Health Place. Author manuscript; available in PMC 2013 June 12.

Published in final edited form as:
Health Place. 2012 November ; 18(6): 1292–1299. doi:10.1016/j.healthplace.2012.09.003.

Variety and quality of healthy foods differ according to neighbourhood deprivation

Christina Black[a,b], **Georgia Ntani**[a], **Ross Kenny**[c], **Tannaze Tinati**[a], **Megan Jarman**[a,b], **Wendy Lawrence**[a], **Mary Barker**[a], **Hazel Inskip**[a], **Cyrus Cooper**[a], **Graham Moon**[d], and **Janis Baird**[a]

[a]Medical Research Council Lifecourse Epidemiology Unit (University of Southampton), Southampton General Hospital Tremona Road, Southampton SO16 6YD England [b]NIHR Biomedical Research Unit in Nutrition, Diet and Lifestyle, University Hospital Southampton NHS Foundation Trust, Tremona Road, Southampton SO16 6YD England [c]Faculty of Medicine University of Southampton, University Road, Southampton SO17 1BJ England [d]Geography and Environment University of Southampton, University Road, Southampton SO17 1BJ England

Introduction

Quality of diet is associated with level of disadvantage (Ball et al. 2004;McLaren 2007;Robinson et al. 2004) and this inequality is costly to the individual and society (Foresight 2007). There is growing evidence that the physical food environment is an important determinant of dietary behaviour and obesity (Holsten 2009), and governments are recognising the need to adapt the food environment to make healthier choices easier for consumers (Department of Health 2010;National Institutes of Health 2011).

Glanz et al (2005) have developed a conceptual model to guide food environment research. This model has become widely-used and links dietary behaviours to four environmental settings: *community nutrition environments, consumer nutrition environments, organisational nutrition environments* and *information environments*.

Most of the food environment research to date has focused on *community nutrition environments*, specifically spatial access to supermarkets (Burns et al. 2007). Research in the US has shown that the presence of a local supermarket is associated with increased intake of fruit and vegetables (Morland et al. 2002;Zenk et al. 2009). Two recent reviews have illustrated that low-income and minority neighbourhoods in the US have poor access to supermarkets and healthier food choices (Larson et al. 2009;Walker et al. 2010). Evidence from other developed countries is less consistent (Amuzu et al. 2009;Shohaimi et al. 2004;Turrell et al. 2009) and uncertainties about inequalities in the neighbourhood food environment remain. The evidence for area differences in the *consumer nutrition environment* (factors that affect customers whilst inside the food store such as the cost, quality and variety of food products) has been highlighted as an area requiring additional investigation (Thornton et al. 2010b).

Corresponding author: Christina Black, Address: MRC Lifecourse Epidemiology Unit (University of Southampton), Southampton General Hospital Tremona Road, Southampton SO16 6YD England, Ph: +44 23 8076 4042, Fax: +44 23 80704021, cb@mrc.soton.ac.uk.
Email addresses for each author: cb@mrc.soton.ac.uk gn@mrc.soton.ac.uk Ross.Kenny@nhs.net tt@mrc.soton.ac.uk mj@mrc.soton.ac.uk wtl@mrc.soton.ac.uk meb@mrc.soton.ac.uk hmi@mrc.soton.ac.uk cc@mrc.soton.ac.uk G.Moon@soton.ac.uk jb@mrc.soton.ac.uk

There are no conflicting interests.

Europe PMC Funders Author Manuscripts

A recent review investigating the consumer nutrition environment shows that store size is associated with cost and availability of healthy products, with larger supermarkets having more products available at a cheaper price than smaller grocery and convenience stores (Gustafson et al. 2012). Price and availability trends by level of neighbourhood deprivation however, remain unclear; while studies in the US have tended to find differences between neighbourhoods and prices for availability of healthier food items, studies conducted in other countries have generally reported no association (Gustafson et al. 2012). Several studies from the US have demonstrated low availability (Andreyeva et al. 2008;Franco et al. 2009) and higher prices of healthy foods in disadvantaged areas (Chung et al. 1999;Hendrickson et al. 2006). Outside the US the literature regarding the consumer nutrition environment is limited. In Australia, one study showed no difference in availability and price of fruit and vegetables by neighbourhood deprivation (Winkler et al. 2006) whilst another showed a slight favouring of availability in higher-income areas but cheaper prices in low-income neighbourhoods (Ball et al. 2009).

In the UK, consumer nutrition environment research in Scotland has suggested that availability and price of fresh fruit and vegetables in lower income areas is not significantly different to higher income areas (Cummins et al. 2002;Cummins et al. 2010). There is a gap in the literature about the role of other consumer nutrition environment factors including variety and quality, and limited evidence in the UK outside the Scottish context. While there is some evidence in the US and UK to suggest that the quality of fresh produce is poorer in low-income neighbourhoods (Block et al. 2006;Cummins et al. 2009;Sloane et al. 2003) few studies have examined spatial differences in product variety and quality, even though these factors may affect consumers' purchasing patterns (Ball et al. 2009;Cummins et al. 2009;Thornton et al. 2010a). Product variety considers the range of product options available to the consumer and enables consumer choice. The quality of fresh fruit and vegetables can also influence purchasing behaviour; if a product is damaged or looks unappealing it is less likely to be purchased (Cummins et al. 2009).

The aims of this study were to extend the evidence about spatial differences in consumer nutrition environment factors to Southern England and contribute to the body of literature that is, unravelling their contribution to dietary inequalities. As a preliminary, we assessed spatial access to supermarkets and grocery stores. We then compared the availability, price and variety of a range of healthy and less healthy foods, and the quality of fruit and vegetables across five levels of neighbourhood deprivation in Southampton, a relatively deprived city in the affluent south of England.

Methods

Neighbourhood deprivation

We measured 'neighbourhood deprivation' using the 2007 income domain of the Index of Deprivation (ID). This measure is provided for Lower Super Output Areas (LSOA), small areas that are focused on social homogeneity and a defined population size (1000-1500 residents) (Noble et al. 2008). LSOAs provide an important tool for identifying the most disadvantaged areas in England and provide the best quality data for comparison across levels of area deprivation. The ID is based on seven distinct domains of deprivation that are recognised and measured separately. In this study we allocated each LSOA in Southampton to a quintile of deprivation by dividing the national rank of the 2007 ID income domain (calculated by the number of individuals seeking financial welfare benefits) (Noble, McLennan, Wilkinson, Whitworth, Barnes, & Dibben 2008) into fifths (1=most deprived and 5=least deprived). We chose not to use the full ID because it includes an access to services domain (which includes access to grocery stores) and because the income domain is the strongest individual component of the composite ID (22.5% weighting).

Study sample – grocery stores

A list of all grocery stores and their postcodes within the Southampton City Council boundary was compiled in July 2010. Store postcodes were used to identify the LSOA in which each store was located.

Southampton is the 91st most deprived local authority out of a total of 354 in England (Southampton City Council 2010). Store postcodes were obtained through desktop analysis of the local council food safety register and on-line service directories including yellow-pages and yell.com. The stores were classified into six categories in descending store size: large supermarkets, discount supermarkets, small supermarkets, world stores (selling predominantly international foods), convenience stores and petrol station stores. Field observation by trained workers confirmed the existence and category of stores during in-store data collection conducted over 9 weeks from July to September 2010.

Consumer nutrition environment data

Data were collected in all grocery stores using a Consumer Nutrition Environment Tool. This tool was developed to measure the availability, price and variety of 12 products, and the quality of two fruits and four vegetables in each store. We defined availability as whether a food product was available for purchase, and recorded the price of the cheapest item, per kilo, in the product range; reduced prices because of expiring sell-by-date were not recorded. Variety was defined as the number of different choices within the product range that were available for purchase, and considered factors such as product flavour, product size, fair trade/ organic range or no-name/ low-cost range. The numbers of varieties were specific to each product and were outlined in our Consumer Nutrition Environment Tool protocol. Information on the quality of fruit and vegetables was collected using the quality indicator in the Health Eating Indicator Shopping Basket (HEISB) tool (Cummins et al. 2009). Quality was assessed visually, based on a three-point Likert scale (1=poor, 2=medium, 3=good).

The 12 food products included in the Consumer Nutrition Environment Tool were selected based on three criteria: ability to predict healthy or less healthy dietary patterns of women of childbearing age (Crozier et al. 2010); high frequency of consumption in England (Food Standards Agency 2009); and the feasibility of being measured by an in-store survey. The 12 products were a subset of items from a 20-item food frequency questionnaire (FFQ) used to characterise better and poorer dietary patterns in women of childbearing age (Crozier et al. 2010) which was derived from the Southampton Women's Survey 100-item FFQ data (Crozier et al. 2008). For analysis purposes, the 12 products were categorised in three ways: all products, healthy products and less healthy products. Healthy products included: peppers, tomatoes, lettuce, onions, apples, bananas and wholemeal bread. Less healthy products included: oven chips, sausages, crisps, sugar and white bread.

Permission to complete the survey was sought from shop managers prior to administration and fieldwork was carried out by trained staff from July to September 2010. Surveys for a selection of ten grocery stores were repeated by all fieldworkers individually, during the same time period, in order to assess inter-rater reliability.

Statistical analyses

We used the Chi Square test for trend to investigate differences in product availability (present/absent), variety (1-2 or 3+ varieties) and quality (good/medium or poor), and Spearman's correlation coefficient to assess cheapest price across the five levels of neighbourhood deprivation and six grocery store types. Poisson regression models were fitted to explore the associations of variety and quality with the five levels of neighbourhood

deprivation. The two most affluent neighbourhood fifths were combined in the analysis of quality because of the small number of observations. Adjusted prevalence ratios were estimated fitting Poisson regression analysis with robust variance (Barros et al. 2003). The level of agreement between fieldworkers on measures of variety and quality was assessed by the Kappa statistic. The statistical analysis was performed using Stata version 11.0 (Statacorp 2009).

Results

Nearly all grocery stores in Southampton agreed to take part in the study (195 out of a possible 198; three store managers refused to participate). Of the 146 LSOAs within the Southampton City Council boundary, 90 contained at least one grocery store. There were more LSOAs in Southampton classified as most deprived (19.2%) than least deprived (12.3%). The distribution of LSOAs with at least one grocery store by level of deprivation is summarised in Table 1. Approximately 70% of LSOAs in the most and second most deprived levels had at least one grocery store compared with only 50-52% in the two most affluent levels.

Figure 1 details the distribution of grocery stores and the levels of LSOA deprivation in Southampton. LSOAs characterised by the three middle layers of deprivation had substantially more supermarkets (large, discount and small) than both the most and least deprived LSOAs. The most deprived LSOAs housed no large or discount supermarkets and one of the least deprived LSOAs had a discount supermarket. Table 2 summarises the distribution of store types across the five levels of neighbourhood deprivation: convenience stores (39.5%) are most prevalent across the city, followed by small supermarkets (22.1%) and world stores (22.1%). Discount supermarkets (3.6%) and large supermarkets (4.1%) were less prevalent.

Table 3 shows the difference in food product availability, price, variety and quality according to level of ID. We found no difference in the availability or median cheapest price of the 12 products between the different levels of neighbourhood deprivation (p=15, p=0.71, respectively). Nor did we find a difference in the availability or median cheapest price for the seven healthy products (p=0.35, p=0.44 respectively) or five less healthy products (p=0.19, p=0.71 respectively) according to level of ID. We did, however, find that the variety of all 12 products and the quality of fruit and vegetables differed significantly by neighbourhood deprivation (p=0.009 and p=0.003 respectively). Variety and quality improved with increasing levels of neighbourhood affluence. We assessed the variety of healthy and less healthy products by level of LSOA ID separately and found that the significant association observed for all products was explained by differences in the number of choices of healthy products (p=0.001) rather than less healthy products (p=0.46).

Table 4 shows our examination of these consumer nutrition environment variables by grocery store type. We found that the difference in availability, median price and variety of both healthy and less healthy products varied significantly across the different store types (all p<0.001). We also found a significant difference in quality of fruit and vegetables by store type (p=0.02). Large supermarkets had 100% of products surveyed, more than three varieties for each product and good quality fruit and vegetables. The poorest availability of both healthy and less healthy items was observed in petrol station stores. Discount supermarkets offered the cheapest median price for healthy products, and equal cheapest with world stores for the less healthy products. Petrol station stores had the dearest median price for less healthy items and convenience stores the dearest for healthy items.

The risk of having low variety and poor quality products was assessed by Poisson regression modelling after adjusting for the possible confounding effect of price, as shown in Table 5. Stores in the poorest neighbourhoods were 11-34% more likely to have low variety of healthy products and 69-74% more likely to have poor quality fruit and vegetables when compared with stores in less deprived neighbourhoods.

The inter-rater reliability was calculated to assess the variation in reporting amongst the four fieldworkers. We observed good inter-rater reliability for variety of products (kappa=0.83), although the inter-rater reliability for quality of fruit and vegetables was poorer (kappa=0.33).

Discussion

The community nutrition environment in Southampton was characterised by higher density of grocery stores in LSOAs in the two most deprived levels of deprivation, where over two thirds of neighbourhoods contained at least one grocery store. There were fewer neighbourhoods categorised as more affluent with grocery stores which suggests that residents living in the poorer neighbourhoods of Southampton had better access to grocery stores than the more affluent residents. However, when we limited our examination to the presence of supermarkets we found that access was highest for LSOAs in the three middle levels of deprivation, with over a third of the LSOAs in these classifications having access to a local supermarket. It may therefore be that residents in the poorest areas of Southampton have good access to stores, but primarily convenience stores which tend to sell fewer products at higher prices (Cummins & Macintyre 2002).

Our findings about supermarket density being poorer in the most and least deprived areas differ from previous UK research which showed no difference in the numbers of supermarkets across LSOA fifths, or better access to supermarkets in poorer areas of Glasgow (Cummins et al. 1999;Macdonald et al. 2009) Our data describing spatial access to supermarkets also differ from previous research in Canada and New Zealand (Apparicio et al. 2007;Pearce et al. 2008;Smoyer-Tomic et al. 2008), but are consistent with research from Wales and Northern England, and Australia (Burns & Inglis 2007;Clarke et al. 2002). Our observation that the poorest LSOAs in Southampton were more likely to contain a convenience store than a supermarket is consistent with previous research from Glasgow and New Zealand (Macdonald et al. 2009;Pearce et al. 2008). The higher presence of convenience stores in the poorest areas of Southampton may be considered a spatial inequality. Residents of poorer areas may be disproportionately disadvantaged by their local stores because they are less likely to have access to a private car to travel to other shopping opportunities and may also be more likely to keep daily activities to a more localised space (Coveney et al. 2009;Cummins et al. 2005).

Our consumer nutrition environment survey results further confirm that product availability, price, variety and quality differ by size and type of grocery store. We found that large supermarkets sold a high variety of all healthy and less healthy products surveyed and that discount supermarkets offered the cheapest price for these healthy and less healthy products. By contrast convenience stores, the second smallest store type we surveyed, stocked the dearest healthy products and had less than half of these healthy products available for purchase. Similarly, convenience stores were more likely to sell poor quality fruit and vegetables than larger supermarkets. These findings are consistent with previous US studies which have shown that the availability of foods from a healthy food basket significantly improves with store size (Laska et al. 2010), and that discount supermarkets offer the cheapest price for a selection of healthy foods and convenience stores the highest price (Block & Kouba 2006).

Our analysis of the consumer nutrition environment in Southampton also showed that there was no difference in the availability or cheapest price of all, healthy and unhealthy food products examined across the five different levels of neighbourhood deprivation. We did, however, observe a significant difference in the variety of healthy products and quality of fresh fruit and vegetables across the five levels of neighbourhood deprivation. Poorer variety and quality were more frequent in more deprived neighbourhoods. After controlling for price, we found that residents living in the most deprived neighbourhoods had 11-34% greater risk of low variety of healthy products, and 69-76% greater risk of poor quality fruit and vegetables than residents living in more affluent neighbourhoods of Southampton.

The lack of association between availability and price of food products and level of neighbourhood deprivation found in our study is consistent with a recent study which found that level of neighbourhood deprivation was not a predictor of the price of 15 types of fruit and vegetables in Scotland (Cummins et al. 2010). The Scottish study further concluded that the availability and price of healthy foods was more closely associated with store type and having access to a medium or large supermarket, rather than level of neighbourhood deprivation (Dawson et al. 2008). Unlike the evidence from US which shows higher cost of healthy foods in disadvantaged urban areas (Chung & Myers 1999;Hendrickson et al. 2006), it appears that the few studies from the UK show little difference between poorer and more affluent neighbourhoods.

There is little research investigating variety and quality and our study is, to our knowledge, the first to have examined product variety according to neighbourhood deprivation in the UK. Our findings suggest that affluent areas have a greater variety of healthy products than poorer areas. Consistent findings have been observed in Australia where studies in Brisbane and Melbourne showed that variety of vegetables was highest in the most affluent areas and poorest in the most disadvantaged areas (Ball et al. 2009;Winkler et al. 2006). A US study by Zenk et al (2009) found a positive trend for area affluence and fruit and vegetables variety, however the association was not significant. A more recent US study showed a significant positive association between fruit and vegetable variety and the probability that consumers purchase fruits and vegetables (Martin et al. 2012). It should be noted that the measure of variety in these US studies differed from that used in the current study, which measured variety of a specific food product (ie. number of different types of peppers) rather than overall variety of a product range (ie number of vegetables). These differing definitions of variety may influence study findings. A study that investigated the quality of fruit and vegetables by neighbourhood deprivation in Scotland revealed results similar to ours, that stores in more deprived neighbourhoods tended to have the lowest quality fruit and vegetables (Cummins et al. 2009). Similarly, research from the US has shown lower quality fresh produce in low income neighbourhoods (Block & Kouba 2006;Glanz et al. 2007). Our findings concerning quality thus confirm existing knowledge and show variations in quality by neighbourhood deprivation are also applicable in the different setting of Southern England.

Strengths and limitations

A key strength of our study was that information on 99% of grocery stores in the city of Southampton was collected. A particular strength of the Consumer Nutrition Environment Tool was the consideration of product variety and quality as additional variables influencing consumer choice. The results of our study illustrate the importance of considering variety in order to provide a more accurate interpretation of the availability of healthy and less healthy products beyond a product being available or not.

One limitation of our study was the subjective measurement of fruit and vegetable quality as shown by the low inter-rater reliability results. Future work may benefit from using

photographs or a simple two-point scale of acceptable/ unacceptable to provide a more accurate measure of product quality.

A more significant limitation was our use of a count of grocery stores within LSOAs as a measurement of access to grocery stores. This container method assumes that grocery shopping opportunities are constrained by administrative geographies and confined to area close to home. It does not consider boundary issues such as the location of grocery stores in neighbouring areas or connectivity issues such as railway, river or road barriers. We acknowledge that alternative approaches, such as a buffer zone around each grocery store, could have been applied however, would have fractured the social homogeneity of LSOA blocks for the study. Future analyses will compare individualised activity zones and LSOA boundaries.

A third limitation is the cross sectional and ecological nature of this study. Cross sectional studies assume that outcome variables are stable over time. However, variables such as price, availability and quality of food products are likely to vary as a result of external factors including seasonal variation, wholesale supply and transport costs. In addition, ecological analysis does not permit us to assess whether there was a direct link between the environmental determinants and individual dietary patterns. The Consumer Nutrition Environment Tool measured the environmental exposures to foods indentified as predictors of better and poorer dietary patterns among women of childbearing age which means our findings may not be generalisable to the broader population. Our study also excluded specialty stores such as green grocers and butchers and therefore does not consider the full local food environment. For feasibility reasons only food stores selling both shelf and fresh foods were included in our study.

Implications

Variety within a product range may be an important influence on purchasing patterns. It has been suggested that taste is the most important influence on dietary choices (Glanz et al. 1998a). We speculate that whether or not a consumer's preference is available may also determine if they do or do not purchase the product. For example, if a consumer prefers red apples and only green apples are available they may not purchase any apples. Furthermore, product quality may impact on dietary inequalities in a similar way. Cummins et al (2009) suggest that if an item is bruised, blemished or moulding it may be less likely to be purchased. We found that fresh items fitting this description were more apparent in the most disadvantaged neighbourhoods.

While these observational findings suggest that product variety and quality may be environmental determinants of dietary inequalities further work is needed to provide a clear understanding of how these factors are contributing to or caused by consumer choice. Is lower variety and quality the result of poor turnover and financial loss for store managers, or is it because the fresh produce available is not enticing enough for consumers to buy? Research from Connecticut, US shows that non-supermarket food retailer managers perceive there is little consumer demand for healthy foods, but the introduction of government subsidies encouraged retailers to supply healthy foods according to the subsidy guidelines (Andreyeva et al. 2011). Efforts to improve the variety and quality of healthy products in more disadvantaged neighbourhoods in the UK may encourage consumers to purchase and consume more fresh produce. However, incentives and support for store managers to endure short periods of financial loss may be required for such strategies to be successfully implemented.

The lack of difference in price between affluent and more deprived neighbourhoods should not negate the impact that the cost of food can have on the household budgets of less

affluent families. Research has shown that healthy foods can be more expensive than less healthy products (Drewnowski 2010;Mooney 1990) and that the cost of food is the second most influential factor on food purchasing and consumption patterns after taste (Glanz et al. 1998b). Unlike research from Australia which showed lower food prices in more deprived neighbourhoods (Ball et al. 2009;Winkler, Turrell, & Patterson 2006), we found that the cheapest price of healthy, less healthy and all products combined was similar across the five levels of neighbourhood deprivation. We speculate that this similarity in food price may be contributing to dietary inequalities in the UK because consumers who have a limited disposable income are constrained by how much they can spend on food. They are therefore more adversely affected by food prices (Furey et al. 2002). This raises an interesting question about the term 'affordability' because what is affordable to higher income earners may not be affordable for consumers with lower incomes or those who rely on receiving benefits.

Conclusion

Our results suggest that stores in more affluent LSOAs have significantly more variety and better quality of healthy food products and that these two environmental factors may be contributing to the poorer dietary choices of residents in the most deprived neighbourhoods. Our study helps address a gap in the food environment literature and suggests that the variety and quality of healthy food products should be considered in addition to accessibility, availability and affordability in future research investigating associations between the local food environment and dietary inequalities. Further research is required to explore with consumers and store managers, the underlying reasons for differences in variety and quality between affluent and poorer areas. Efforts to improve the variety and quality of healthy products in more disadvantaged neighbourhoods in the UK may encourage consumers to purchase and consume more fresh produce and thus reduce dietary inequalities.

Acknowledgments

We are grateful to the managers of the grocery stores we visited, to Jamie Lawrence for assistance with data collection and Greg Deakin for computing support. We are also grateful to all those working on the Southampton Initiative for Health, the larger intervention project of which this study is part. This study is funded by the Medical Research Council (UK), NIHR Biomedical Research Unit (Nutrition, Diet and Lifestyle), University Hospital Southampton NHS Foundation Trust, and is supported by NHS Southampton City. Christina Black is a NIHR Doctoral Research Fellow.

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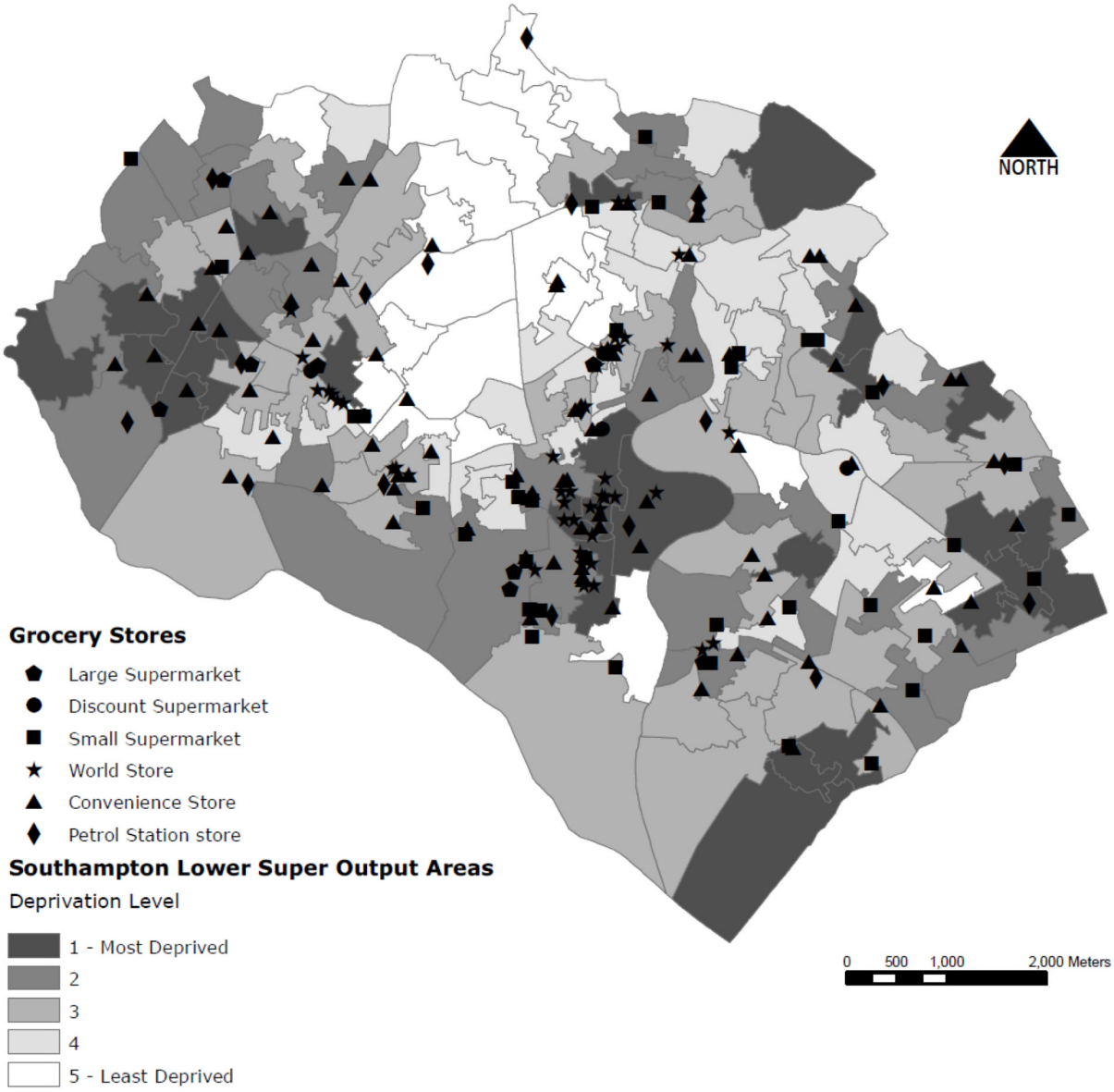

Figure 1. Map of Southampton showing type of grocery store by level of area deprivation

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Table 1
Distribution of LSOAs and grocery stores by level of deprivation

	ID=1 Most deprived	ID=2	ID=3	ID=4	ID=5 Least deprived
Number LSOAs (n = 146)	28	32	41	27	18
Number LSOAs with ≥1 grocery store	19 (67.9%)	23 (71.9%)	25 (61.0%)	14 (51.9%)	9 (50.0%)

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Table 2

Distribution of grocery stores by store type across levels of area deprivation

	ID=1 Most deprived	ID=2	ID=3	ID=4	ID=5 Least deprived	Total
Large supermarkets	0	4 (50.0%)	2 (25.0%)	2 (25.0%)	0	8 (4.1%)
Discount supermarkets	0	1 (14.3%)	3 (42.9%)	2 (28.6%)	1 (14.3%)	7 (3.6%)
Small supermarkets	7 (16.3%)	17 (39.5%)	11 (25.6%)	5 (11.6%)	3 (7.0%)	43 (22.1%)
World stores	12 (27.9%)	14 (32.6%)	12 (27.9%)	4 (9.3%)	1 (2.3%)	43 (22.1%)
Convenience stores	15 (19.5%)	21 (27.3%)	23 (29.9%)	12 (15.6%)	6 (7.8%)	77 (39.5%)
Petrol station stores	3 (17.7%)	4 (23.5%)	8 (47.1%)	0	2 (11.8%)	17 (8.7)
Total	37 (19.0%)	61 (23.5%)	59 (30.3%)	25 (12.8%)	13 (6.7%)	195

Table 3

The availability, variety and quality, and median price of observed food products according to level of LSOA Index of Deprivation (ID)

	ID=1 Most deprived	ID=2	ID=3	ID=4	ID=5 Least deprived	p-value
Availability (n (%)) **(7 healthy products)**						0.35[a]
Yes	162 (62.6%)	240 (56.2%)	257 (63.2%)	109 (62.3%)	59 (64.8%)	
No	97 (37.4%)	187 (43.8%)	156 (37.8%)	66 (37.7%)	23 (35.2%)	
Availability (n (%)) **(5 unhealthy products)**						0.19[a]
Yes	152 (82.2%)	257 (84.3%)	254 (86.1%)	104 (83.2%)	59 (90.7%)	
No	33 (17.8%)	48 (15.7%)	41 (13.9%)	21 (16.8%)	6 (9.3%)	
Cheapest price (£/kg) **(7 healthy products)** (median (IQR))	1.99 (1.29, 2.99)	1.89 (1.22, 3.00)	1.96 (1.49, 3.09)	1.96 (1.30, 2.94)	2.06 (1.35, 3.00)	0.44[b]
Cheapest price (£/kg) **(5 unhealthy products)** (median (IQR))	1.54 (1.00, 4.99)	1.55 (0.99, 4.60)	1.53 (0.99, 5.00)	1.38 (0.99, 3.44)	1.81 (1.03, 5.64)	0.71[b]
Variety (n (%)) **(7 healthy products)**						0.001[a]
≥3 varieties	27 (16.7%)	79 (33.2%)	64 (24.9%)	38 (34.9%)	25 (42.4%)	
1 or 2 varieties	135 (83.3%)	159 (66.8%)	193 (75.1%)	71 (65.1%)	34 (57.6%)	
Variety (n (%)) **(5 unhealthy products)**						0.46[a]
≥3 varieties	89 (58.6%)	167 (65.0%)	157 (61.8%)	66 (63.5%)	39 (66.1%)	
1 or 2 varieties	63 (41.4%)	90 (35.0%)	97 (38.2%)	38 (36.5%)	20 (33.9%)	
Quality (n (%)) **(6 fruit & vegetables)**						0.003[a, c]
Good/ medium	114 (85.1%)	177 (95.7%)	197 (96.1%)	132 (96.4%)		
Poor	20 (14.9%)	8 (4.3%)	8 (3.9%)	5 (3.6%)		

The number of observations for each variable shown in the table are not equal because of missing data and because quality was only recorded for the six fruit and vegetables. Price was missing for 26 products and variety was missing for two products out of a total of 1653 products recorded as available. Quality was missing for 26 products out of a total of 687 fruit and vegetables recorded as available.

[a] Chi squared test for trend

[b] Spearman test for trend

[c] ID=4 and ID=5 were merged because of the small number of observations

Table 4

The availability, variety and quality, and median price of observed food products according to level of LSOA Index of Deprivation

	Large supermarket	Discount supermarket	Small supermarket	World store	Convenience store	Petrol station store	p-value
Availability (n (%)) **(5 unhealthy products)**							<0.001[a]
Yes	40 (100%)	35 (100%)	213 (99.1%)	134 (62.3%)	343 (89.1%)	61 (71.8%)	
No	0	0	2 (0.9%)	81 (37.7%)	42 (10.9%)	24 (28.2%)	
Availability (n (%)) **(7 healthy products)**							<0.001[a]
Yes	56 (100.0%)	45 (91.8%)	290 (96.4%)	136 (45.2%)	251 (46.6%)	49 (41.2%)	
No	0	4 (8.2%)	11 (3.6%)	165 (54.8%)	288 (53.4%)	70 (58.8%)	
Cheapest price (£/kg) **(5 unhealthy products)** (median (IQR))	0.97 (0.59-1.86)	0.94 (0.59-1.67)	1.55 (1.02-2.75)	1.24 (0.99-6.24)	1.62 (0.99-5.26)	1.81 (1.30-8.23)	<0.001[b]
Cheapest price (£/kg) **(7 healthy products)** (median (IQR))	1.53 (0.84-2.08)	1.49 (1.00-1.96)	1.96 (1.27-3.24)	1.49 (1.11-2.20)	2.50 (1.69-3.13)	2.20 (1.64-3.59)	<0.001[b]
Variety (n (%)) **(5 unhealthy products)**							<0.001[a]
≥3 varieties	40 (100.0%)	28 (80.0%)	174 (81.7%)	55 (41.0%)	191 (55.7%)	30 (49.2%)	
1 or 2 varieties	0	7 (20.0%)	39 (18.3%)	79 (59.0%)	152 (44.3%)	31 (50.8%)	
Variety (n (%)) **(7 healthy products)**							<0.001[a]
≥3 varieties	56 (100.0%)	23 (51.1%)	104 (36.0%)	23 (16.9%)	18 (7.2%)	9 (18.4%)	
1 or 2 varieties	0	22 (48.9%)	185 (64.0%)	113 (83.1%)	232 (92.8%)	40 (81.6%)	
Quality (n (%)) **(6 fruit & vegetables)**							0.02[a]
Good/ medium	45 (100.0%)	37 (100.0%)	224 (94.9%)	103 (91.2%)	177 (90.3%)	34 (100.0%)	
Poor	0	0	12 (5.1%)	10 (8.8%)	19 (6.7%)	0	

[a] Chi squared test for trend

[b] Spearman test for trend

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Table 5

The relative risk of having low variety of healthy foods and poor quality fruit and vegetable according to level of neighbourhood deprivation

	Low Variety[a] (healthy foods)		Poor Quality[b] (fruit and vegetables)	
	Relative risk[c] (95%confidence interval)	*p-value[e]*	*Relative risk[c] (95% confidence interval)*	*p-value[f]*
Level of ID				
1 = most deprived	Baseline		Baseline	
2	0.81 (0.72, 0.91)	<0.001	0.31 (0.14, 0.69)	0.004
3	0.89 (0.80, 0.98)	0.019	0.27 (0.12, 0.60)	0.001
4	0.79 (0.68, 0.91)	0.002	0.26 (0.10, 0.67)	0.006[d]
5=least deprived	0.66 (0.53, 0.83)	<0.001		

[a] After adjusting for price

[b] After adjusting for price and variety

[c] Relative risks were estimated from Poisson regression models

[d] ID=4 and ID=5 were merged because of the small number of observations

[e] Test for trend p<0.001

[f] Test for trend p=0.007