

# Variation in supermarket exposure to energy-dense snack foods by socio-economic position

Adrian J Cameron\*, Lukar E Thornton, Sarah A McNaughton and David Crawford

Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Deakin University, 221 Burwood Highway, Burwood, Victoria 3125, Australia

Submitted 23 November 2011: Final revision received 10 April 2012: Accepted 13 April 2012: First published online 22 May 2012

## Abstract

**Objective:** The present study aimed to examine the availability of energy-dense, nutrient-poor snack foods (and fruits and vegetables) in supermarkets located in socio-economically advantaged and disadvantaged neighbourhoods.

**Design:** Cross-sectional supermarket audit.

**Setting:** Melbourne, Australia. Measures included product shelf space and number of varieties for soft drinks, crisps, chocolate, confectionery and fruits and vegetables, as well as store size.

**Subjects:** Thirty-five supermarkets (response 83%) from neighbourhoods in the lowest and highest quintile of socio-economic disadvantage.

**Results:** Shelf space allocated to soft drinks (23.6 m *v.* 17.7 m,  $P=0.006$ ), crisps (16.5 m *v.* 13.0 m,  $P=0.016$ ), chocolate (12.2 m *v.* 10.1 m,  $P=0.022$ ) and confectionery (6.7 m *v.* 5.1 m,  $P=0.003$ ) was greater in stores from socio-economically disadvantaged neighbourhoods. After adjustment for store size (stores in disadvantaged areas being larger), shelf space for confectionery (6.3 m *v.* 5.6 m,  $P=0.024$ ) and combined shelf space for all energy-dense foods and drinks (55.0 m *v.* 48.9 m,  $P=0.017$ ) remained greater in stores from socio-economically disadvantaged neighbourhoods. The ratio of shelf space allocated to fruits and vegetables to that for energy-dense snack foods also varied by socio-economic disadvantage after adjustment for store size (most disadvantaged *v.* least disadvantaged: 1.7 *v.* 2.1,  $P=0.025$ ). Varieties of fruits and vegetables and chocolate bars were more numerous in less disadvantaged areas ( $P<0.05$ ).

**Conclusions:** Exposure to energy-dense snack foods and soft drinks in supermarkets was greater in socio-economically disadvantaged neighbourhoods. This may impact purchasing, consumption and cultural norms related to eating behaviours and may therefore work against elimination of the known socio-economic gradient in obesity levels. Reform of supermarket stocking practices may represent an effective means of obesity prevention.

**Keywords**  
Snack food  
Socio-economic status  
Disadvantage  
Supermarket

The increases in energy intake and obesity levels observed in many countries over recent decades have occurred in parallel with increased snacking behaviour<sup>(1,2)</sup>. One key factor that may have contributed to the increase in snacking behaviour is greater opportunity to purchase snack foods<sup>(3)</sup>. In urban residential environments, opportunities to purchase snack foods are influenced both by exposure to those food outlets that stock these products (known as the 'community nutrition environment') as well as by exposure to features within stores that impact on purchasing decisions, including the availability, variety, price, placement and promotion of snack foods (known as the 'consumer nutrition environment')<sup>(4)</sup>. A link between food availability and purchasing behaviour has previously been demonstrated,

with Cheadle *et al.* reporting a strong relationship between the availability of healthy products such as low-fat milk and their consumption by individuals living nearby<sup>(5)</sup>.

Supermarkets form an important component of the nutrition environment. In Australia, 63% of all food spending occurs in supermarkets<sup>(6)</sup>, with the two dominant supermarket chains (ranked the 20th and 23rd largest global retailers)<sup>(7)</sup> having a 68% market share of all supermarket and liquor retail sales<sup>(6)</sup>. In relation to snack foods, previous reports suggest that almost twice as much supermarket shelf space is dedicated to unhealthy snack foods in comparison to fruits and vegetables in some US supermarkets<sup>(8)</sup>. Given the level of exposure to snack foods within supermarkets and the volume of sales

\*Corresponding author: Email adrian.cameron@deakin.edu.au

they generate, the nutrition environment of supermarkets has the potential to significantly influence the eating behaviours of populations.

Both the consumer and community nutrition environments are known to vary by area-level disadvantage<sup>(9)</sup>. These differences may either enhance or restrict the opportunity for local residents to eat healthily. Most previous research on supermarket food availability has focused on healthier items (e.g. fruits and vegetables), with some studies finding a relationship between level of disadvantage and variety of fruits and vegetables<sup>(10)</sup> but others failing to demonstrate this<sup>(11)</sup>. Shoppers at supermarkets in socio-economically disadvantaged neighbourhoods have been shown to purchase more snack foods than those in advantaged neighbourhoods<sup>(12)</sup>. Availability of energy-dense snack foods in supermarkets according to area-level disadvantage has been investigated in two previous studies, both from Australia. Neither study found any association between energy-dense snack food availability and area-level disadvantage<sup>(10,12)</sup>. Both studies had significant limitations, however, with one considering only the numbers of varieties of items present (measured categorically)<sup>(10)</sup> and the other considering shelf space in a limited sample of only nine supermarkets<sup>(12)</sup>.

The concept of behavioural justice<sup>(13)</sup> provides a helpful framework for the examination of exposure to energy-dense snack foods and drinks by level of socio-economic disadvantage. Behavioural justice suggests that 'no group should bear a disproportionate share of health problems resulting from inadequate resources for engaging in healthy behaviours'<sup>(14)</sup>. Although this definition focuses on the resources required for healthy behaviours, the same principles apply with regard to limiting environments that stimulate unhealthy behaviours. This justice model provides a conceptual link between the behaviours of the individual and the neighbourhood in which he/she exists, and focuses on the rights of the individual to an environment that does not harm his/her health. An environment dominated by easy access to energy-dense, nutrient-poor snack foods and limited access to fruits and vegetables can effectively stack the odds against achieving good nutrition and health.

A thorough examination of the way in which the supermarket energy-dense snack food and fruit and vegetable environments vary according to area-level socio-economic disadvantage has been lacking. Here, we report the findings of an audit undertaken in supermarkets from neighbourhoods of low and high levels of socio-economic disadvantage in Melbourne, Australia. The study explored differences in the availability of crisps (potato chips), chocolate, confectionery, soft drinks (both diet and regular) and mineral/soda water as well as fruits and vegetables. In addition, we tested whether the ratio of shelf space devoted to diet *v.* regular soft drinks was patterned by area-level socio-economic disadvantage.

## Methods

### Sampling

The present study was undertaken in urban neighbourhoods <30 km from the central business district (CBD) of Melbourne, Australia. Each neighbourhood within this radius (mean population 9280; mean area 7.8 km<sup>2</sup>) was ranked according to the Socio-economic Index for Areas (SEIFA) Index of Relative Social Disadvantage (IRSD) produced by the Australian Bureau of Statistics. The SEIFA IRSD is a measure of relative socio-economic position and is derived from disadvantage-related variables in the 2006 Census such as low income, low educational attainment, unemployment and dwellings without motor vehicles<sup>(15)</sup>. Low scores on this index indicate neighbourhoods with relatively greater disadvantage. We extracted the neighbourhood names from the highest and lowest quintiles of SEIFA IRSD and compiled a list of supermarkets from the two largest Australian supermarket retailers within these neighbourhoods. Stores from these two chains were chosen so that store types would be roughly comparable in the most and least disadvantaged areas, and because these two chains have a 68% market share of supermarket and liquor retail sales in Australia<sup>(6)</sup>. The location of all supermarket outlets was identified through company websites and other online directories (e.g. White Pages). We then randomly selected forty-two supermarkets to survey, stratified by level of neighbourhood disadvantage and supermarket chain. Of all the supermarkets from the two surveyed chains that are located in neighbourhoods from the top quintile of SEIFA IRSD <30 km of the Melbourne CBD (an area with a population of ~465 000), our sample included 50% and 82% of them from the two chains, respectively. Of all the supermarkets from the two surveyed chains that are located in neighbourhoods from the bottom quintile of SEIFA IRSD <30 km of the Melbourne CBD (an area with a population of ~687 000), our sample included 35% and 42% of them from the two chains, respectively.

### Audit tool development

An audit tool to assess the number of different product varieties and product shelf space was developed based on similar measures used in previous studies<sup>(8,10)</sup>. Two fieldwork staff members were trained within stores in the use of the audit tool and were provided with written instructions for its use. The project proposal was assessed by a Human Research Ethics Advisor from the Office of Research Integrity at Deakin University (ethics committee approval was unnecessary because it was not human research). Consent to take measurements was obtained from store managers, with consent being gained in 35/42 supermarkets (83.3%). Of the seven stores where consent was not gained, four were from the most disadvantaged neighbourhoods. Supermarket audits were carried out between 22 September 2010 and 19 November 2010 and

between 16 January 2011 and 16 February 2011. Although the measures included in the study are likely to be static (as opposed to dynamic displays such as end-of-aisle and island displays), the measurement period nevertheless avoided the Christmas/New Year period where displays of snack foods may be higher than normal. Sampling from the most and least disadvantaged areas was undertaken equally in both survey periods.

## Measures

### Snack foods

Our research was limited to food and beverages types that are usually consumed outside the three main meals and would be considered high in energy, low in micro-nutrients and (often) high in sodium. The total aisle length (in metres) dedicated to each of soft drinks, crisps, chocolate and confectionery was measured using a measuring wheel. Shelf space of several individual soft drink varieties was measured using a tape measure (this being a measure of individual shelves, rather than aisle length). The soft drink varieties chosen were those with the greatest shelf space in a pilot supermarket and in order to survey a representative sample of product types (i.e. both regular and diet soft drinks, two-litre bottles and 24-can bulk packs). No measure of total shelf space allocated to diet and regular soft drinks was possible because of the large number of product types of each, with diet and regular varieties interspersed within the same shelves (i.e. they were not stocked in separate sections). We were, however, able to assess the ratio of shelf space allocated to diet *v.* regular soft drinks using shelf space measurements of the individual diet and regular soft drink varieties included in the audit (effectively used as indicators of the total shelf space dedicated to regular and diet soft drinks). Shelf space allocated to natural mineral water or water, reduced-fat crisps and children's confectionery items (where a defined section existed, measured as height and width and presented as metres squared) was also measured using a tape measure. The children's confectionery section was measured as area (in metres squared) because the separate products were small and a mix of hanging bags and other types, meaning that this section did not typically have distinct shelves. The numbers of different varieties of soft drinks (diet and regular), crisps, chocolate (bars, blocks and hanging bags separately) and confectionery were counted using a hand-held counter. The number of children's toys hanging in the confectionery aisle was also counted (using a hand-held counter) so that an assessment of the degree to which the confectionery aisle is promoted to children could be made.

### Fruits and vegetables

The total length (in metres) of shelf, refrigerator and island displays dedicated to fresh fruits and vegetables

was measured using a measuring wheel. The number of different varieties of fruits and vegetables was counted using a hand-held counter. Two different types of the same fruits or vegetables (e.g. Granny Smith apple and Fuji apple) were counted as different varieties.

### Store size

Total store size was measured so that aisle length of snack foods could be adjusted for store size. This was calculated as total aisle length in metres, measured using a measuring wheel (for example, 11 aisles  $\times$  9 m each = 99 m total aisle length). The length and breadth of the store was not measured because of the reality that some stores were not square or rectangular in shape.

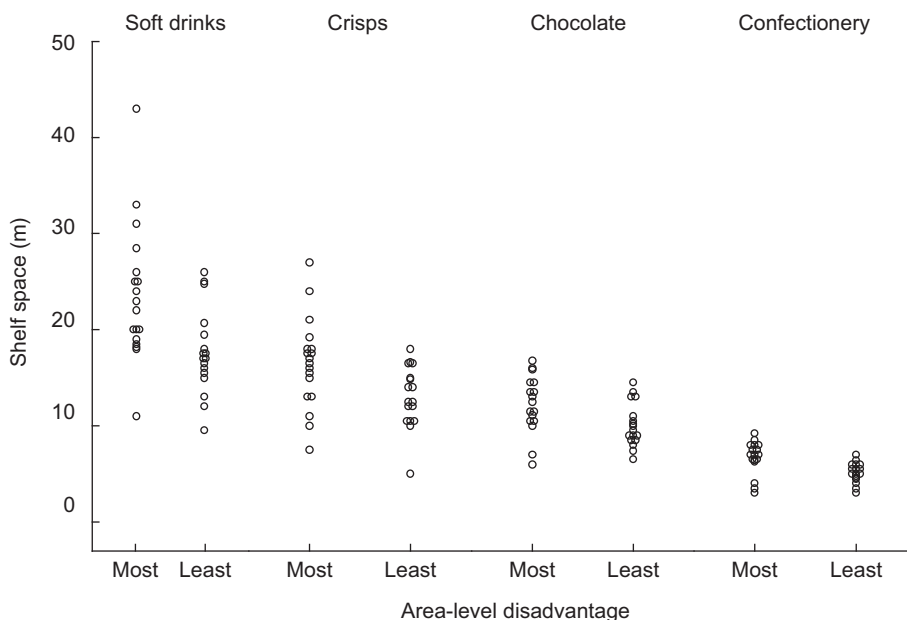
## Statistical analysis

Independent-sample *t* tests were used to compare differences in mean shelf space or number of varieties between stores in neighbourhoods from the top and bottom quintiles of relative socio-economic disadvantage. The distribution of shelf space for each of fruits and vegetables, soft drinks, crisps, chocolate and confectionery was plotted to provide a visual impression of the difference between stores. In order to account for the total size of the store, the estimated marginal mean number of varieties and shelf space for stores from the top and bottom quintiles of socio-economic disadvantage were calculated using models that also included a term for total store size. Statistical analysis was undertaken using the statistical software package SPSS Statistics version 19 (IBM Corp., Armonk, NY, USA).

## Results

Shelf space allocated to each of soft drinks (most disadvantaged *v.* least disadvantaged: 23.6 m *v.* 17.7 m), crisps (16.5 m *v.* 13.0 m), chocolate (12.2 m *v.* 10.1 m) and confectionery (6.7 m *v.* 5.1 m) was greater in supermarkets from socio-economically disadvantaged neighbourhoods before adjustment for store size (all  $P < 0.05$ ; Fig. 1). Total shelf space allocated to each of these products was 26.4% higher in supermarkets from the most socio-economically disadvantaged areas (58.0 m *v.* 45.9 m,  $P = 0.002$ ). Shelf space allocated to fruits and vegetables (most disadvantaged *v.* least disadvantaged: 105 m *v.* 95 m,  $P = 0.41$ ) and the ratio of shelf space allocated to fruits and vegetables to that for energy-dense foods and drinks (1.8 *v.* 2.0,  $P = 0.16$ ) were not significantly different between stores from areas of high and low levels of socio-economic disadvantage prior to adjustment for store size.

Total store size, measured as the sum of aisle length, was greater in stores from socio-economically disadvantaged neighbourhoods (287.0 m *v.* 235.9 m,  $P = 0.025$ ). After adjustment for the size of the store, statistically significant



**Fig. 1** Shelf space (in metres, unadjusted for total store size) allocated to soft drinks, crisps, chocolate and confectionery in supermarkets (*n* 35) located in the most and least socio-economically disadvantaged areas in Melbourne, Australia, September–November 2010 and January–February 2011. Mean values (most disadvantaged *v.* least disadvantaged) and *P* values for comparison of means: 23.6 m *v.* 17.7 m, *P* = 0.006 for soft drinks; 16.5 m *v.* 13.0 m, *P* = 0.016 for crisps; 12.2 m *v.* 10.1 m, *P* = 0.022 for chocolate; 6.7 m *v.* 5.1 m, *P* = 0.003 for confectionery

**Table 1** Shelf space (aisle length in metres), adjusted for total store size, of fruits and vegetables and energy-dense snack foods and drinks in supermarkets (*n* 35) located in the most and least socio-economically disadvantaged areas in Melbourne, Australia, September–November 2010 and January–February 2011

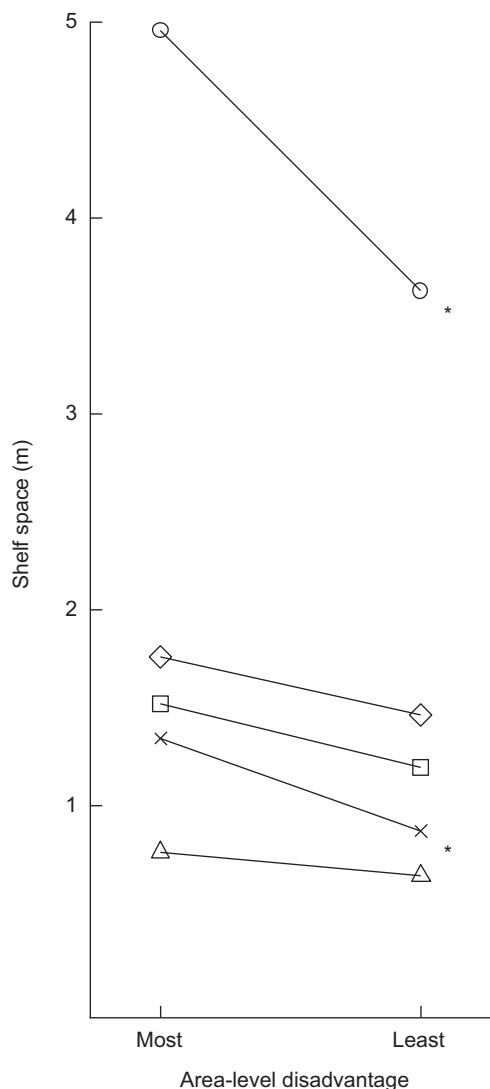
Item	Area-level socio-economic disadvantage				<i>P</i>
	Most		Least		
	Mean	SE	Mean	SE	
Fruits and vegetables	95.7	6.4	104.9	6.6	0.35
Soft drinks	22.7	1.3	18.6	1.4	0.054
Crisps	15.2	0.6	14.3	0.6	0.327
Chocolate	11.5	0.4	10.8	0.4	0.28
Confectionery	6.3	0.2	5.6	0.2	0.024
Total energy-dense foods and drinks	55.0	1.7	48.9	1.7	0.017
Ratio of fruits and vegetables to energy-dense foods and drinks	1.7	0.1	2.1	0.1	0.025

differences remained in shelf space allocated to confectionery (most disadvantaged *v.* least disadvantaged: 6.3 m *v.* 5.6 m, *P* = 0.024) and the total shelf space allocated to all energy-dense foods and drinks surveyed (55.0 m *v.* 48.9 m, *P* = 0.017; Table 1). In addition, the ratio of shelf space allocated to fruits and vegetables to that for energy-dense snack foods and soft drinks (most disadvantaged *v.* least disadvantaged: 1.7 *v.* 2.1, *P* = 0.025) also varied by socio-economic disadvantage after adjustment for store size. The difference in shelf space allocated to soft drinks in stores from the most and least disadvantaged areas (22.7 m *v.* 18.6 m, *P* = 0.054), although large, was of borderline statistical significance.

Assessing shelf space of two-litre diet and regular varieties of the cola brands with the largest shelf space

(including Coca Cola<sup>TM</sup>, Diet Coke<sup>TM</sup>, Coke Zero<sup>TM</sup>, Pepsi<sup>TM</sup> and Pepsi Max<sup>TM</sup>), more shelf space was allocated to regular compared with diet soft drinks (5.07 m *v.* 4.21 m). The ratio of shelf space allocated to two-litre bottles of regular *v.* diet soft drinks did not vary by level of socio-economic disadvantage (*P* > 0.05).

Before adjustment for store size, significant differences by socio-economic disadvantage were seen for shelf space of two-litre regular Coca Cola (most disadvantaged *v.* least disadvantaged: 5.30 m *v.* 3.38 m, *P* = 0.001), two-litre Diet Coke (1.91 m *v.* 1.32 m, *P* = 0.003) and two-litre Pepsi Max (1.39 m *v.* 0.81 m, *P* = 0.010). Following adjustment for total store size, socio-economic differences in shelf space remained for two-litre bottles of Coca Cola (5.0 m *v.* 3.7 m, *P* = 0.030) and Pepsi Max



**Fig. 2** Shelf space (in metres) allocated to two-litre cola soft drink varieties (—○—, Coca Cola™; —◇—, Coke Zero™; —□—, Diet Coke™; —×—, Pepsi Max™; —△—, Pepsi™) in supermarkets ( $n = 35$ ) located in the most and least socio-economically disadvantaged areas in Melbourne, Australia, September–November 2010 and January–February 2011. \*Value was significantly different from that in the most disadvantaged area:  $P < 0.05$

(1.35 m *v.* 0.87 m,  $P = 0.039$ ; Fig. 2). For 24-can packs of the same varieties, differences according to level of socio-economic disadvantage were observed only for Pepsi Max (most disadvantaged *v.* least disadvantaged: 2.28 m *v.* 1.05 m,  $P = 0.003$ ), with this difference remaining after adjustment for total store size (1.98 m *v.* 1.26 m,  $P = 0.038$ ).

Shelf space allocated to mineral or bottled water (most disadvantaged *v.* least disadvantaged: 2.11 m *v.* 2.29 m,  $P = 0.6$ ), reduced-fat crisps (4.36 m *v.* 4.01 m,  $P = 0.58$ ) and children's confectionery (2.79 m<sup>2</sup> *v.* 2.41 m<sup>2</sup>) did not vary according to area-level socio-economic disadvantage ( $P > 0.05$ ).

### Variety

The number of varieties of soft drinks, crisps, chocolate and confectionery, fruits and vegetables stocked was similar in stores from areas of high and low levels of socio-economic disadvantage (Table 2). Adjusted for store size, the number of varieties of fruits and vegetables and the number of chocolate bar varieties were greater in stores from the least socio-economically disadvantaged neighbourhoods. The number of children's toys hanging in the confectionery aisle, while almost double in stores from socio-economically disadvantaged neighbourhoods, was not significantly different after adjustment for store size.

### Temporal variation and test–retest reliability

To assess temporal variation and test–retest reliability of audit measures, the full supermarket audit was conducted in two stores (one from each supermarket chain with both located in an area of the same level of disadvantage), six weeks apart. The average difference in numbers of varieties of fruits and vegetables, soft drinks, crisps, chocolate bars, chocolate blocks, chocolate hanging bags, box or gift chocolates and confectionery hanging bags between the store visits, expressed as an absolute value, was 12.8%. The difference in shelf space allocated to each of fruits and vegetables, soft drinks, crisps, chocolate and confectionery was 4.8% (or 0.58 m). Based on these figures, the measures of shelf space and number of varieties in the audit tool used were considered to have good test–retest reliability, with little temporal variation in shelf space, and slightly more variation in numbers of product varieties.

### Discussion

These findings demonstrate differences in supermarket exposure to energy-dense snack foods and soft drinks based on neighbourhood level of socio-economic disadvantage. Shelf space of soft drinks, crisps, chocolate and confectionery was greater in supermarkets from socio-economically disadvantaged neighbourhoods, and even once overall store size was taken into account, the total aisle length of the energy-dense foods and soft drinks measured remained 12.5% greater in stores from the most disadvantaged neighbourhoods. In addition, the ratio of shelf space dedicated to fruits and vegetables to that for energy-dense foods and soft drinks was lower in supermarkets from the most socio-economically disadvantaged areas, although this difference was apparent only after adjustment for total store size. We found no support for the hypothesis that the ratio of shelf space dedicated to regular *v.* diet soft drinks is patterned by area-level socio-economic disadvantage.

The numbers of varieties of soft drinks, crisps, confectionery and most types of chocolate (blocks, hanging bags, box or gift chocolate) did not vary by level

**Table 2** Numbers of varieties of fruits and vegetables and energy-dense snack foods and drinks in supermarkets (*n* 35) located in the most and least socio-economically disadvantaged areas in Melbourne, Australia, September–November 2010 and January–February 2011

Item	Unadjusted			Adjusted for store size				
	Area-level socio-economic disadvantage			Area-level socio-economic disadvantage				
	Most	Least	<i>P</i>	Most		Least		<i>P</i>
				Mean	SE	Mean	SE	
Fruits and vegetables	132.8	145.1	0.13	129.2	5.3	148.7	5.3	0.018
Soft drinks								
Regular only	63.9	57.5	0.19	61.9	3.3	59.5	3.4	0.62
Diet only	22.9	19.6	0.24	20.9	1.6	21.7	1.6	0.72
Crisps								
All	82.3	74.9	0.17	78.4	3.0	79.0	3.1	0.90
Chocolate and confectionery								
Chocolate bars	58.0	62.5	0.21	56.1	2.3	64.5	2.3	0.020
Chocolate blocks	71.6	67.5	0.40	69.1	3.2	70.1	3.3	0.83
Chocolate hanging bags	60.3	57.6	0.49	58.2	2.5	59.8	2.5	0.67
Box/gift chocolate	44.7	41.8	0.35	42.8	1.9	43.7	2.0	0.74
Confectionery hanging bags	112.6	100.4	0.12	106.3	3.9	107.0	4.0	0.91
Children's toys in confectionery aisle	8.3	5.2	0.21	8.5	1.8	4.9	1.8	0.18

of socio-economic disadvantage, suggesting that the increased shelf space of these products in socio-economically disadvantaged areas is related to greater amounts of the same products. More variety in fruits and vegetables was evident in stores from the least socio-economically disadvantaged neighbourhoods, with this possibly relating to a greater number of lower-volume, niche fruits and vegetables.

Few studies in public health have investigated within-store supermarket measures, with the available studies focusing on the number of different items available and with a primary focus on healthy items such as fruits and vegetables<sup>(11,16)</sup>. Exposure measures such as number of different varieties may not allow accurate matching of within-store environments to purchasing behaviours and it is clear that tools to better assess the supermarket snack food environment are required<sup>(17)</sup>. To our knowledge, no previous study has observed significant differences in shelf space allocated to energy-dense snack foods and soft drinks according to level of socio-economic disadvantage. The single previous study investigating this topic audited only nine Australian supermarkets and therefore had limited power to detect differences<sup>(12)</sup>. Another Australian study<sup>(10)</sup> examined the numbers of varieties of various snack foods (chocolates, biscuits, cakes/muffins/scones/sweet pastries, ice cream, meat pie/sausage roll/savoury pastries, pizza and sweet pastries) within stores from areas of low, mid and high socio-economic disadvantage. Consistent with the present results, that study found no evidence of variation in the number of varieties according to neighbourhood disadvantage. That study did, however, find greater availability of fruits and vegetables in less disadvantaged areas, which again mirrors the present observation<sup>(10)</sup>.

The recent Australian National Preventative Health Strategy<sup>(18)</sup> has recognized that dietary behaviours are not solely related to personal choice, particularly among those experiencing socio-economic disadvantage, noting that:

Choosing to eat healthy food... requires people to be empowered to make [this choice]. This means that the healthy choice must be physically, financially and socially the easier and more desirable choice than the less healthy option. This is not always the case, particularly with decreasing social position.

Greater shelf space of energy-dense foods and drinks may reinforce a cultural norm which promotes their consumption and makes them socially an easier or more desirable choice. Recent research has suggested that healthy eating may be 'contagious', with social norms for both healthy and unhealthy eating behaviour being found to be predictive of greater intakes of fruits and vegetables and of fast food and soft drinks, respectively<sup>(19)</sup>. Social norms in relation to the retail shelf space of individual products have also been found to impact on purchasing decisions<sup>(20)</sup>. The existing socio-economic gradient in the prevalence of overweight and obesity<sup>(21)</sup> suggests that from a public health perspective, shelf space dedicated to energy-dense foods and drinks should be no higher in disadvantaged areas.

With supermarkets accounting for the majority of the food retail market<sup>(6)</sup>, and with the two major supermarket chains in Australia sharing 68% of market share<sup>(6)</sup>, changes to stocking practices of energy-dense foods and drinks in their stores has the potential to influence eating practices of a large percentage of the Australian population. Shelf space is not driven solely by demand, with a vast literature from the business and marketing fields on optimal methods for allocation of retail shelf space to

maximize profits. Shelf space indeed drives demand<sup>(22)</sup> and is seen as a promotional tool by retailers, with the link between greater shelf space and increased sales having been known for decades<sup>(23,24)</sup>. Increasingly common practices such as payment for competitive shelf space by manufacturers ('slotting fees')<sup>(25)</sup> demonstrate the use of shelf space by retailers and manufacturers as a mechanism to increase profits. As we did not measure purchasing behaviour and consumption here, we could not assess the association between exposure to energy-dense, nutrient-poor snack foods and their consumption. Regardless of the causal direction of the relationship, however, the stocking practices we observed may prevent changes in entrenched social norms<sup>(20)</sup> and patterns of behaviour, and are contrary to the concept of behavioural justice<sup>(14)</sup>. Altering shelf space allocations may be a relatively low-cost option in comparison with many individual obesity-prevention interventions<sup>(26)</sup>. Previous campaigns focusing on the presence of energy-dense snack foods at supermarket checkouts have shown that some supermarkets are willing to change shelf-stocking practices in response to strong public demand<sup>(27,28)</sup>.

Some aspects of the study design should be considered when interpreting our findings. Soft drinks, chocolate, confectionery and crisps are not the only energy-dense snack foods available in supermarkets and supermarkets are not the only source of such foods<sup>(29)</sup>. Whether stores in disadvantaged areas also dedicate more shelf space to other high-energy, nutrient-poor products such as pizzas, pies, cakes, pastries and biscuits is unknown. Due to the difficulties of measuring total shelf space dedicated to diet and regular soft drinks (as detailed in the Methods), we do not know whether the observed shelf space ratio for diet *v.* regular varieties of the individual soft drinks we measured would also be seen for all soft drinks within the stores sampled. The sample size, while adequate to detect the observed differences in shelf space of several product types, may have been insufficient to detect smaller differences. Finally, replication of our study in other countries or regions is required to determine whether a socio-economic gradient in energy-dense snack food availability is present in other settings.

## Conclusions

Exposure to energy-dense snack foods and soft drinks in supermarkets was shown to be related to the level of relative socio-economic disadvantage. Supermarkets in relatively disadvantaged neighbourhoods expose consumers to markedly greater shelf space of energy-dense snack foods and soft drinks, even after accounting for the larger size of these supermarkets. This situation has the potential to influence social norms related to eating behaviour, and could provide customers with greater time and opportunities (while walking through supermarkets)

to trigger impulse purchases of such items. In addition, this situation works against the behavioural justice imperative to provide an environment that does not stack the odds of achieving good health against individuals in socio-economically disadvantaged communities<sup>(14)</sup>. Changes to supermarket stocking practices of such foods and beverages in areas of relative socio-economic deprivation could represent an effective means of nutrition promotion and obesity prevention.

## Acknowledgements

This study was funded by Deakin University. A.J.C. is supported by a National Health and Medical Research Council (NHMRC) Post-doctoral Training Fellowship. L.E.T. is supported by an NHMRC Capacity Building Grant (ID 425845). D.C. is supported by a VicHealth Fellowship. S.A.M. is supported by an Australian Research Council Future Fellowship (FT100100581). This work was undertaken independent of any influence of the funding agencies. No authors have conflicts of interest in relation to this manuscript. A.J.C. and L.E.T. had primary responsibility for study design and conduct, data entry, data analysis, interpretation of results and drafting of the manuscript. S.A.M. and D.C. assisted with study design, interpretation of results and provided critical revision for the final manuscript draft. All authors approved the final manuscript draft prior to submission. The authors are grateful to Kate Udorovic and Leah Salmon for assistance with data collection, to Brian Miller for data management and to Jay Wen for assistance with geospatial analyses and store selection.

## References

1. de Graaf C (2006) Effects of snacks on energy intake: an evolutionary perspective. *Appetite* **47**, 18–23.
2. Zizza C, Siega-Riz AM & Popkin BM (2001) Significant increase in young adults' snacking between 1977–1978 and 1994–1996 represents a cause for concern! *Prev Med* **32**, 303–310.
3. Brug J (2008) Determinants of healthy eating: motivation, abilities and environmental opportunities. *Fam Pract* **25**, Suppl. 1, i50–i55.
4. Glanz K, Sallis JF, Saelens BE *et al.* (2005) Healthy nutrition environments: concepts and measures. *Am J Health Promot* **19**, 330–333, ii.
5. Cheadle A, Psaty BM, Curry S *et al.* (1991) Community-level comparisons between the grocery store environment and individual dietary practices. *Prev Med* **20**, 250–261.
6. Spencer S, Kneebone M (2012) FOODmap: An analysis of the Australian food supply chain. <http://www.daff.gov.au/agriculture-food/food/publications/foodmap-a-comparative-analysis> (accessed February 2012).
7. Deloitte (2011) Global Powers of Retailing 2011. [https://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Consumer%20Business/GlobPowDELOITTE\\_14%20Jan.pdf](https://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Consumer%20Business/GlobPowDELOITTE_14%20Jan.pdf) (accessed November 2011).
8. Farley TA, Rice J, Bodor JN *et al.* (2009) Measuring the food environment: shelf space of fruits, vegetables, and snack foods in stores. *J Urban Health* **86**, 672–682.

9. Thornton L & Kavanagh A (2010) The local food environment and obesity. In *Geographies of Obesity: Environmental Understandings of the Obesity Epidemic*, pp. 79–110 [J Pearce and K Witten, editors]. Farnham: Ashgate.
10. Ball K, Timperio A & Crawford D (2009) Neighbourhood socioeconomic inequalities in food access and affordability. *Health Place* **15**, 578–585.
11. Winkler E, Turrell G & Patterson C (2006) Does living in a disadvantaged area entail limited opportunities to purchase fresh fruit and vegetables in terms of price, availability, and variety? Findings from the Brisbane Food Study. *Health Place* **12**, 741–748.
12. Vinkeles Melchers NV, Gomez M & Colagiuri R (2009) Do socio-economic factors influence supermarket content and shoppers' purchases? *Health Promot J Aust* **20**, 241–246.
13. Adler NE & Stewart J (2009) Reducing obesity: motivating action while not blaming the victim. *Milbank Q* **87**, 49–70.
14. Adler NE & Stewart J (2010) Health disparities across the lifespan: meaning, methods, and mechanisms. *Ann N Y Acad Sci* **1186**, 5–23.
15. Australian Bureau of Statistics (2006) *Socio-Economic Indexes for Areas (SEIFA 2006)*. Canberra: ABS.
16. Andreyeva T, Blumenthal DM, Schwartz MB *et al.* (2008) Availability and prices of foods across stores and neighbourhoods: the case of New Haven, Connecticut. *Health Aff (Millwood)* **27**, 1381–1388.
17. Thornton LE, Cameron AJ, Crawford DA *et al.* (2011) Is greater variety of chocolates and confectionery in supermarkets associated with more consumption? *Aust NZ J Public Health* **35**, 292–293.
18. National Preventative Health Taskforce (2009) Australia: The Healthiest Country by 2020. National Preventative Health Strategy – the roadmap for action. [http://www.health.gov.au/internet/preventativehealth/publishing.nsf/Content/CCD7323311E358BECA2575FD000859E1/\\$File/nphs-roadmap.pdf](http://www.health.gov.au/internet/preventativehealth/publishing.nsf/Content/CCD7323311E358BECA2575FD000859E1/$File/nphs-roadmap.pdf) (accessed June 2011).
19. Ball K, Jeffery RW, Abbott G *et al.* (2011) Is healthy behavior contagious: associations of social norms with physical activity and healthy eating. *Int J Behav Nutr Phys Act* **7**, 86.
20. Montoya DY, Mandel N & Nowlis SM (2005) Social norms and shelf space strategies: influencing consumer purchase decisions at the retail shelf. *Adv Consum Res* **32**, 268–269.
21. Cameron AJ, Welborn TA, Zimmet PZ *et al.* (2003) Overweight and obesity in Australia: the 1999–2000 Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Med J Aust* **178**, 427–432.
22. Lee J-Y & Brown MG (2001) The effect of shelf space on sales of fruit beverages. *J Food Prod Mark* **7**, 3.
23. Curhan RC (1972) The relationship between shelf space and unit sales in supermarkets. *J Mark Res* **9**, 406–412.
24. Frank RE & Massy WF (1970) Shelf position and space effects on sales. *J Mark Res* **7**, 59–66.
25. Klein B & Wright JD (2007) The economics of slotting contracts. *J Law Econ* **50**, 421–454.
26. Vos T, Carter R, Barendregt J, *et al.* (2010) *Assessing Cost-Effectiveness in Prevention (ACE-Prevention): Final Report*. Brisbane/Melbourne: University of Queensland/Deakin University.
27. The Parents Jury (2008) Junk At The Checkout. [http://www.parentsjury.org.au/tpj\\_browse.asp?ContainerID=junk\\_at\\_the\\_checkout](http://www.parentsjury.org.au/tpj_browse.asp?ContainerID=junk_at_the_checkout) (accessed June 2011).
28. The Food Commission (2009) Chuck snacks off the checkout. [http://www.foodmagazine.org.uk/articles/chuck\\_snacks\\_off\\_checkout/](http://www.foodmagazine.org.uk/articles/chuck_snacks_off_checkout/) (accessed April 2011).
29. Farley TA, Baker ET, Futrell L *et al.* (2010) The ubiquity of energy-dense snack foods: a national multicity study. *Am J Public Health* **100**, 306–311.