A multilevel analysis of socioeconomic (small-area) differences in household food purchasing behaviour

Running head: Socioeconomic status and diet

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Abstract

Study objective: To examine the association between area- and individual-level socioeconomic status (SES) and food purchasing behaviour.

Design: The sample comprised 1000 households and 50 small areas, selected using a stratified two-stage cluster design. Data were collected by face-to-face interview (66.4% response rate). SES was measured using a composite area index of disadvantage (mean 1026.8, sd=95.2) and household income. Purchasing behaviour was scored as continuous indices ranging from 0 to 100 for three food-types: fruits (mean 50.5, sd=17.8), vegetables (61.8, 15.2), and grocery items (51.4, 17.6), with higher scores indicating purchasing patterns more consistent with dietary guideline recommendations.

Setting: Brisbane metropolitan region, Australia, 2000

Participants: Persons aged 16-94 who were primarily responsible for their household's food purchasing.

Main results: Controlling for age, gender, and household income, a two standard deviation increase on the area-based SES measure was associated with a 2.01 unit-increase on the fruit purchasing index (95% CI -0.49 to 4.50). The corresponding associations for vegetables and grocery foods were 0.60 (-1.36 to 2.56) and 0.94 (-1.35 to 3.23). Prior to controlling for household income, significant area-level differences were found for each food, suggesting that clustering of household income within areas (a composition effect) accounted for the food purchasing variability between them.

Conclusions: Living in a socioeconomically disadvantaged area was associated with a tendency to have a healthier food purchasing profile, however, the magnitude of the association was weak-to-moderate and the 95% confidence intervals for area-SES included the null. Even though urban areas in Brisbane are differentiated on the basis of their socioeconomic characteristics, it seems unlikely that where you live shapes your procurement of food over and above your personal characteristics. This is in contrast to metropolitan regions of the US and Britain, where spatial segregation along socioeconomic lines is large enough to be detectable in people's food behaviour and dietary intakes.

Keywords: Socioeconomic status, diet, health inequalities

Introduction

A large literature shows that socioeconomic groups differ in their rates of mortality and morbidity for cardiovascular disease, type 2 diabetes, and many cancers, with the socioeconomically disadvantaged experiencing the poorest health.[1][2] Diet plays a role in the onset and progression of these degenerative conditions,[3][4][5] and it is increasingly believed that dietary differences between socioeconomic groups contributes in part to their different health profiles for chronic disease.[6][7]

Most studies investigating the relationship between socioeconomic status (SES) and diet have focused on individual-level factors. Sampled individuals are grouped on the basis of similar socioeconomic characteristics such as occupation, education or income, and these groupings are compared in terms of their dietary behaviours or food and nutrient intakes. Studies of this type often show that socioeconomically disadvantaged groups are least likely to engage in behaviours that accord with healthy eating messages, [8][9] and they are more likely to have food and nutrient intake profiles that parallel their higher rates of diet-related disease. [10][11]

During the last decade, researchers have increasingly called for a greater focus on the potential contribution of environments and places in terms of shaping and circumscribing the health-related behaviour of individuals. [12][13][14] It is argued that an improved understanding of the determinants of behaviour, and by extension, more effective approaches to advancing health, will necessarily require studies that consider the individual, their context or setting (eg neighbourhood, work, family), and interactions between these. Dietary studies of this type have been conducted in Britain, [15][16][17][18][19] Finland [20][21] and the US. [22][23][24] Despite differences in analytic method, and heterogeneity of area-unit, sample size, or how diet was measured, each study found evidence that area characteristics might influence diet independent of individual-level characteristics. The findings of some of these studies, however, are challengeable, as they were based on statistical methods that didn't allow for the partitioning of area- and individual-level sources of variation (ie between contextual and compositional effects). Less open to challenge are the findings of multilevel studies, which do allow for this partitioning, and of the few that have examined area variations in diet, each has provided suggestive evidence that both individual and contextual factors separately influence diet. [19][23][25] Specifically, these studies showed that residents of socioeconomically disadvantaged areas had poorer dietary intakes after adjusting for individual-level SES, suggesting that unmeasured features of the wider social and physical environment in disadvantaged areas acted to hinder the procurement and consumption of a healthy diet.

British and US researchers have identified a number of possible explanations for dietary differences between urban areas that vary in their socioeconomic characteristics. First, some socioeconomically disadvantaged areas are underserved by large supermarkets, [12][25][26] and as a result, residents are disproportionately reliant on smaller shops, which typically stock a limited range of foods, their prices are higher, and fresh food is often of a lesser quality. Second, socioeconomically disadvantaged groups sometimes experience difficulties accessing large (and often distant) shopping facilities because they lack private transport, or live in areas where public transport is inadequate or non-existent, [27][28][29] which also increases the likelihood that a greater amount of food is purchased from smaller local shops. Third, healthy foods (ie those consistent with dietary guideline recommendations) have been found to be less readily available in shops located in socioeconomically disadvantaged areas, and also more expensive than their less-healthful equivalents. [30][31]

In this paper, we add to the international evidence-base about context effects on diet by examining small-area variations in food purchasing behaviour among residents of Brisbane City, Australia. Specifically, we use multilevel modelling to determine whether there is variation between socioeconomically different areas in the purchase of fruits, vegetables, and grocery foods after controlling for personal and household sociodemographic characteristics. Significant area-level variation independent of individual- and household-level factors would raise the possibility that urban regions in Australia are differentiated on the basis of food availability, accessibility, and affordability, making the procurement of healthy food difficult for socioeconomically disadvantaged groups. In the US and Britain two societal-level processes have probably contributed to area-variations in diet. First, these countries have witnessed markedly increased spatial segregation of their populations along social and economic lines. [32][33][34] Second, this increasing socioeconomic polarisation appears to have been accompanied by concomitant changes to the structure and organisation of the food retail industry, such that supermarkets and large stores have disinvested in, and relocated from urban disadvantaged areas to regions characterised by large population-size and density, higher average incomes, and reduced operating costs. [35][36] While urban areas in Australia are also socially and economically segregated [37], the nature and extent of this separation appears qualitatively different (ie less extreme) than that observed elsewhere. In addition, this country hasn't seemingly undergone similar changes to the food retailing industry. As a result, it remains an open question whether or not urban areas in Australia are differentiated in their dietary behaviours in ways that are found in the US and Britain. [38]

Methods

The data were collected as part of the 2000 Brisbane Food Study (BFS). Details of the study's scope and coverage, its research design, sampling procedures, data collection methods, and representativeness have been published elsewhere. [39] Only a brief overview is provided here.

Sample design

The BFS was conducted in the Brisbane City Statistical Sub-Division (SSD). The sample comprised 1000 households and 50 Census Collectors Districts (CCD), and was selected using a stratified two-stage cluster design. A CCD is the smallest administrative-unit used by the Australian Bureau of Statistics (ABS) to collect census data. As at 1996, the Brisbane SSD consisted of 1517 contiguous CCD, each containing an average of 200 occupied private dwellings. Stratification consisted of ranking the CCD on the basis of each area's Index of Relative Socioeconomic Disadvantage (IRSD) score. A CCD's IRSD score is derived by the ABS using Principal Components Analysis, and it reflects the overall level of socioeconomic disadvantage of each area measured on the basis of attributes such as low income, low educational attainment, high levels of public sector housing, high unemployment, and jobs in relatively unskilled occupations. [40] The IRSD scores used in this present study were calculated from data collected in the 1996 Australian Census. The distribution of IRSD scores was subsequently divided into ten strata (deciles) and five CCD were selected from each of the strata using systematic without-replacement probability proportional to size sampling. The spatial and socioeconomic characteristics of the 50 CCD are presented in Figure 1. As would be predicted from the stratification process, the sampled CCD differed markedly on all key socioeconomic indicators.

FIGURE 1 ABOUT HERE

Stage 2 involved selecting 1000 private dwellings from the 50 CCD (20 dwellings on average per CCD), and this was undertaken using simple random sampling. Given the focus of the study, we interviewed the person within each dwelling who was primarily responsible for most of the food shopping. A final response rate of 66.4% was achieved. [39]

Data Collection

The individual-level data collection within each CCD occurred between September and December 2000, and was conducted on the basis of face-to-face interviews. Interviews lasted an average of one hour, and respondents were offered a small financial gratuity (AUS$10). The interview sought information on food purchasing choices, factors influencing choice, shopping practices, subjective perceptions of food availability and food prices, food expenditure, food and nutrition knowledge, and the sociodemographic characteristics of the respondent and other household head (if a couple household). Although the data were collected from a single individual, the interview questions elicited information about food purchasing patterns for the household as a whole.

Measures

Area-level SES for each CCD was measured using its IRSD score (see above).

Individual-level SES was measured by the study participant's estimate of total household income (including pensions, allowances, and investments) collected as a 14 category variable and subsequently re-coded into four categories for analysis: (1) less than AUS$20 799, (2) $20 800-36 399, (3) $36 400-51 999, and (4) $52, 000 or more. Households in categories 1 and 2 received incomes at or below the Australian average as at 2000, and those in categories 3 and 4, above the average. [41] Household income was used as the socioeconomic indicator for three reasons. First, income is a well established and important determinant of dietary quality, and impacts directly on a family's ability to afford and procure food. [42] Second, household income was likely to capture the socioeconomic characteristics of all people living in the household (reflecting individual-level incomes, and to some extent education and occupation) and therefore presumably embodied most of the within-household socioeconomic processes influencing food choice. Third, it seemed appropriate (substantively and analytically) to examine the relationship between SES and food purchasing using variables that were each measured at the same level (ie household), thus improving model specificity and fit.

Foods purchased for each household were classified into two broad groups: grocery items (including meat and chicken), and fruit and vegetables. Grocery purchasing was examined on the basis of 16 questions, each of which had two or more response categories. For example, respondents were asked: "When you go shopping, what type of bread do you usually buy?" The response options included: I do not buy bread, white, wholemeal, multigrain, white high in fibre, rye, soy and linseed, plus others. Multiple responses were permitted for each question. The other 15 questions were structured in an identical manner and pertained to rice, pasta, baked beans, fruit juice, tinned fruit, milk, cheese, yoghurt, beef mince, chicken, tinned fish, vegetable oil, margarine, butter, and solid cooking fat. In Australia, health promotion and education campaigns [43] directed at disseminating dietary guideline messages [44] recommend that people purchase and consume a variety of nutritious foods that are comparatively high in fibre, and low in fat, salt, and sugar. In keeping with these campaigns, we classified respondents' food purchasing choices into a 'recommended' and 'regular' category (Table 1).

TABLE 1 ABOUT HERE

Purchasing patterns for each grocery food-type were then scored as follows. Respondents were categorised as never purchasing the food (scored 0), as purchasing the regular option exclusively (scored 1), as purchasing a variety of food that included both the recommended and regular options (scored 2), or as purchasing the recommended option exclusively (scored 3). The food-types were then summed to form a purchasing index, and using an approach described elsewhere, [8][45] the index scores were adjusted to account for the fact that some people didn't purchase particular foods. This index was then scaled to range from range from 0 to 100, with high scores being indicative of greater compliance with dietary guideline recommendations.

Fruit purchasing information was elicited 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, tinned fruit, and dried fruit. The question item-set consisted of 19 fruits selected from the food frequency questionnaire used in the 1995 Australian National Nutrition Survey. [46] Respondents were asked to indicate their usual fruit purchasing pattern on the basis of five-point scales that ranged from never buy (scored 0) to always buy (scored 4). A fruit-purchasing index was created by summing the items, and scoring the measure to range from 0 to 100. Higher scores indicated that respondents regularly purchased many different types of fruits when shopping for their household (ie a high score was obtained by reporting "Always" or "Nearly always" for most of the fruits listed). In addition, high scores were consistent with two of the Australian Dietary Guideline recommendations, namely, "Eat a wide variety of nutritious foods", and "Eat plenty of….vegetables (including legumes) and fruits". [44]

Vegetable purchasing behaviour was measured using an identical format and method to that used for fruit. Respondents were asked to indicate how often they purchased 21 vegetables (including fresh and frozen, but excluding tinned or dried) using five-point items. These were subsequently summed to form an index and re-scored to range from 0 to 100, with higher scores being interpreted in the same way that was outlined for fruit purchase.

Analysis

Table 2 presents descriptive statistics for each of the measures used in this analysis. Of the 1000 households interviewed for the BFS, 24 declined to answer the income question, four did not know the income of other people in their household, and two provided insufficient information for their food purchasing behaviours to be reliably assessed. Each of these respondents was excluded, resulting in a final useable sample of 970.

The data were analysed as a two-level random intercept variance components model, using MLwiN version 2.1c. [47] Three models were specified for each food purchasing behaviour. First, a null model, comprising individuals (level 1) nested in CCDs (level 2) with no predictor variables in the fixed part of the model. Substantive interest for the null model focuses on the CCD-level random term, which if significant (indicated using chi-square), suggests between-area variation in food purchasing behaviour. For the null (and all other) models the intra-class correlation was calculated to estimate the percentage of total variance in food purchasing behaviour that was between the CCD (the remaining percentage is between-individual variation). The null model was subsequently extended to include fixed-effects for age, sex, and household income (Model 2) and then the exposure of interest in this study: area socioeconomic disadvantage (Model 3). The effect size for the area-SES variable was expressed as a two standard deviation increase in area-SES, which is equivalent to the difference in area-SES score between the median values for the top and bottom quartiles of the area-SES index. Improvements in the fit of the three nested models due to the successive inclusion of the fixed-effect variables were assessed using the deviance statistic.

TABLE 2 ABOUT HERE

Results

Table 3 presents the multilevel results for fruit purchasing behaviour. The CCD-level random term was significant (χ^2 = 4.96, p=0.025) indicating that the average purchasing score was not constant across the 50 small-areas. Of the total variability, 4.1% occurred between CCD and 95.9% between individuals. Thus whilst the vast majority of the variance in fruit purchasing behaviour was accounted for by individual-level factors, the null model tentatively suggested that area-characteristics might also independently contribute to this behaviour. Model 2 adds the fixed-effect terms for age, sex and household income. The coefficients and 95% CI indicate that older persons, females, and high income households had significantly higher fruit purchasing scores. The inclusion of these fixed effect terms significantly increased the overall fit of this model relative to the null model (χ^2 = 153.9, p<0.0001). The variance of the CCD-level random term, however, was reduced to non-significance after adjustments for compositional variations based on age, sex, and household income (χ^2 = 2.09, p=0.147). Model 3 adds the fixed term for area socioeconomic disadvantage, and this was only moderately related with fruit purchasing. A two standard deviation increase on the area-based SES measure was associated with a 2.01 unit-increase on the fruit purchasing index, and the confidence intervals included null (95% CI -0.49 to 4.50). The inclusion of area-SES made a negligible contribution to the fit of the fruit purchasing model (χ^2 = 2.43, p=0.119). For a model that included area-SES but not household income (results not shown), a two standard deviation increase in area-SES was associated with a 3.97 unit increase on the fruit purchasing index (95% CI 1.55 to 6.40).

TABLE 3 ABOUT HERE

Tables 4 and 5 present the equivalent results for vegetable and grocery purchasing respectively. The null models for both vegetable and grocery purchase showed that no statistically significant variation was evident at the CCD level: vegetables (χ^2 = 0.613, p=0.433), grocery foods (χ^2 = 0.581, p=0.445). In other words, apart from non-systematic sampling fluctuations, there were no differences in the purchasing scores among the 50 areas. The inclusion of the fixed terms for age, sex, and household income (Model 2) showed that these factors significantly improved the fit of each model (results for deviance tests not reported). For both vegetable and grocery purchasing, average index scores were significantly higher for older persons, females, and residents of high-income households. Area-SES was only weakly related with the purchase of vegetables and grocery foods (Model 3). A two standard deviation increase on the area-SES measure was associated with a 0.60 unit increase on the vegetable purchasing index (95% CI -1.36 to 2.56) and a 0.94 unit increase on the grocery index (95% CI -1.35 to 3.23). The inclusion of area-SES produced no statistically significant improvement in the fit of the models for vegetable and grocery purchasing. For models that included area-SES but not household income, a two standard deviation increase in area-SES was associated with a 1.86 unit increase on the vegetable index (95% CI 0.00 to 3.73) and a 3.22 unit increase on the grocery purchasing index (95% CI 1.04 to 5.39).

TABLES 4 AND 5 ABOUT HERE

Discussion

Multilevel studies conducted in the US and Britain have found evidence in support of contextual or neighbourhood socioeconomic effects on diet independent of individual-level factors. [19][23][25] Typically, residents of socioeconomically disadvantaged areas have poorer diets than those in more advantaged areas. Our study in the Brisbane metropolitan region suggests that small-area variation in the purchase of fruit, vegetables, and grocery foods mainly reflect spatial differences in the socioeconomic composition of the people living in the areas. Much of the apparent association of area-SES with food purchasing was due to confounding by household income. After controlling for household income, and the age and sex of respondents, a two standard deviation increase on the area-SES measure produced a modest increase of 2.01 units on the fruit purchasing index, with the 95% confidence interval including zero (-0.49 to 4.50), and very small unit increases for the vegetable (0.60, 95% CI -1.36 to 2.56) and grocery indexes (0.94, 95% CI -1.35 to 3.23). A two standard deviation change in area-SES was equivalent to the difference in score between the median values for the top and bottom quartiles of the area-SES measure, enabling an approximate comparison with the effect-sizes between the high and low categories of household income. This comparison shows that the area-SES effect for fruit purchasing was only about 25% of the household income association, and about 10% of the income association for vegetable and grocery purchase.

Our findings of a null, or at best modest association of area-SES with food purchasing behaviour suggest that urban areas in Brisbane are not highly differentiated on the basis of food availability, accessibility, or affordability – unlike the US and Britain, where living in a socioeconomically disadvantaged area appears to act as a hindrance to the procurement and consumption of healthy food. US research has shown that socioeconomically disadvantaged neighbourhoods are underserved by supermarkets relative to more advantaged areas [24][26][29][35][49] and that intakes' of fruits and vegetables are linked with the number of supermarkets in a neighbourhood. [25] This work is consistent with results reported by ecologic studies conducted in Britain. [12][27][28][31] There is little Australian research that can be used to help interpret the essentially negative findings of this multilevel study, however, some research does exist, and it provides evidence (albeit indirect) supporting the likely limited impact of contextual or neighbourhood effects on food purchasing in Brisbane. Two studies published in the early 1990s reported that foods being recommended in the Australian Dietary Guidelines were affordable by low income families; indeed, some diets based on the guidelines were actually cheaper than a more traditional diet. [50][51] A later representative study of the Brisbane population in 1993, found that although socioeconomic groups differed significantly in terms of their food purchasing choices, most respondents from all socioeconomic groups shopped at large supermarkets where dietary guideline food was readily available, few reported difficulties accessing these shops, and the price difference between recommended and regular foods was, in most cases, small or nonexistent. [38] Further, as part of the BFS, we collected information on the number and types of food-shops, and their location and distance vis-à-vis the sampled households, and preliminary (unpublished) results are suggesting that socioeconomically advantaged and disadvantaged areas of Brisbane are similarly served by food shops.

Importantly, our results and conclusions about the likely limited effect of area-SES on food purchasing behaviour in Brisbane needs to be considered against a number of study limitations. First (and with the benefit of hindsight) our study was seemingly under-powered to detect statistically significant contextual effects. This notwithstanding however, the association of area-SES with each outcome variable was in the expected direction, thus whilst a larger study may have found statistically significant area effects due to increased precision, it is unlikely that a larger sample would have found a substantially increased strength of association between area SES and food purchasing behaviour. Second, we only controlled for one individual-level socioeconomic factor as a potential confounder (ie income), which argues against there being any true contextual effect. If we had controlled for other (potentially confounding) individual-level socioeconomic factors such as occupation or education, then it is likely that the already weak-to-moderate area-SES effect would have further reduced to the null. Third, it is possible that our study was adversely influenced by selection or information bias, although we are uncertain of the likely magnitude and direction of this bias. As with most multilevel studies [52][53] our areal units were selected for reasons of sampling and analytic convenience rather than for reasons that were hypothesized to influence food purchasing behaviour, and this would probably underestimate area-SES associations. Further, non-differential misclassification bias of food purchasing would likely result in an underestimate of the area-SES association and the (confounding) income association. In short, the net effect of measurement error in our multilevel study (and multivariable models generally) is unclear. [54][55[56] Fourth, the inclusion of individual-level covariates in multilevel analyses may result in over-control, which argues for the possibility of a true contextual-effect on food purchasing behaviour in Brisbane. Household income, for example, may in part depend on where you live or on cumulative small-area effects over the lifecourse. Given each of these limitations, the finding of no significant area-SES effect needs to be viewed circumspectly, and further research in a variety of settings is required before more definitive conclusions can be reached.

There is now a large body of Australian and international research that has examined the relationship between individual-level SES and diet, with diet most often being measured on the basis of food and nutrient intake. [8] These studies usually find that socioeconomically disadvantaged groups have intakes that are least in accord with minimal risk for the onset of chronic disease. [10][11][57][58] The individual-level results of the BFS adds to this research, and shows that low income households were less likely to purchase foods consistent with recommendations promulgated in diet-related promotion messages. For each food-type, purchasing score was graded across the income categories, suggesting a high degree of income sensitivity to the purchase of healthy food.

In sum, this first-known Australian multilevel study of diet found little evidence that food purchasing behaviour in Brisbane was influenced by area-level socioeconomic disadvantage. Thus despite the fact that major urban areas in this country are differentiated on the basis of their social and economic characteristics [37] this doesn't seem to be sufficient to shape and circumscribe the procurement of food. It appears that what matters most in Brisbane City in terms of food purchasing behaviour is the socioeconomic characteristics of individuals and their households, rather than the socioeconomic characteristics of the areas in which they live. This Australian finding seems to be in contrast with countries like the US and Britain, where the nature and extent of spatial segregation along social and economic lines is large enough to be detectable in people's dietary behaviour.

Key Points

- In the US and Britain, area-level socioeconomic status is associated with food and nutrient intake and dietary behaviour independent of individual-level socioeconomic characteristics
- Within Brisbane City, Australia, there is no convincing association between area-level socioeconomic status and food purchasing behaviour
- Much of the apparent association of area socioeconomic status with food purchasing in Brisbane was due to confounding by household income, thus the clustering of household income within areas (a composition effect) accounted for the food purchasing variability between them
- Despite urban areas in Brisbane being differentiated in their socioeconomic characteristics, this doesn't seem to influence the procurement of healthy food, which is in contrast to that found in other countries

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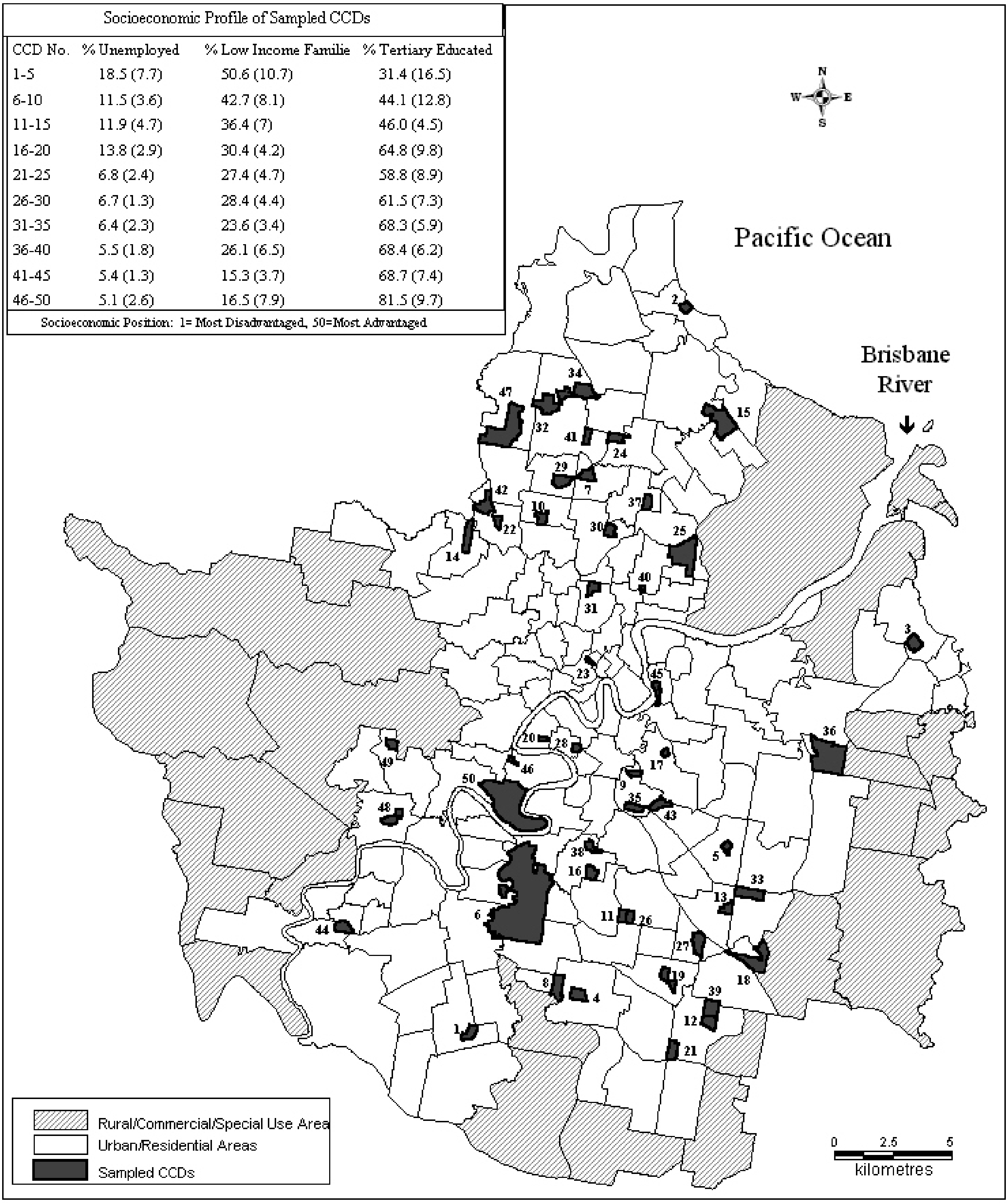
Figure 1: **Sampled Census Collectors Districts (CCDs) in the Brisbane Statistical Sub-Division and their Socioeconomic Characteristics**



Socioeconomic Profile of Sampled CCDs

CCD No.	% Unemployed	% Low Income Familie	% Tertiary Educated
1-5	18.5 (7.7)	50.6 (10.7)	31.4 (16.5)
6-10	11.5 (3.6)	42.7 (8.1)	44.1 (12.8)
11-15	11.9 (4.7)	36.4 (7)	46.0 (4.5)
16-20	13.8 (2.9)	30.4 (4.2)	64.8 (9.8)
21-25	6.8 (2.4)	27.4 (4.7)	58.8 (8.9)
26-30	6.7 (1.3)	28.4 (4.4)	61.5 (7.3)
31-35	6.4 (2.3)	23.6 (3.4)	68.3 (5.9)
36-40	5.5 (1.8)	26.1 (6.5)	68.4 (6.2)
41-45	5.4 (1.3)	15.3 (3.7)	68.7 (7.4)
46-50	5.1 (2.6)	16.5 (7.9)	81.5 (9.7)

Socioeconomic Position: 1= Most Disadvantaged, 50=Most Advantaged

Table 1: Classification of grocery food-types into 'recommended' and 'regular' categories*

Food-type	Recommended †	**Regular**
Bread	Wholemeal, multigrain, white high in fibre, rye, soy and linseed	White
Rice	Wholemeal or brown	White
Pasta	Wholemeal or brown	White
Baked Beans	Salt-reduced or unsalted	Regular salt
Fruit Juice	No added sugar (unsweetened)	Added sugar, fruit drink (5-35% fruit juice)
Tinned Fruit	In natural juice	In syrup
Milk	Reduced fat (Trim), low fat (Skim), high calcium (Physical, Shape), high calcium skim (Physical), high iron (Life), high protein (Lite White), reduced lactose (Lactaid), no cholesterol (Dairy Wise), soy or soy & linseed (Skim)	Extra Creamy, full cream, soy or soy & linseed (full cream)
Cheese	Reduced Fat (25% less fat), low fat (<10% fat)	Full fat
Yoghurt	Low-Fat (plain and fruit)	Full fat (plain and fruit)
Beef Mince	Lean (Trim/Premium)	Regular (Choice/Fine Grade)
Chicken	Breast fillet without skin, thigh fillet without skin, drumstick without skin	Breast fillet with skin, thigh fillet with skin, drumstick with skin, wings, whole chicken with skin
Tinned Fish	In spring water	In oil or brine
Vegetable Oil	Canola, sunflower, safflower, olive, corn, soy sesame	Peanut, sesame, blended edible, macadamia
Margarine	Salt-reduced, fat-Reduced	Regular salt, full fat
Butter	Salt-reduced, unsalted	Regular salt
Solid Cooking Fat	Margarine, solidified oil	Solid animal fat (lard, beef dripping), vegetable shortening

* The food types are based on the five core food-groups of the Australian Guide to Healthy Eating, [43] and findings of the 1995 Australian National Nutrition Survey. [46] † Food options endorsed in dietary guideline publications and considered preferable choices to minimise risk for the development of diet-related diseases. [44]

Table 2: Descriptive statistics for the fixed-effect variables and food purchasing indexes

Fixed-effect variables		
Sex of main food purchaser (N, %) *		
Male	207	21.3
Female	763	78.7
Household income (N, %)		
$52,000 or more	407	42.0
$36400 – 51999	173	17.8
$20,800 – 36399	206	21.2
≤$20799	184	19.0
Age of main food purchaser (Mean, SD)		45.2 (16.7)
Area socioeconomic disadvantage (Mean, SD)†		1026.8 (95.2)
Food purchasing indexes (Mean, SD)‡		
Fruit		50.5 (17.8)
Vegetables		61.8 (15.2)
Grocery		51.4 (17.6)

* Interviews were conducted with the person in each household who was primarily responsible for food shopping, and given that females typically purchased the food, they represented 78.7% of the final sample. † Area scores ranged from 634.8 to 1184.2, with lower scores indicating greater socioeconomic disadvantage. ‡ Each food purchasing index was scored to range from 0 – 100, with higher indicating greater compliance with dietary guideline recommendations.

Table 3: Area and individual-level effects on fruit purchasing (random intercept models)*

Areas = 50 Individuals = 970	Model 1 (null model)		Model 2 (plus age, sex, & household income)		Model 3 (plus area disadvantage)	
Constant	50.46		40.43		29.55	
Fixed effects			Est.	95%CI	Est.	95% CI
Age of main food purchaser			0.34	0.27, 0.41	0.33	0.26, 0.40
Sex of main food purchaser (male)			-10.74	-13.25, -8.23	-10.69	-13.20, -8.18
Household income						
$52,000 or more			--	--	--	--
$36,400 – 51,999			-0.68	-3.62, 2.24	-0.44	-3.39, 2.50
$20,800 – 36,399			-5.76	-8.55, -2.98	-5.29	-8.14, -2.46
≤ $20, 799			-8.60	-11.84, -5.36	-7.85	-11.23, -4.48
Area socioeconomic disadvantage†					2.01	-0.49, 4.50
Random effects variance	Est.	SE	Est.	SE	Est.	SE
Level 2 (areas)	12.94	5.81	5.58	3.85	4.69	3.65
Level 1 (individual)	304.03	14.16	262.79	12.24	262.79	12.23
Deviance	8328.02		8174.04		8171.61	
Intraclass correlation (%) ‡	4.08		2.08		1.74	

* The fruit purchasing index ranged from 0 – 100, with higher scores indicating a wider variety and greater regularity of fruit purchase. † Expressed as a two standard deviation effect-size. ‡ The proportion of the total variance in fruit purchasing behaviour that is between the Census Collectors Districts (small urban areas)

Table 4: Area and individual-level effects on vegetable purchasing (random intercept models)*

Areas = 50 Individuals = 970	Model 1 (null model)		Model 2 (plus age, sex, & household income)		Model 3 (plus area disadvantage)	
Constant	61.81		57.52		54.27	
Fixed effects			Est.	95%CI	Est.	95% CI
Age of main food purchaser			0.17	0.11, 0.24	0.17	0.11, 0.23
Sex of main food purchaser (male)			-9.11	-11.34, -6.88	-9.10	-11.34, -6.87
Household income						
$52,000 or more			--	--	--	--
$36,400 – 51,999			-0.06	-2.65, 2.53	0.03	-2.57, 2.65
$20,800 – 36,399			-1.93	-4.39, 0.52	-1.75	-4.28, 0.77
≤ $20, 799			-6.27	-9.11, -3.44	-5.97	-8.97, -2.97
Area socioeconomic disadvantage †					0.60	-1.36, 2.56
Random effects variance	Est.	SE	Est.‡	SE	Est.	SE
Level 2 (areas)	2.20	2.81	0.00	0.00	0.00	0.00
Level 1 (individual)	230.58	10.73	211.20	9.59	211.12	9.58
Deviance	8038.58		7944.99		7944.63	
Intraclass correlation (%) §	0.94		0.00		0.00	

* The vegetable purchasing index ranged from 0 – 100, with higher scores indicating a wider variety and greater regularity of fruit purchase. † Expressed as a two standard deviation effect-size. ‡ See Snijders and Bosker (p.57) for a discussion of why level 2 random effects variance can be estimated as zero. [48] § The proportion of the total variance in vegetable purchasing behaviour that is between the Census Collectors Districts (small urban areas)

Table 5: Area and individual-level effects on grocery purchasing (random intercept models) *

Areas = 50 Individuals = 970	Model 1 (null model)		Model 2 (plus age, sex, & household income)		Model 3 (plus area disadvantage)	
Constant	51.40		46.80		41.72	
Fixed effects			Est.	95%CI	Est.	95% CI
Age of main food purchaser			0.21	0.14, 0.29	0.21	0.14, 0.28
Sex of main food purchaser (male)			-4.49	-7.10 -1.88	-4.47	-7.08, -1.86
Household income						
$52,000 or more			--	--	--	--
$36,400 – 51,999			-5.46	-8.48, -2.44	-5.30	-8.35, -2.25
$20,800 – 36,399			-6.98	-9.86, -4.12	-6.69	-9.65, -3.74
≤ $20, 799			-9.22	-12.54, -5.91	-8.74	-12.26, -5.23
Area socioeconomic disadvantage †					0.94	-1.35, 3.23
Random effects variance	Est.	SE	Est.‡	SE	Est.	SE
Level 2 (areas)	2.84	3.73	0.00	0.00	0.00	0.00
Level 1 (individual)	307.33	14.30	288.80	13.55	288.61	13.10
Deviance	8317.05		8248.53		8247.88	
Intraclass correlation (%) §	0.91		0.00		0.00	

* The grocery purchasing index ranged from 0 – 100, with higher scores indicating a greater compliance with dietary guideline recommendations. † Expressed as a two standard deviation effect-size. ‡ See Snijders and Bosker (p.57) for a discussion of why level 2 random effects variance can be estimated as zero [48] § The proportion of the total variance in grocery purchasing behaviour that is between the Census Collectors Districts (small urban areas)