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Do perceptions of the neighbourhood food environment predict fruit and vegetable intake in low-income neighbourhoods?

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Abstract

The aim of this study is to investigate the extent to which perceptions of the quality, variety and affordability of the local food retail provision predict fruit and vegetable intake. Secondary analysis of baseline data from the Philadelphia Neighbourhood Food Environment Study was undertaken. This study investigating the role of the neighbourhood food environment on diet and obesity comprised a random sample of households from two low-income Philadelphia neighbourhoods, matched on socio-demographic characteristics and food environment. The analytic sample comprised adult men and women aged 18–92 (n=1263). Perception of food environment was measured using five related dimensions pertaining to quality, choice and expense of local food outlets and locally available fruits and vegetables. The outcome, portions of fruits and vegetables consumed per day, was measured using the Block Food Frequency Questionnaire. Results from multivariate regression analyses suggested that measured dimensions of perceived neighbourhood food environment did not predict fruit and vegetable consumption. Further investigation of what constitutes an individual's 'true' food retail environment is required.

Keywords

Fruit and vegetable consumption; food retail environment; neighbourhood; perceptions of food environment

Background

A diet rich in fruits and vegetables provides satiety and hydration without excessive energy intake, protecting against obesity (Drewnowski, 2004). Increasing the proportion of fruits and vegetables in the diet also protects against CVD and a number of cancers, as vegetable

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matter is low in saturated fats (Van Duyn & Pivona, 2000). However socioeconomic inequalities in fruit and vegetable consumption have been widely reported, with deprived individuals reporting lower intake of fruits and vegetables compared to their more affluent counterparts (CDC, 2010). Researchers have also long reported neighbourhood-level variations in diet, with neighbourhood deprivation independently predicting food consumption (Forsyth *et al.*, 1994). In order to account for these variations, it has been suggested that differences in the structure of the built food environment between deprived and affluent neighbourhoods exist, and that exposure to poor quality food environments in deprived areas amplifies the individual-level risk factors for poor diet (Macintyre, 2007). The relationship between the food environment and diet has been hypothesised as the primary mechanism through which obesogenic settings operate (Caspi *et al.*, 2012). Understanding this relationship is therefore of importance to population health improvement.

Previous work in this field has sought to describe and quantify local food environments, and investigate the ways in which their characteristics predict fruit and vegetable intake. These studies can broadly be divided into two groups: (i) those which have used Geographic Information Systems (GIS) and/or store audits to objectively measure dimensions of the food environment (e.g., Glanz *et al.*, 2007; Bodor *et al.*, 2012; Thornton *et al.*, 2012); and (ii) those which have used survey data to capture respondents' perceptions of their local food environments (e.g. Williams *et al.*, 2012; Inglis *et al.*, 2007; Blitstein *et al.*, 2012). Only a few studies have used a combination of these approaches (e.g. Gustafson *et al.*, 2011; Sharkey *et al.*, 2010; Zenk *et al.*, 2009). In their systematic review of work on the relationship between the food environment and diet, Caspi *et al.* (2012) noted that those using perceived measures of the food environment were very low in number, compared to those using objective/GIS-based methods. However, these approaches are complementary and both are informed by a strong theoretical framework which has emerged from the literature, dividing the food environment into *community* and *consumer* dimensions (Glanz *et al.*, 2005). Charriere *et al.*, (2010) advocated the appropriation of Penchansky and Thomas's five healthcare access dimensions to encapsulate the characteristics of the food environment: availability, accessibility, affordability, acceptability and accommodation (Penchansky and Thomas, 1981). As described by Caspi *et al.* (2012), evidence of a relationship between these dimensions and fruit and vegetable intake is mixed. Most studies which have measured perceptions of food *availability* found a significant association between perceived high availability of fruits and vegetables, and intake (Inglis *et al.*, 2008; Moore *et al.*, 2008; Sharkey *et al.*, 2010; Blitstein *et al.*, 2012). In contrast, evidence for an association between perceived *accessibility* and fruit and vegetable intake has been mixed, with both positive (Blitstein *et al.*, 2012) and null (Inglis *et al*., 2008; Gustafson *et al.*, 2011; Lucan *et al.*, 2012) associations reported. Evidence of an association between perceived *affordability* of fruits and vegetables and intake is also inconclusive, with some studies showing an association with increased intake (Zenk *et al.*, 2005) and others reporting null (Sharkey *et al.*, 2010; Blitstein *et al.*, 2012) or counterintuitive (Inglis *et al.* 2008) findings. Stronger evidence has been found for an association between perceived *acceptability* and fruit and vegetable intake (Inglis *et al.*, 2008; Sharkey *et al.*, 2010, Zenk *et al.*, 2005; Blitstein *et al.*, 2012), although null findings have also been reported (Dean *et al.*, 2011;

Lucan *et al.*, 2012). Findings from studies which used objective measures to quantify these dimensions of the food environment, such as store audits and GIS methods, are even more heterogenous and inconclusive.

The present study aims to contribute to the evidence base by assessing the extent to which perceived availability, affordability and acceptability of the neighbourhood food environment predict fruit and vegetable consumption in two ways. Firstly, we investigate whether perceptions related to the general food retail environment (perceived quality of grocery stores in the neighbourhood; perceived level of choice of different types of grocery stores in the neighbourhood) are associated with fruit and vegetable intake. Secondly, whether perceptions directly related to fruit and vegetable consumption (perceived quality of fruits and vegetables available in the neighbourhood; perceived variety of fruits and vegetables available in the neighbourhood and perceived expense of fruits and vegetables available in the neighbourhood) are associated with fruit and vegetable intake.

Methods

Study background

Baseline data from the Philadelphia Neighbourhood Food Environment Study were used. This was a prospective quasi-experimental study in two Philadelphia neighbourhoods investigating the effects of a supermarket intervention and the role of the neighbourhood food environment on diet and obesity. For the present study, only cross-sectional data from the 2006 pre-intervention baseline were used. The study neighbourhoods were selected for the purpose of matched comparison based on race/ethnicity, socioeconomic characteristics and food environment characteristics. The two site boundaries (intervention and control) were based on aggregations of contiguous census tracts (9 and 10 tracts). For the intervention site, the selection was based on a 1-mile radius around a proposed intervention store with all full and part census tracts falling within the radius constituting the study neighbourhood. For the control neighbourhood selection was based on a 1-mile radius based around a potential site of a store. The neighbourhoods are 3–4 miles apart and both lie within Philadelphia County, approximately equidistant from the downtown area. Both sites were similar on race/ethnic structure, age structure, and other demographic indicators. Moreover, at the time of the study (2006), both neighbourhoods were considered ‘food deserts’ as there was relatively limited full-service food retail available. Data from a Nutrition Environment Measure Survey (NEMS) undertaken as part of the fieldwork showed that at baseline, both sites had two grocery stores and 55/56 convenience stores (Glanz *et al.*, 2007). The accessibility of these food retail outlets is described in detail by Fuller *et al.*, (2013). The mean distance from participants’ homes to their primary food store was 3.6km (± SD 3.1km) (Fuller *et al.*, 2013). The baseline telephone survey of residents in these two neighbourhoods was conducted in 2006. The baseline consisted of a random directory-listed and random-digit dialled telephone survey of a representative sample of residents of households in each of the two neighbourhoods. Respondents were contacted with a pre-notification letter along with a $1 cash incentive. Following this letter, a telephone survey was completed by the household primary food shopper and questions relating to diet, perceptions of the neighbourhood food environment, along with a range of socio-

demographic data were collected. To be eligible, households had to be located in either of the two neighbourhoods and to have one primary food shopper aged 18 years of age or older residing within the home. Respondents received $20 for participation. The sample size at baseline was 1440, representing a 47.2% screener response rate (response rate 2 defined by the American Association for Public Opinion Research (AAPOR, Version 7)). This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the *[name of the ethics committee removed for blinding]*. Verbal informed consent was obtained from all subjects. Verbal consent was witnessed and formally recorded.

Variables

The baseline questionnaire contained five statements designed to capture respondents' perceptions of their neighbourhood food retail environment, each addressing a distinct dimension. These measures were adapted from those used in the Perceived Availability of Health Foods Scale in the Multi Ethnic Study of Atherosclerosis (MESA) study (Mujahid *et al.*, 2007). Two pertained to the general food retail environment and three specifically to environmental factors related to fruit and vegetable consumption. Respondents were asked to state the extent to which they agreed or disagreed with these statements, with five possible responses: *strongly disagree; disagree; no preference; agree; strongly agree*. The five statements were as follows: (1) there is a good choice of different types of grocery stores in my neighbourhood; (2) the quality of grocery stores in my neighbourhood is good; (3) the choice of fresh fruit and vegetables to purchase in my neighbourhood is good; (4) the quality of fresh fruit and vegetables to purchase in my neighbourhood is good; (5) fresh fruit and vegetables in my neighbourhood are expensive. These five continuous variables were used as five separate exposure variables in the analyses. Perception of fruit and vegetable expense was reverse-coded so that 'agreement' indicated the most positive situation for all five dimensions. The outcome, fruit and vegetable consumption, was operationalized as the number of fruit and vegetable portions consumed per day and was derived, using standard algorithms (CDC 2005–2006), from responses to the Block Food Frequency Questionnaire (Block FFQ), which measures the intake of 10 fruits and 12 vegetables over the past month (Block *et al.*, 1986). Consistent with past research, and to limit the influence of outliers, the Block FFQ was truncated at 15 items per day in these analyses (Michels *et al.*, 2006).

Statistical analysis

For the purposes of this study, the baseline sample was restricted to those who provided complete information on all analytic variables, yielding a study sample size of 1263. Descriptive analysis was performed to determine the distribution of responses for each of the food retail environment exposure variables and for the outcome, fruit and vegetable consumption. In order to determine whether each dimension of perceived food retail environment was predictive of fruit and vegetable consumption, five unadjusted linear regression models were run for each exposure variable. A range of demographic and socioeconomic factors were then added to each of these models as hypothesised confounding covariates. These were: age (in years); sex; race/ethnicity (white, black, Hispanic or other); presence of children under 12 in the household (yes/no); household income (greater/less than $40,000 per year – the approximate median household income in

Pennsylvania in the 2000 US Census); completed secondary education (yes/no); employment status (employed, unemployed, economically inactive); and mode of transport for food shopping (private/public transport). All statistical analyses were performed using Stata 12 (StataCorp, 2011).

Results

Description of the characteristics of the study sample with regard to exposure, outcome and selected socioeconomic and demographic indicators is provided in Table 1. The sample had a mean age of 48 (SD 16.21) and was predominantly black (85%), female (78%), economically inactive or unemployed (53%) and low income (72%) with an annual household income of <US$40,000. Mean daily fruit and vegetable consumption was 3.6 portions per day (SD 2.4).

Table 1 shows high levels of heterogeneity in perceptions of the relatively homogenous local food environment. The sample was evenly divided on their perception of the quality of grocery stores (with 49% agreeing that the quality of grocery stores in their neighbourhood is good and 45% disagreeing with this statement). The perceptions that locally available fruits and vegetables are of good quality and variety are also fairly evenly split (with 56% and 55% agreeing, respectively). Thirty-six percent agreed that there is a good choice of different types of grocery stores in their neighbourhood, and 61% report that fruits and vegetables are expensive. These descriptive analyses paint a discordant picture of how a relatively homogenous local food environment is perceived by its residents. Table 2 shows results from the series of linear regression models investigating associations between the five dimensions of perceived food retail environment and daily fruit and vegetable intake. There were no significant associations between the measured dimensions of neighbourhood food environment and fruit and vegetable consumption, neither in bivariate nor multivariate analyses. Those who perceived a greater choice of grocery stores in their neighbourhood, and who perceived local grocery stores to be of higher quality did not have a statistically significantly higher intake of fruit and vegetables per day than those who reported little choice and low quality (choice: adjusted b −0.03, p=0.53; quality: adjusted b −0.03, p=0.64). Similarly, those who perceived a greater choice of fruits and vegetables available in their neighbourhood, and who perceived locally available fruits and vegetables to be of higher quality did not have a statistically significantly higher intake than those who reported little choice and low quality (choice: adjusted b 0.03, p=0.64; quality: adjusted b −0.01, p=0.81). Perception of locally available fruit and vegetables as inexpensive did not predict greater consumption of these foodstuffs than perception of expense (adjusted b 0.04, p=0.51).

Discussion

This study aimed to investigate the extent to which perceived availability, affordability and acceptability of the neighbourhood food retail environment predicted fruit and vegetable intake. Factors pertaining to the general food retail environment, and those directly related to fruit and vegetable intake were considered. The results presented here suggest that perceived availability, affordability and acceptability of the neighbourhood food environment did not predict fruit and vegetable consumption. These null findings contradict those of other studies

on similar urban, low-income populations (Zenk *et al.*, 2005; Blitstein *et al.*, 2012), but corroborate null findings from another Philadelphia-based study (Lucan *et al.*, 2012) and in the wider literature (e.g. Sharkey *et al.*, 2010).

A number of study limitations must be considered when interpreting these findings. This is a cross-sectional study in two low-income, predominantly African-American communities with a heavily female sample. Our findings therefore require confirmatory studies in other settings and populations. The use of complete case analyses may have introduced bias, but we did not find any systematic bias in missing data. As the sample was predominantly African American, it is possible that the Block FFQ may exclude some fruits and vegetables which are culturally specific to this study population (Grigsby-Toussaint *et al.*, 2010).

The lack of consensus among the study participants as to the quality of the local food environment may provide clues as to the reasons underlying the results reported here. It may be that people do not rely solely on their local food environment for fruit and vegetable shopping; sourcing these items outside of the area they define as their neighbourhood. Some current work suggests that only considering the neighbourhood food environment may seriously underestimate exposure to the food environment (Burgoine & Monsivais, 2013). This may mean that even though overall access to acceptable food outlets may be an important factor, access at the neighbourhood level may be less important. However, this relationship is likely to be complex. Using the same Philadelphia dataset as the present study, Fuller *et al.*, (2013) found that objectively measured distance to primary food store did not predict fruit and vegetable consumption, irrespective of the mode of transport used for shopping journeys. However, in a similar study population Caspi *et al.*, (2012) found that while living within objectively measured walking distance to a supermarket did not predict fruit and vegetable intake, living within perceived walking distance did. The authors comment that the discordance observed between objective and subjective measures of supermarket access suggests that these are tapping into different constructs; concluding that perceived measures of the food environment may be important predictors of diet quality (Caspi *et al.*, 2012). Indeed, other studies (Zenk *et al.*, 2005; Blitstein *et al.*, 2012) have shown that perceptions of the local food environment are significantly associated with this outcome. The contradictory results reported here may therefore reflect a flawed individual notion of ‘neighbourhood’. In certain settings, the ‘local’ may not the most appropriate scale of interest. Good access to food may include the availability of resources several miles from home (for the mobile), or closer to the place of employment (Cummins, 2007; Purcell & Brown, 2005; Purcell, 2005; Born & Purcell, 2006). A priority for future research should focus on investigating where individuals shop, how far they travel, and what geographical scale constitutes their ‘food retail environment’.

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Research highlights

- Previous research provides mixed evidence that positive perceptions of the local fruit and vegetable retail environment are independently associated with a higher intake of these foods.
- This study contributes to the evidence base by investigating the relationship between perceptions of the food retail environment and fruit and vegetable intake in two low-income neighbourhoods of Philadelphia, USA.
- Perceived quality, choice and affordability of local food retail options did not predict fruit and vegetable intake.
- Perceived quality, variety and affordability of locally available fruits and vegetables did not predict level of consumption.

Table 1

Descriptive characteristics of 1263 respondents drawn from two neighbourhoods in Philadelphia, USA, Summer 2006.

Variable	N	%
Age		
18–35 years	314	25.0
36–55 years	524	41.5
56–75 years	363	28.7
76+ years	62	4.9
Sex		
Male	276	21.9
Female	987	78.2
Ethnicity		
White	100	7.9
Black	1074	85.0
Hispanic	38	3.0
Other	51	4.0
Education		
Did not graduate high school	200	15.8
High School Graduate	467	37.0
Further Education	596	47.2
Household Income		
<$40,000pa	910	72.1
>$40,000pa	353	28.0
Employment Status		
Employed	589	46.6
Unemployed	182	14.4
Economically inactive	492	39.0
Children in household		
No children in household	857	67.9
1+ children in household	406	32.2
Perceptions of food environment		
The quality of grocery stores in my neighbourhood is good		
Strongly Agree	64	5.1
Agree	556	44.0
No opinion or preference	72	5.7
Disagree	419	33.2
Strongly Disagree	152	12.0
There is a good choice of different types of grocery stores in my neighbourhood		
Strongly Agree	78	6.2
Agree	380	30.1
No opinion or preference	43	3.4

Variable	N	%
Disagree	503	39.8
Strongly Disagree	259	20.5
The quality of fresh fruit and vegetables to purchase in my neighbourhood is good		
Strongly Agree	89	7.1
Agree	622	49.3
No opinion or preference	65	5.2
Disagree	375	29.7
Strongly Disagree	112	8.9
The choice of fresh fruit and vegetables to purchase in my neighbourhood is good		
Strongly Agree	101	8.0
Agree	589	46.6
No opinion or preference	66	5.2
Disagree	378	29.9
Strongly Disagree	129	10.2
Fresh fruit and vegetables in my neighbourhood are expensive		
Strongly Agree	199	15.8
Agree	570	45.1
No opinion or preference	83	6.6
Disagree	377	29.9
Strongly Disagree	34	2.7
Fruit and Vegetable Intake		
Mean Block Food Frequency Questionnaire score: 3.6		
Standard deviation: 2.4		

Table 2

Results from series of five bivariate and multivariate linear regression models, investigating the relationship between each dimension of perceived food environment and fruit and vegetable consumption (number of portions per day, measured using the Block FFQ).

	Model 1: Grocery store choice		Model 2: Grocery store quality		Model 3: Choice of F&V		Model 4: Quality of F&V		Model 5: F&V are inexpensive	
	Unadjusted b	Adjusted b	Unadjusted b	Adjusted b	Unadjusted b	Adjusted b	Unadjusted b	Adjusted b	Unadjusted b	Adjusted b
Food environment exposure	−0.03	−0.03	−0.01	−0.03	0.02	0.03	0.02	0.01	0.03	0.04
Male		0.00		0.00		0.00		0.00		0.00
Female		0.02		0.02		0.00		0.00		0.00
Age		0.01*		0.01*		0.01*		0.01*		0.01*
Ethnicity: Black		0.00		0.00		0.00		0.00		0.00
Ethnicity: White		−0.21		−0.21		−0.20		−0.21		−0.21
Ethnicity: Hispanic		0.72		0.72		0.71		0.71		0.71
Other ethnicity		0.44		0.43		0.43		0.43		0.42
Income <$40k		0.00		0.00		0.00		0.00		0.00
Income >$40k		0.28		0.28		0.28		0.28		0.28
<High school education		0.00		0.00		0.00		0.00		0.00
High school graduate		0.11		0.10		0.09		0.09		0.10
Higher education		0.20		0.19		0.18		0.18		0.19
Employed		0.00		0.00		0.00		0.00		0.00
Unemployed		−0.14		−0.14		−0.13		−0.13		−0.13
Economically inactive		0.06		0.07		0.07		0.07		0.07
No children under 12		0.00		0.00		0.00		0.00		0.00
Children under 12		−0.50*		−0.50*		−0.51*		−0.51*		−0.51*
Household size		0.24*		0.24*		0.24*		0.24*		0.24*

n=1263.

*Statistically significant at the 5% level