	40.0 (8.3)	0.51 (0.15)
Decile 10 (Least disadv.)	119 (13.2)	2.11 (1.28–3.07)***	21.0 (3.7)***	0.19 (0.04)***	45 (15.2)	1.97 (1.27–2.46)***	17.8 (5.7)***	0.22 (0.08)***

FF=fast food restaurant; SA2=Statistical Area Level 2; SEIFA IRSD=Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD).

[a] *p* value of difference compared to the most disadvantaged decile determined using the Wilcoxon–Mann–Whitney test: * < 0.05; ** < 0.01; *** < 0.001.
[b] *p*-value of difference compared to the most disadvantaged decile determined by logistic regression: * < 0.05; ** < 0.01; *** < 0.001.
[c] *p*-value of difference compared to the most disadvantaged decile determined by Poisson regression: * < 0.05; ** < 0.01; *** < 0.001.

(mean=9.31), lower mean numbers of fast food restaurants were found in decile 5 (mean=6.61), decile 7 (mean=3.88), and the least disadvantaged decile (decile 10: mean=4.56).

The ORs (fast food restaurant presence) and IRRs (fast food restaurant count) from adjusted models of access by deciles of area-disadvantage for both SA2s and LGAs are presented in Figs. 1 and 2, respectively. The difference in the associations for SA2s and LGAs, both in terms of presence and number, are clearly demonstrated in these figures.

Presence and number of fast food restaurant with SA2s by urban–rural locality

Unadjusted analyses showed that inner and outer regional areas had both fewer SA2s with a fast food restaurant present (inner: 37%; outer: 17%) and a lower count on average (inner regional: mean=0.8; outer regional: mean=0.4) than SA2s within major cities (62%; mean=1.5) (Table 3). However, after adjusting for population, geographic area and proportion of the population aged <25 years, we found no evidence of a difference in either fast food restaurant presence or mean number. Additional testing showed that the association between higher levels of disadvantage and counts of fast food restaurants persisted in the major city and inner regional areas but no relationship was detected for outer regional areas (results not shown).

Fast food restaurant access around schools

Across the state the median distance from schools to the nearest fast food restaurant was 2.07 km (Table 4). Compared to primary schools, secondary schools had greater access to fast food whereas no difference was observed amongst schools that had combined primary/secondary age groups (Table 4). Subsequent testing revealed that schools in the major city areas had a shorter proximity and higher count of fast food restaurants within 0.5 km, 1 km, and 2 km than schools in inner regional and outer regional areas (results not shown). For example, the median proximity to the nearest fast food restaurant was 1.52 km in major city areas, 10.63 km in inner regional areas, and 37.49 km in outer regional areas.

Differences in fast food restaurant location from schools in major city areas by area-level disadvantage

For both primary and secondary schools in major city areas, the median proximity to the nearest fast food restaurant was furthest in the least disadvantaged areas (primary: 2.11 km (IQR 1.28–3.07); secondary: 1.97 km; IQR 1.27–2.46) and was significantly greater than the distance from schools in the most disadvantaged areas (primary: 1.27 km (IQR 0.87–1.85); secondary: 1.00 km; IQR 0.61–1.49) (Table 5). Compared to the most disadvantaged decile (47%), a lower percentage of primary schools were found to have a fast food restaurant within 1 km in decile 5 (27%), decile 6 (27%), decile 8 (28%), decile 9 (24%) and the least disadvantaged decile, 10 (21%). The mean number of fast food restaurants within 1 km of primary schools was lower in decile 8 (mean=0.32), decile 9 (mean=0.30) and the least disadvantaged areas (decile 10: mean=0.19) compared to schools in the most disadvantaged areas (decile 1: mean=0.58). The highest proportion of secondary schools with a fast food restaurant within 1 km was found in decile 3 (71%). Compared to the most disadvantaged decile (62%), decile 8 (31%) and the least disadvantaged decile (18%; the lowest percentage of any decile) had a significantly lower percentage of secondary schools with a fast food restaurant within 1 km. The least disadvantaged decile had the lowest mean number of fast food restaurants within 1 km of secondary schools (decile 10: mean 0.22). This was significantly lower than the most disadvantaged decile (decile 1: mean=0.95) and secondary schools in decile 5 (mean=0.37) and decile 8 (mean=0.42).

Discussion

This study has provided a comprehensive assessment of chain-brand fast food restaurant locations across the state of Victoria relative to area-level disadvantage, urban–regional locality, and around schools. This is the first large-scale (state-level) study of fast food restaurant location in Australia. Associations between greater area-level disadvantage and higher fast food restaurant exposure were more apparent within the smaller, more homogenous SA2 level areal units than at LGA level, even once factors likely to influence the raw count were adjusted for (namely population, geographic size, and the percentage of the population aged <25 years). Although patterns were less apparent at the LGA level, results revealed a state-wide average of almost seven fast food restaurants per LGA. This is important to note as planning approval for fast food restaurants are made by the governing authority of this level (in accordance with the state planning framework).

This study's results support evidence from prior international investigations across large-areas that are limited to major fast food chains (Cummins et al., 2005; Macdonald et al., 2007; Pearce et al., 2007). However, given known differences exist with regards to other aspects of the food environment between developed nations, large-scale quantification of this within Australia is long overdue; particularly given that prior Australian studies that have included measures of fast food restaurant location have been limited in their scope (Burns & Inglis, 2007; Reidpath et al., 2002; Thornton et al., 2012a).

With the majority of food environment studies in recent years being focused on socioeconomic inequalities, exploration of urban–regional differences remain rare. Results indicate a higher mean number of fast food restaurants in the major city area compared to inner regional and outer regional areas but this difference did not remain once the administrative units' geographic size, population and percentage of the population under the age of 25 years were adjusted for. Our study could not differentiate suburban areas from urban areas within the major cities category like prior work from Powell et al. (2007); nor did it have a measure of proximity from neighbourhoods like Pearce et al. (2007). In subsequent analysis however, our study explored school access by urban–regional locality, finding, like Pearce et al. (2007), that schools in major city (urban) areas were more proximate to fast food restaurants than schools in non-urban settings.

To the authors' knowledge, there is no published data from Australia on chain fast food restaurant locations relative to schools. The present study shows a closer proximity to and greater density of fast food restaurants near secondary schools compared to primary schools. Prior work from the US also found that fast food restaurants were more prominent around high schools (~student age 14–18 years) compared to middle schools (~student age 11–14 years) (Zenk & Powell, 2008). This is likely to be a reflection of the fact pupils attending secondary schools are generally of an age where they have their own money, utilise fast food restaurants as a social gathering place, and have greater independence in terms of their travel patterns, with each of these factors making them more likely to be potential customers than younger children who are more reliant on their parents/carers. Furthermore, Australian schools tend to not have a school-provided meal system meaning those who do not bring lunch from home would potentially purchase food. This may occur on or off school grounds depending on whether the school has food available for purchase and the rules in relation to allowing students to go off-site.

In the present study we undertook further testing to explore whether fast food restaurant access around schools differed by area-level of disadvantage of schools in major city areas. Within the major city areas, primary and secondary schools located within more disadvantaged neighbourhoods were located nearer to and had access to more fast food restaurants within 1 km. These results are consistent with international findings that have shown fast food restaurants were more often located around schools in larger cities (Zenk & Powell, 2008) and around schools in areas with lower income/higher levels of deprivation (Day & Pearce, 2011; Pearce et al., 2007; Zenk & Powell, 2008); although the association was less apparent in the urban setting of Glasgow (Ellaway et al., 2012).

Land-use planning as a way to manage fast food restaurant proliferation

Results of these analyses can usefully inform efforts to develop mechanisms to manage future fast food restaurant developments and proliferation in vulnerable communities. Many new fast food restaurants are approved in an uncontroversial manner and may be seen as a positive for the community due to potential benefits such as encouraging youth employment. However, currently Victoria's planning system means that local authorities have little scope to control the location and density of convenience restaurants. Thus, proposals for new fast food restaurant developments that local authorities do not view as appropriate (e.g. those near a school or in an area with a large number of existing fast food restaurants and limited healthy food retailers) are still likely to be approved under current planning laws in Victoria (Taylor, 2015).

Kent and Thompson (2014) discuss three urban planning domains related to health and well-being: (1) physical activity; (2) community interaction; and (3) healthy eating. Focusing on areas surrounding schools, the authors state "…planning processes can, through land use zoning and regulation, influence the types of uses near educational establishments, including the density of fast-food outlets" (p. 247). As there is no single planning system that operates in Australia, each State and Territory is responsible for its own planning system and these change over time. In Victoria, the main instrument used to manage land uses at the local level is the planning scheme. This consists of a hierarchy, including state policy which is applicable to every municipality, and separate local considerations that are relevant to the municipality in question. Currently in Victoria there is no specific clause pertaining to fast food restaurant exclusion zones around schools, and whilst other planning mechanisms may exist to achieve this goal, their applicability to this specific situation is largely untested. A specifically developed planning mechanism of school-fast food exclusion zones will require the support from a number of different government departments, both at local and state government level. This, however, seems unlikely to be achieved in the current climate, with recent changes meaning some land uses that were previously deemed discretionary or prohibited are now permissible without planning approval. Consistent with national planning reform in Australia, this move has further eroded the power of local planners in Victoria and is described as favourable to those seeking to develop (Buxton & Goodman, 2014).

Internationally, moves are afoot to ensure land-use planning is a primary tool for managing fast food restaurant developments. A US review found that land use regulations have been successfully used as a public health tool to control the location and operation of retail alcohol, tobacco and firearm outlets in the community (Ashe, Jernigan, Kline & Galaz, 2003). It is believed that these same powers can be applied to limit fast food restaurant development within a community through, for example, restrictions on drive-through service and requirements that outlets locate a minimum distance from youth-orientated facilities such as schools and playgrounds (Ashe, Graff & Spector, 2011; Ashe et al., 2003). The ability of the City of Los Angeles to successfully introduce a control ordinance that prohibited new fast food developments in South Los Angeles (Office of the City Clerk, City of Los Angeles, 2008) is in stark contrast to the lack of control that local planning authorities face in Victoria and indeed, much of Australia.

In the UK, a strategic document aimed at local authorities called the "Takeaways Toolkit" was released in November 2012 by the Greater London Authority (The Mayor of London, 2012). This document provided advice to local authorities on how to control the sale of takeaway food in their local area. A subsequent overview of the planning system in relation to fast food restaurants considered how health promotion can use planning as a tool to enhance healthy eating choices and identified specific examples such the introduction of bans on the development of new outlets within 400 m of schools (Caraher, O'Keefe, Lloyd & Madelin, 2013). While community responses to such initiatives have not been investigated in Australia, evidence from elsewhere suggests these approaches would have community support (Sallis & Glanz, 2006).

Strengths and limitations

To our knowledge, this study is the first state-wide analysis of fast food restaurant locations in Australia relative to area-level disadvantage, urban–regional locality, and to schools. In addition, this study provides commentary on the current planning mechanisms related to fast food restaurant development in Victoria and elsewhere which contributes to the policy discussion.

Whilst only four chains were examined (underestimating the total exposure to fast food restaurants and other takeaway food sources), the data sourcing methodology meant this study had valid measures of fast food restaurant locations and investigated fast food chains that made it comparable and consistent with prior work (Macdonald et al., 2007; Reidpath et al., 2002). This study did not attempt to measure how access influences consumption and health. Further, the cross-sectional design does not allow us to test whether fast food restaurant locations are driven by demand or whether supply and increased environmental opportunities to access these products locally is driving demand. We did, however, control for factors that may explain the higher distribution in some areas (population, geographic size, percentage of the population aged <25 years) allowing us to better isolate potential associations with area-level socioeconomic disadvantage and urban–regional locality. Few prior studies have adjusted for other factors likely to influence location, with one exception being a US study where environmental factors (e.g. alcohol outlet density, presence of interstate or major state highways and median home value as a proxy for property values) were adjusted for to help understand the associations between fast food restaurant density and both income and race (Block, Scribner & DeSalvo, 2004). A further limitation of our study is that the analysis for area-level disadvantage and urban–regional locality was restricted to administrative units with no consideration of fast food restaurants within buffers around these units (although spatial autocorrelation was considered). Using administrative units also means results are subject to the modifiable areal unit problem (O'Sullivan & Unwin, 2010). Finally, it must be kept in mind that individuals residing in these areas would have additional exposure to fast food restaurants beyond these areas.

Conclusion

Increased opportunities to access fast food restaurants in areas with greater levels of disadvantage and around schools may serve to shift norms towards unhealthy choices amongst vulnerable populations. Understanding the distributional patterns of fast food restaurants may assist authorities to target appropriate potential policy mechanisms, such as planning regulations, where they are most needed.

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