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A multilevel study of area socio-economic status and food purchasing behaviour

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Abstract

Objective: The present study examined the association between area socio-economic status (SES) and food purchasing behaviour.

Design: Data were collected by mail survey (64·2 % response rate). Area SES was indicated by the proportion of households in each area earning less than $AUS 400 per week, and individual-level socio-economic position was measured using education, occupation and household income. Food purchasing was measured on the basis of compliance with dietary guideline recommendations (for grocery foods) and variety of fruit and vegetable purchase. Multilevel regression analysis examined the association between area SES and food purchase after adjustment for individual-level demographic (age, sex, household composition) and socio-economic factors.

Setting: Melbourne city, Australia, 2003.

Subjects: Residents of 2564 households located in fifty small areas.

Results: Residents of low-SES areas were significantly less likely than their counterparts in advantaged areas to purchase grocery foods that were high in fibre and low in fat, salt and sugar; and they purchased a smaller variety of fruits. There was no evidence of an association between area SES and vegetable variety.

Conclusions: In Melbourne, area SES was associated with some food purchasing behaviours independent of individual-level factors, suggesting that areas in this city may be differentiated on the basis of food availability, accessibility and affordability, making the purchase of some types of foods more difficult in disadvantaged areas.

Keywords
Multilevel
Neighbourhood
Socio-economic status
Diet
Food purchasing

A large literature has examined the association between individual-level socio-economic position (SEP) and diet. The findings of this work typically show that socio-economically disadvantaged groups have diets that are least consistent with recommended intakes of foods and nutrients(1–3) and least in accord with dietary guideline messages promoting foods that are high in fibre and low in fat, salt and sugar(4,5). Significantly, the poorer dietary intake of disadvantaged groups contributes in part to their higher rates of mortality and morbidity for chronic disease(6,7).

During the last decade, researchers have increasingly turned their attention to the question of whether place of residence influences diet independently of individual-level factors; and more particularly, whether living in a socio-economically disadvantaged area is associated with a less healthy diet. Our review of this (small) literature suggested that area studies of diet can be broadly divided into two types that reflect the analytical method used: (i) studies that undertake multivariable analyses using both area- and individual-level variables but without the capacity to statistically integrate the two levels (i.e. contextual studies); and (ii) multilevel studies. Six of the former types of study(8–13) and five of the latter were identified(14–18), and key aspects of each are summarised in Table 1.

The findings of the contextual studies were reasonably consistent in that they each found some evidence that living in a disadvantaged area was associated with a poorer diet after adjusting for individual-level socio-economic and demographic factors. However, these studies were often based on a small number of areas and, in most

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Table 1 Studies examining the association between areal-level socio-economic disadvantage and diet

Study and country	Sample	Dietary outcome	Significant area differences in diet (after adjustment for individual-level factors)	Significant association between area disadvantage and diet (after adjustment for individual-level factors)
Contextual (non-multilevel) studies				
Diehr *et al.* (1993)[8], USA	Areas: *n* 15 Individuals: *n* 7863 adults aged 18+ years	Percentage of energy from fat	Yes (but very small)	Areas with higher unemployment rates had higher percentage of energy from fat
Forsyth *et al.* (1994)[9], Scotland	Areas: *n* 4 Individuals: *n* 691 adults aged 40 and 60 years	Reported consumption of vegetables, potatoes, fruit, fish, bread, cereals, cakes, pastries and biscuits, confectionery, savoury snacks, meat, spreads, sugar, milk and soft drinks	Area differences in consumption of fruits, vegetables, fried or roast potatoes, white bread, brown/wholemeal bread, meat (all), processed meat, poultry, shallow fat frying	Residents of disadvantaged areas were less likely to use PUFA, brown/wholemeal bread and natural fruit juice; more likely to add sugar to drinks and consume soft drinks
Karvonen and Rimpela (1996)[10], Finland	Area: *n* 460 Individuals: *n* 9121 adolescents aged 16 and 18 years	Percentage using high-fat milk and butter daily	Yes	Consumption of high-fat products was higher in areas with fewer services (boys); lower in less educated areas (girls)
Ellaway and Macintyre (1996)[11], Scotland	Areas: *n* 4 Individuals: *n* 691 adults aged 40 and 60 years	'Healthy' and 'less healthy' food consumption indices	Yes	Not explicitly stated; however, bivariate analyses suggested that residents of disadvantaged areas consumed a less healthy diet
Karvonen and Rimpela (1997)[12], Finland	Areas: *n* 33 Individuals: *n* 1048 adolescents aged 16 and 18 years	Abstaining from use of milk and fat-containing spreads	Could not be determined	Among girls, rates of abstinence from dietary fat were higher in areas with lower rates of prolonged unemployment; no area effects for boys
Shohaimi *et al.* (2004)[13], England	Areas: not reported Individuals: *n* 22 562 adults aged 39–79 years	Mean intakes (g/d) of fruits (*n* 11) and vegetables (*n* 26) combined	Could not be determined	Residents of disadvantaged areas (Townsend index) were more likely to report lower intakes of fruits and vegetables
Multilevel studies				
Diez-Roux *et al.* (1999)[14], USA	Areas: not reported Individuals: *n* 13 095 adults aged 45–64 years	Energy-adjusted daily intakes of fruits, vegetables, meats and fish. Daily intake of saturated and polyunsaturated fat and cholesterol. Key score: extent to which diet increases serum cholesterol	No	Lower-income neighbourhoods typically had lower energy-adjusted intakes of fruits, vegetables and fish, and increased intake of meats, but the associations were weak and often not significant. Inconsistent associations between neighbourhood income and intakes of fats and cholesterol
Ecob and Macintyre (2000)[15], Scotland	Areas: *n* 52 Individuals: *n* 3036 persons aged 15, 35 and 55 years	Consumption of five foods (fresh fruits and vegetables, wholemeal bread *v.* white, soft margarine *v.* butter, low-fat milk *v.* full cream) scored as a 'good' diet (i.e. consumes 4+ healthy options) and 'bad' diet (no healthy options)	Yes ('bad' diet only)	Residents of disadvantaged areas (Carstairs–Morris deprivation index) were significantly more likely to have a 'bad' diet and less likely to have a 'good' diet

Table 1 *Continued*

Study and country	Sample	Dietary outcome	Significant area differences in diet (after adjustment for individual-level factors)	Significant association between area disadvantage and diet (after adjustment for individual-level factors)
Turrell *et al.* (2004)[16], Australia	Areas: *n* 50 Individuals: *n* 970 adults aged 18–94 years	Three indices measuring purchase of fruits, vegetables and grocery foods	No	Advantaged and disadvantaged areas did not differ significantly in their food purchasing patterns
Ball *et al.* (2006)[17], Australia	Areas: *n* 45 Individuals: *n* 1347 women aged 18–65 years	Servings of fruits and vegetables each day (1, 2, 3–4, 5 or more)	Fruit: no. Vegetables: yes	Not reported
Giskes *et al.* (2006)[18], The Netherlands	Areas: *n* 85 Individuals: *n* 1339 adults aged 25–79 years	Index measuring food choices consistent with Dutch dietary guidelines; fruit consumption (servings/d); breakfast consumption (d/week); total and saturated fat intake (% of energy)	No	Advantaged and disadvantaged areas did not differ significantly in their grocery food purchasing patterns, their consumption of fruit and propensity to skip breakfast, nor in terms of their total and saturated fat intake

cases, the analytical approach did not allow for the partitioning of area- and individual-level sources of variation. Hence it was unclear whether differences in diet between advantaged and disadvantaged areas were due to a composition effect (i.e. the clustering of rich and poor people in rich and poor areas) or the environmental characteristics of the areas per se (i.e. a context effect, possibly reflecting area differences in physical infrastructure, services and facilities). The findings of the multilevel studies, which allow for area- and individual-level variation to be partitioned and quantified, present a somewhat different picture. Of the five identified, only two reported a significant difference in diet between areas after adjustment for individual-level factors[15,17]. Diez-Roux *et al.*[14] and Ecob and Macintyre[15] found that residents of socio-economically disadvantaged areas had poorer diets than those in more advantaged areas, although the findings of the former were weak and often not statistically significant. Area socio-economic status (SES) was not associated with food purchasing behaviour in an Australian study[16] or with dietary intake and food choice in a Dutch study[18].

The present paper contributes to the literature on areas and diet by reporting on a multilevel study that examined the association between area SES and food purchasing behaviour in the Melbourne metropolitan region (Australia) in 2003. The relationship between SES and diet in Australia (and elsewhere) has to date been investigated primarily using 'quantitative' dietary indicators such as mean daily intakes of nutrients, nutrient density levels or percentage contribution of food to nutrition and energy[5]. By contrast, few studies have examined the relationship using 'qualitative' indicators such as food purchasing behaviour. Clearly, people need to procure food (which usually means purchase it) before it can be consumed and converted into energy and nutrients, and there are a number of compelling reasons why it is important to better understand the factors that influence the food purchasing choices of different socio-economic groups. First, most people make dietary decisions in relation to food and not nutrients[19]; thus when shopping food choices are more likely to be influenced by factors such as price, availability, taste preference and convenience than by the vitamin and mineral content of the food. Second, research has shown that the type of food people buy influences dietary quality[20]. Third, food choice differences between socio-economic groups translate into concomitant differences in nutrient intake[21,22]. Fourth, knowing about the factors that influence socio-economic differences in food purchasing is important in assessing the reach and impact of health promotion messages, many of which focus on encouraging people to make healthy food choices when shopping[23–25].

The study investigates whether residents of socio-economically advantaged and disadvantaged areas differ in

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their purchase of grocery foods, fruits and vegetables. Specifically, three questions are examined:

1. Do areas vary in their food purchasing profiles?
2. To what extent does within-area clustering by individual-level SEP account for any observed differences between areas in their food purchasing profiles?
3. What is the relationship between area SES and food purchasing after adjustment for within-area differences in food purchasing by individual-level SEP?

Methods

Geographic scope

The present paper is based on data collected as part of the Victorian Lifestyle and Neighbourhood Environment Study (VicLANES), a cross-sectional multilevel investigation of area- and individual-level factors and health-related behaviour. The target population for VicLANES comprised people living in an area extending 20 km from the central business district of Melbourne city, the capital of the state of Victoria.

Sample design

The sample comprised non-institutionalised residents of private dwellings (households) and Census Collector Districts (CCD). A CCD is the smallest administrative unit used by the Australian Bureau of Statistics to collect census data. In urban areas such as Melbourne, a CCD contains an average of 200 private dwellings which are deemed to be relatively homogeneous in terms of their socio-economic characteristics. Households and CCD were selected using a stratified two-stage cluster design. At the first stage, all CCD in the Melbourne metropolitan area were ranked according to the proportion of households in each CCD with an income of less than $AUS 400 per week. The resultant distribution was stratified into septiles, and a total of fifty CCD were randomly selected from the low- (n 17), middle- (n 16) and high-income (n 17) strata. At the second stage, we used names and addresses on the Australian Electoral Roll to identify all residents aged 18–74 years in each of the fifty CCD. Voting is compulsory in Australia for persons aged 18 years and over, so the electoral roll provides near-complete coverage of the resident adult population. A total of 3995 households were then randomly sampled, and the person within each household who was primarily responsible for most of the food shopping was targeted for data collection.

Data collection

The household-level data collection within each CCD occurred between September and December 2003, and was conducted using a mail-survey method described by Dillman[26]. A total of 2564 usable surveys were returned to yield a final response rate of 64·2 %.

Measures

Area socio-economic status

The septiles forming the sampling strata were used as the basis for measuring area SES. In each of the three strata the average proportion of households earning less than $AUS 400 per week was 7·0 % (range 3·5–8·5 %), 15·3 % (14·4–16·7 %) and 31·0 % (24·1–59·6 %), respectively; these strata were subsequently labelled as high, medium and low SES. The area-level socio-economic characteristics of the three strata were further examined using 2001 census data[27], and they differed markedly in terms of their unemployment rate (4·0 %, 6·6 % and 11·0 %, respectively), the percentage of employees in unskilled and semi-skilled jobs (7·1 %, 13·8 % and 20·7 %, respectively), the percentage of dwellings that were rented from the public housing authority (0·17 %, 1·6 % and 14·5 %, respectively) and the percentage of dwellings with no motor vehicle (3·9 %, 9·6 % and 21·2 %, respectively).

Education

Respondents were asked to provide information about whether they had attained further education since leaving school and, if so, the highest qualification completed. Respondent's education was subsequently coded as: (i) bachelor degree or higher (the latter included postgraduate diploma, master's degree or doctorate); (ii) diploma (associate or undergraduate); (iii) vocational (trade or business certificate, or apprenticeship); and (iv) no post-school qualifications.

Occupation

Respondents who were employed at the time of completing the survey were asked to indicate their job title and then to describe the main tasks or duties they performed. This information was subsequently coded to the Australian Standard Classification of Occupations (ASCO)[28]. For the purposes of the present study, the original nine-level ASCO classification was re-coded into three categories: (i) managers/professionals (managers and administrators, professionals and para-professionals); (ii) white-collar employees (clerks, salespersons and personal service workers); and (iii) blue-collar employees (trades-persons, plant and machine operators and drivers, labourers and related workers). A fourth category, 'not in the labour force', comprising the retired, unemployed, students and those engaged in home duties on a full-time basis, was also created.

Income

Respondents were asked to indicate their total annual household income (including pensions, allowances and investments) using a fourteen-category measure that was subsequently re-coded into five groups for analysis: (i) $AUS 78 000 or more; (ii) $AUS 52 000–77 999; (iii) $AUS 36 400–51 999; (iv) $AUS 20 800–36 399; and (v) less than $AUS 20 799. Households in categories (iv) and

(v) received annual incomes at or below the Australian average in 2000[29].

Confounding

Age in years (centred), sex and household composition were used as potential confounding variables.

Food purchasing

As part of the questionnaire, information was sought about the purchase of grocery items, fruits and vegetables.

Grocery food purchase. This was examined on the basis of fifteen questions, each of which had two or more response options. For example, respondents were asked 'When shopping for your household, what type of milk do you usually buy?' The response options included: 'I do not buy milk', 'extra creamy', 'full cream', 'low-fat/trim', 'skimmed/fat-free', plus others. Multiple responses were permitted for each question. The other fourteen questions were structured in an identical manner and pertained to bread, rice, pasta, noodles, baked beans, tinned fruit, cheese, yoghurt, beef mince, chicken, tinned fish, cooking oils, butter and solid cooking fat. In Australia, dietary authorities recommend that people purchase and consume a variety of foods that are relatively high in fibre and low in fat, salt and sugar[25]; consistent with these guidelines, we classified the foods into a recommended and regular category (Table 2). Using this classification, we developed a measure that captured the extent to which peoples' grocery purchasing patterns were consistent (or not) with dietary guideline recommendations. First, for each food type (e.g. milk), respondents were assigned the value 1 if they reported usually purchasing only the regular option exclusively (and not any recommended options); they were assigned the value 3 if they reported usually purchasing only the recommended option exclusively (and not any regular options); and they were assigned a value of 2 if they reported usually purchasing a mix of regular and recommended options (e.g. full cream and skimmed milk). There was a small number of respondents who reported that they never purchased a particular type of food and these were assigned the value 0. In sum, for each of the fifteen food types, respondents were assigned a value of 0, 1, 2 or 3. Second, an initial food purchasing index was created that involved summing the scores for the fifteen food types, with those scoring 0 being excluded at this point. This initial index had a potential range of 15–45, with 15 denoting people who purchased the regular option for each food type and 45 denoting those who purchased the recommended option for all foods. It is important to note that the respondents included in this initial index reported purchasing all of the fifteen food types. Those scoring 0 for one or more food type(s) were excluded because their final index score would not accurately reflect their purchasing pattern. For example, someone who purchased all fifteen food types and chose the recommended option for each item would score 45, whereas someone who purchased thirteen food types and chose the recommended option for each item would score 39. Clearly, both people have identical purchasing patterns with respect to the dietary guidelines (i.e. they are making the healthier choice for every food item) but this is not reflected in their index score. To deal with this issue, and as a way of including the full sample in the analyses, respondents who reported not buying one or more of the food items were included in the index using the following formula: Index score $= a/(15 - b)$. The quantity a represented each respondent's initial score which was derived by summing the values (1, 2 or 3) for each of the food types. The denominator comprised the constant '15', which represented the number of food types in the index, and the variable b, which represented the number of food

Table 2 Classification of grocery food types into 'recommended' and 'regular' categories

Food type	Recommended	Regular
Bread	Wholemeal, multigrain, white high in fibre, rye, soya and linseed	White
Rice	Wholemeal or brown	Plain white and other white rice (basmati, jasmine, Arborio)
Pasta	Wholemeal or brown	Other pasta (white, spinach, herb)
Noodles	Wholemeal or brown	Other noodles (white, egg, spinach)
Baked beans	Salt-reduced or unsalted	Regular salt
Tinned fruit	In natural juice	In syrup
Cheese	Reduced fat (25 % less fat), low-fat (<10 % fat)	Full-fat
Milk	Reduced fat, low-fat, high-Ca, high-Ca skimmed, high-Fe, high-protein, reduced lactose, no cholesterol, soya or soya & linseed (skimmed)	Extra creamy, full cream, soya or soya & linseed (full cream)
Yoghurt	Low-fat (plain and fruit)	Full-fat (plain and fruit)
Beef mince	Lean (trim/premium)	Regular (choice/fine grade)
Chicken (uncooked)	Without skin, with skin (and remove before eating)	With skin (and eat skin)
Tinned fish	In water/spring water	In oil or brine
Vegetable oil	Canola, sunflower, safflower, olive, corn, soyabean, peanut or sesame, grape seed or macadamia	Blended oils, coconut oil, palm oil
Butter	Salt-reduced, unsalted	Regular salt
Solid cooking fat	Cooking margarine, solidified oil	Solid animal fat (lard, beef dripping), vegetable shortening, ghee or butter (and use for cooking)

types not purchased by the respondent. In effect, the formula calculated a mean food purchasing score for each respondent. Finally, the index was re-scored to range from 0 to 100, with higher scores indicating a purchasing pattern that was more consistent with dietary guideline recommendations (sample mean 47·6, SD 13·4).

Fruit purchasing. This was examined using a question that asked 'When shopping for fresh fruit, how often do you buy these types?' The respondent was instructed to include seasonal fruits, but exclude fruit juice, canned and dried fruit. The question item-set consisted of twenty-two fresh fruits selected (mostly) from the FFQ used in the 1995 Australian National Nutrition Survey[30]. For each fruit, respondents were asked to indicate their usual purchasing pattern on the basis of five-point scales: 1 = 'never buy', 2 = 'rarely buy', 3 = 'sometimes buy', 4 = 'nearly always buy' and 5 = 'always buy'.

Using these items we created an index that measured variety of fruit purchased. For each fruit item, respondents reporting 'never' or 'rarely' buy were scored 0, and those reporting any of the other three options were scored 1. The items were then summed, with the resultant index score for each respondent indicating the variety of fruits purchased (sample mean 14·2, SD 4·1). Importantly, the variety score does not reflect the range of fruits purchased on any particular shopping trip, but rather the types that are purchased at least sometimes over the course of many shopping episodes depending on factors such as seasonality, price and quality. As the variety index was essentially a count-measure and non-normally distributed it was categorised into quartiles, with Q1 denoting high variety and Q4 low variety.

Vegetable purchasing. Respondents were asked to indicate how often they purchased twenty-five vegetables, including fresh and frozen, but excluding canned or dried vegetables. A purchasing index measuring vegetable variety was constructed using an identical format and method to that used for fresh fruit. The mean variety score for vegetables for the sample was 18·5 (SD 4·1).

Analysis

Table 3 presents descriptive statistics for each of the measures used in this analysis.

From the 2564 questionnaires that were returned, missing data were identified for education (*n* 106, 4·1 %), occupation (*n* 83, 3·2 %), income (*n* 903, 35·2 %), sex (*n* 4, 0·16 %), age (*n* 5, 0·20 %) and household composition (*n* 55, 2·1 %). In total, the proportion of the sample with completely observed data for all the variables examined (complete cases) was 57 %. We have not reported results obtained by analysing only the complete cases because of the potential bias and loss of precision associated with the large proportion of missing income data; instead, we used multiple imputation. We imputed all missing data under a missing at random (MAR) assumption and adopted an inclusive strategy for the imputation model[31–33].

Table 3 Descriptive statistics for the socio-economic and demographic variables and the measures of food purchasing behaviour (Melbourne city, Australia, 2003; *n* 2564)

	n	%
Area disadvantage		
Low	914	35·7
Medium	895	34·9
High	755	29·5
Education		
Bachelor degree or higher	815	31·8
Diploma	290	11·3
Vocational	393	15·3
No post-school qualifications	1006	41·6
Occupation		
Professionals	861	33·6
White collar	485	18·9
Blue collar	140	5·5
Not in the labour force	1078	42·0
Annual income		
$AUS 78 000 or more	702	27·4
$AUS 52 000–77 999	605	23·6
$AUS 36 400–51 999	398	15·5
$AUS 20 800–36 399	391	15·3
$AUS 20 799 or less	468	18·3
Sex		
Female	2181	85·1
Male	383	14·9
Household composition		
1 adult, no children	427	16·7
1 adult, 1 or more children	207	8·1
2 or more adults, no children	911	35·5
2 or more adults, 1 or more children	1019	39·7
	Mean	SD
Age (years)	49·0	13·5

Five data sets with imputed values for missing items on each variable were estimated using the command 'Imputation by Chained Equations (ICE)' in the STATA statistical software package version 9·2 (Stata Corporation, College Station, TX, USA).

The grocery data were analysed as a two-level random intercept model in STATA. We specified three models that directly addressed the three research questions identified earlier. Model 1 (baseline) quantified the extent of area-level variation in food purchasing behaviour conditional on the confounders. Here, the substantive interest was on the random term which, if significant, indicated that food purchasing patterns differed between the fifty CCD. For this and subsequent models we also calculated an intra-class correlation (ICC) by dividing the between-CCD variance by the total variance, and this is interpreted as the proportion of the total variation in food purchasing behaviour that is between the CCD. Model 2 extends Model 1 by adding education, occupation and income as fixed effects, and examined the extent to which they account for variation in food purchasing between the CCD. Model 3 then extended Model 2 by including the measure of area SES as a fixed effect; here the focus is on whether area SES is associated with food purchasing independently of within-area variation in age, sex, household composition and individual-level SEP.

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Variety of fruit and vegetable purchase was examined using a two-level ordered multinomial logit-link model. 'High' variety (Q1) was denoted the reference category; hence positive regression coefficients for any of the predictor variables indicate a greater odds of purchasing a lower variety of fruits and vegetables. Three models were specified. Model 1 (baseline) quantified the extent of area-level variation in fruit and vegetable variety conditional on the confounders. Model 2 added education, occupation and income, and Model 3 included area SES. The results are presented as odds ratios and their 95 % confidence intervals.

Results

Table 4 presents the findings of the multilevel analyses which examined the independent contribution of area- and individual-level socio-economic factors to grocery food purchase. In Model 1, the area-level random term was statistically significant ($P=0{\cdot}033$), indicating that the average grocery purchasing score was different (beyond chance) across the fifty CCD. Of the total variability in grocery purchase, 1·5 % occurred between CCD and 98·5 % between individuals. Model 2 adds the fixed (average) effects for education, occupation and income; this attenuated the between-area variation by 59·8 %, and the random term was no longer significant ($P=0{\cdot}241$). Education and income were associated with grocery purchase: respondents with no post-school qualifications and those living in low-income households scored significantly lower on the index. No significant occupational effects were observed. Model 3 adds the fixed effect for area SES and the coefficients indicate that residents of medium- and low-SES areas scored significantly lower on the grocery purchasing index than their counterparts from high-SES areas.

Table 5 presents the findings of the ordered multilevel logistic regression analysis which examined the contribution of area- and individual-level socio-economic factors to variety of fruit and vegetable purchasing. Fruit variety scores were significantly different ($P=0{\cdot}01$) across the fifty CCD (Model 1). After adjustment for education, occupation and income (Model 2), the between-area variation in fruit variety was attenuated by 50·0 % and remained marginally statistically significant ($P=0{\cdot}06$). Respondents with no post-school qualifications had 1·72 (95 % CI 1·25, 2·38) times higher odds of purchasing a lower variety of fruits. The corresponding odds for respondents

Table 4 Area- and individual-level socio-economic effects on the purchase of grocery foods consistent with dietary guideline recommendations (Melbourne city, Australia, 2003)

	Groceries†					
	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Intercept	43·0	1·5	41·5	1·1	42·8	1·1
Area SES						
High					–	
Medium					−2·09	0·70**
Low					−2·43	0·76***
Education						
Bachelor degree or higher			–		–	
Diploma			0·35	0·99	0·45	0·98
Vocational			0·22	0·93	0·20	0·93
No post-school qualifications			−1·73	0·79**	−1·54	0·78*
Occupation						
Professionals			–		–	
White collar			−0·09	0·89	−0·07	0·88
Blue collar			0·41	1·38	0·64	1·37
Not in the labour force			−0·85	0·80	−0·83	0·80
Annual income						
$AUS 78 000 or more			–		–	
$AUS 52 000–77 999			−0·86	0·81	−0·70	0·80
$AUS 36 400–51 999			−1·08	0·94	−0·78	0·93
$AUS 20 800–36 399			−2·47	0·99*	−2·06	0·99*
$AUS 20 799 or less			−2·98	1·05**	−2·31	1·06*
Random effects						
Area variance	2·54	1·2	1·02	0·9	0·182	0·7
P value for area variance	0·033		0·241		0·784	
Intra-class correlation (%)	1·5		0·60		0·10	

SES, socio-economic status.
Effect was significant: $^{*}P\leq0{\cdot}05$, $^{**}P\leq0{\cdot}01$, $^{***}P\leq0{\cdot}001$.
†Model 1, baseline model adjusted for age, sex and household composition; Model 2, Model 1 plus education, occupation and income; Model 3, Model 2 plus area SES.

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Table 5 Area- and individual-level socio-economic effects on variety of fruit and vegetable purchasing (Melbourne city, Australia, 2003)†

	Fruit variety‡					Vegetable variety				
	Model 1	Model 2		Model 3		Model 1	Model 2		Model 3	
		OR	95 % CI	OR	95 % CI		OR	95% CI	OR	95% CI
Area SES										
High				1·00					1·00	
Medium				1·07	0·84, 1·37				0·88	0·70, 1·11
Low				1·30	1·00, 1·67				1·06	0·83, 1·35
Education										
Bachelor degree or higher		1·00		1·00			1·00		1·00	
Diploma		1·27	0·84, 1·91	1·26	0·94, 1·68		1·08	0·78, 1·48	1·07	0·79, 1·45
Vocational		1·44	0·99, 2·11	1·45	1·11, 1·89		1·01	0·75, 1·36	1·01	0·76, 1·34
No post-school qualifications		1·72	1·25, 2·38	1·70	1·35, 2·14		1·36	1·06, 1·75	1·36	1·08, 1·72
Occupation										
Professionals		1·00		1·00			1·00		1·00	
White collar		0·85	0·59, 1·22	0·85	0·66, 1·10		1·02	0·77, 1·35	1·02	0·78, 1·33
Blue collar		0·94	0·54, 1·64	0·93	0·62, 1·37		1·14	0·74, 1·76	1·15	0·76, 1·73
Not in the labour force		0·91	0·66, 1·27	0·91	0·72, 1·15		1·13	0·88, 1·46	1·12	0·88, 1·43
Annual income										
$AUS 78 000 or more		1·00		1·00			1·00		1·00	
$AUS 52 000–77 999		1·26	0·90, 1·75	1·25	0·99, 1·58		0·19	0·93, 1·56	1·21	0·95, 1·55
$AUS 36 400–51 999		1·09	0·74, 1·60	1·07	0·81, 1·40		0·88	0·65, 1·18	0·88	0·66, 1·17
$AUS 20 800–36 399		1·43	0·95, 2·13	1·39	1·04, 1·85		1·12	0·81, 1·53	1·12	0·83, 1·52
$AUS 20 799 or less		1·69	1·11, 2·57	1·59	1·18, 2·16		1·17	0·84, 1·63	1·16	0·84, 1·60
Random effects										
Area variance and SE	0·08 0·03	0·04	0·02	0·04	0·02	0·03 0·02	0·02	0·02	0·01	0·02
P value for area variance	0·01	0·06		0·11		0·11	0·30		0·41	

SES, socio-economic status.
†High variety (quartile 1) was denoted the reference category; hence odds ratios greater than 1 indicate an increased likelihood of purchasing a lower variety of fruits and vegetables.
‡Model 1, baseline model adjusted for age, sex and household composition; Model 2, Model 1 plus education, occupation and income; Model 3, Model 2 plus area SES.

from low-income families were 1·69 (95 % CI 1·11, 2·57). Model 3 adds the measure of area SES which made no appreciable difference to the between-CCD variation (relative to Model 2) although the random term was no longer statistically significant ($P = 0·11$). The coefficients for area SES show that residents of low-SES areas had significantly higher odds of purchasing a lower variety of fruits than residents in the high-SES areas (OR = 1·30, 95 % CI 1·00, 1·67). Independent of area SES, respondents with lower levels of education, and residents of lower-income households, had significantly higher odds of purchasing a more limited variety of fruits than their higher status counterparts.

Vegetable variety scores did not differ significantly across the fifty CCD (Model 1) and the inclusion of education, occupation and income further attenuated the CCD variation (Model 2). Respondents with no post-school qualifications had a significantly higher odds of purchasing a lower variety of vegetables relative to those with a bachelor degree (OR = 1·36, 95 % CI 1·08, 1·72). There was no association between vegetable variety and occupation, income or area SES (Model 3).

Discussion

In metropolitan Melbourne in 2003, area SES was associated with the purchase of grocery foods and fruit variety. Compared with their counterparts in high-SES areas, residents of low-SES areas were less likely to buy groceries that were high in fibre and low in fat, salt and sugar; and they purchased a smaller variety of fruits. These findings are broadly consistent with the results of multilevel studies conducted in the USA[14] and Scotland[15]; however, they are at odds with multilevel research conducted in The Netherlands[18] and Brisbane, Australia[16]. Reconciling these differences, and hence being able to generalise about the relationship between area SES and diet, is difficult. In part, these difficulties stem from the limited evidence base (i.e. the small number of multilevel studies) and methodological issues such as differences in the conceptualisation and measurement of diet, the individual-level variables used as confounders, and the number and size of the area units used[15]. The inconsistencies between study findings, however, are likely to be more than a methodological artefact, and may reflect 'real' historical, cultural, political, socio-economic and geospatial differences between countries (e.g. USA and Australia) and between regions within the same country (e.g. Brisbane and Melbourne). At present, the mixed findings of the small number of multilevel studies do not provide a sufficiently reliable basis on which to make a general call for area-level public health interventions to improve conditions in deprived areas to facilitate the procurement of foods that are conducive to a healthy diet; rather, any 'call' may have to be specific and tailored to each particular geographic and spatial context.

A large literature documents an association between individual-level SEP and diet, and most of this work has focused on socio-economic differences in food and nutrient intakes[5]. These studies usually find that socio-economically disadvantaged groups have intakes that are consistent with their higher rates of diet-related chronic disease[1–3]. To some extent at least, the results of the present food purchasing study extend and complement the findings of the intake studies by showing that those of low SEP are less likely to buy grocery foods that accord with diet-related health promotion messages and dietary guidelines. In addition, low socio-economic groups had significantly higher odds of purchasing a lower variety of fruits and vegetables.

Study limitations

First, survey non-response tends to be higher in disadvantaged areas[34] and among individuals of low SEP[35]. Non-response in the VicLANES study was 35·8 %; hence the sample probably under-represents the disadvantaged areas and individuals and over-represents the advantaged, and the observed socio-economic differences in food purchasing are likely to be an underestimate of the actual differences in the Melbourne population.

Second, as with most multilevel studies[36], our use of a CCD to represent a neighbourhood was made for reasons of sampling and analytic convenience rather than being underpinned by an explicit theory linking area SES and food purchasing; hence associations among these variables are likely to be underestimated.

Third, our finding of an association between area SES and food purchase might be confounded by individual-level socio-economic factors not included in the models. This said however, we included the three most widely used indicators of a person's socio-economic characteristics[37] and, given the correlation among these indicators[38], it is likely that education, occupation and income were capturing most of the unmeasured influences of other socio-economic factors excluded from the models. Alternatively, it may be that the inclusion of these individual-level measures resulted in 'over-adjustment', which argues for the possibility of an even stronger contextual effect on food purchase than was observed here. If education, occupation and household income represent part of the pathway via which area SES influences food procurement, then modelling individual-level socio-economic variables may inappropriately attenuate the variation that is more correctly attributable to area disadvantage[39].

Conclusion

In the Melbourne metropolitan region in 2003, differences between advantaged and disadvantaged areas in their purchasing profiles for grocery foods and fruits, and the 'healthier' purchasing in higher-SES areas, suggest that the areas may be differentiated on the basis of food availability, accessibility and affordability, making the purchase of some types of foods more difficult for people living in disadvantaged areas. To date, the between- and within-country (multilevel) evidence linking area disadvantage and diet is both sparse and inconsistent. Methodological issues notwithstanding, this might suggest that area deprivation is not universally associated with poorer access to healthy food. Cummins and Macintyre[40] reached a somewhat similar conclusion based on their review of the literature on food environments and obesity. A challenge for future area-based dietary research is to identify those ecological characteristics (e.g. urban design, shopping infrastructure, transport services) that promote equality of access to healthy food, and those characteristics that make its attainment difficult.

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