

Deprivation, diet, and food-retail access: findings from the Leeds 'food deserts' study

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Abstract. Within a context of public policy debate in the United Kingdom on social exclusion, health inequalities, and food poverty, the metaphor of the 'food desert' caught the imagination of those involved in policy development. Drawing from a major cross-disciplinary investigation of food access and food poverty in British cities, the authors report in this paper findings from the first 'before/after' study of food consumption in a highly deprived area of a British city experiencing a sudden and significant change in its food-retail access. The study has been viewed as the first opportunity in the United Kingdom to assess the impact of a *non-healthcare intervention* (specifically a retail-provision intervention) on food-consumption patterns, and by extension diet-related health, in such a deprived, previously poor-retail-access community. The paper offers evidence of a positive but modest impact of the retail intervention on diet, and the authors discuss the ways in which their findings are potentially significant in the context of policy debate.

Introduction

During the late 1990s, significant government-led policy debate in the United Kingdom on the tackling of social exclusion and the reduction of health inequalities produced a focus on the linkages which might exist between compound social exclusion, poor food-retail access, compromised diets, and poor health in deprived urban neighbourhoods. Areas of poor access to the provision of healthy affordable food where the population is characterized by deprivation and compound social exclusion became known as *food deserts* (Beaumont et al, 1995; DoH, 1996). It was a metaphor which caught the imagination of those involved in policy development, not least because it encouraged a shift in focus in health-promotion activity (Lang and Caraher, 1998).

It soon became clear, however, that it was a metaphor which urgently needed 'unpacking' and subjecting to critical evidence-based assessment. In response, a number of major cross-disciplinary investigations of food access and food poverty in British cities were funded by the research councils and government departments and are currently in progress. In this paper we report findings from one part of one of those studies—specifically the first 'before/after' study of food consumption in a highly deprived area of a British city experiencing a sudden and significant change in its food-retail access. Adopting the terminology of the Department of Health (DoH, 1999a), the study has been viewed as offering the first opportunity in the United Kingdom to assess the impact of a *non-healthcare intervention* (specifically a retail provision intervention) on food consumption patterns (and by extension diet-related health) in such a deprived, previously poor-retail-access community. The findings reported in the paper are novel and potentially significant in the context of public policy debate. As such, the paper attempts both to contextualize those findings within on-going debates on social exclusion, health inequalities, and food poverty, and to provide sufficient technical

information on the nature of the study to allow researchers working on these issues to judge the quality of the results reported.

Policy context: tackling social exclusion and the ‘food deserts’ debate

Tackling social exclusion in British cities was a major policy priority of the first Blair administration. Immediately after the election of a Labour government in 1997 a Social Exclusion Unit was set up within the Cabinet Office and, by September 1998, that Unit had presented to parliament its action report *Bringing Britain Together: A National Strategy for Neighbourhood Renewal*. Drawing on a wide range of academic and government department research, some of it by geographers (for example, Dorling, 1997; Green et al, 1998), the report highlighted the increasingly polarized position of the poorest neighbourhoods in Britain, beset by poverty, unemployment, poor health, and crime, and lacking basic public and private services (Speak and Graham, 1999). Noting that, between 1979 and 1994/95, net incomes after housing costs of the richest tenth of the population had grown by 68%, whereas those of the bottom tenth had fallen by 8% and that the proportion of children growing up in households with below half the average income had increased from 10% to 32%, it provided evidence of a process of local polarization in the geography of poverty, with the most deprived households becoming increasingly concentrated in small areas of acute need. [For further discussion of the nature of this polarization, including the segregation of ‘work-rich’ from ‘work-poor’ households over the period, see Green (1994), Dorling and Woodward (1996), and a useful review of research on this topic by Mohan (2000).] In these areas, poor health provided a key marker of social exclusion and there was disturbing evidence, outlined by the influential *Independent Inquiry into Inequalities in Health* (Acheson, 1998) of progressively widening health inequalities between acutely deprived neighbourhoods and elsewhere.

In response to the report, and the perceived limitations of the many previous initiatives (for example, the Urban Programme, the Urban Development Corporations, and the Single Regeneration Budget) aimed at tackling the problems of poor neighbourhoods, the *National Strategy for Neighbourhood Renewal* proposed eighteen cross-cutting action teams, involving ten government departments, working on a fast track to develop policy solutions. Each team was to be championed by a minister, and the government committed itself to completing the work by the end of 1999 and developing a coherent action plan during the following year. The timetable was adhered to, and by early 2001 *A National Strategy Action Plan* (Social Exclusion Unit, 2001a; 2001b) had been produced, summarizing the work of the Policy Action Teams (PATs) and outlining new policies, funding, and targets, ways of improving local coordination of initiatives and services and of stimulating community empowerment, and new national and regional support structures.

One of the teams involved in this process, PAT 13, had been led by the Department of Health with the remit of developing a strategy for improving access to shopping in poor neighbourhoods hit by retail and service disinvestment. A consultation report released by PAT 13 (DoH, 1999b) outlined a grim picture of these neighbourhoods in which:

“once vibrant local shopping centres or neighbourhood stores that provided a safe place for the local community to meet and access a range of services to meet their everyday needs have mostly disappeared. Boarded up small shops on street corners or in small neighbourhood parades, with only the locals knowing which are open for business and which are not, remain. And only people left with no other choice shop there” (DoH, 1999b, page 2).

In turn, the views of PAT 13 were strongly influenced by earlier work of the Low Income Project Team (Beaumont et al, 1995) of the Nutrition Task Force (DoH, 1996; Nelson, 1997). In examining the complex interlinkages between undernutrition, social exclusion, and health inequalities, that group had drawn attention to retail-development-induced differential access to food-retail provision in deprived urban areas (for details of that process, see Guy, 1996; Thomas and Bromley, 1993; Wrigley, 1998), coining the term *food deserts* to describe the nutrition and public health problems of those areas of poor retail access.

“Food deserts, the Minister of Public Health was told... are those areas of cities where cheap, nutritious food is virtually unobtainable. Car-less residents, unable to reach out-of-town supermarkets, depend on the corner shop where prices are high, products are processed and fresh fruit and vegetables are poor or non-existent” (*The Independent* 11 June 1997, cited in Whitehead, 1998, page 189).

Despite its rather imprecise definition, the metaphor of the ‘food desert’ was rapidly pressed into service in policy debate. By the time the Social Exclusion Unit released its initial action report in September 1998 food deserts were simply assumed to exist—the *Bringing Britain Together* report arguing that:

“some areas [of Britain] have become ‘food deserts’ exacerbating the problems those on low incomes face in affording a healthy diet” (Social Exclusion Unit, 1998, page 72).

In the same manner, the *Independent Inquiry into Inequalities in Health*, chaired by Sir Donald Acheson, focused attention on the differential and worsening access to food experienced by certain deprived groups in the United Kingdom, linking this via under-nutrition and compromised diets to the problem of increasing health inequalities. Its report observed that

“the increasing tendency to out of town supermarkets has led to the creation of ‘food deserts’ where cheap and varied food is only accessible to those who have private transport or are able to pay the costs of public transport if this is available” (Acheson, 1998, page 65).

In response, it recommended

“policies which will increase the availability and accessibility of foodstuffs to supply an adequate and affordable diet... [and] which will ensure adequate retail provision of food to those who are disadvantaged” (Acheson, 1998, pages 65–66).

The issue rapidly became what should those policies most appropriately be, and what was the role of retail planning policy in tackling these issues (Wrigley et al, 2002a). The consultation report of PAT 13 (DoH, 1999b) strongly favoured local small-scale-retailer-oriented solutions based upon explicit involvement of the local community and its key stakeholders—the development of what it termed ‘local retail strategies’. This theme was taken up by what was then the Department of the Environment, Transport and Regions (DETR).⁽¹⁾ Via ministerial statements and speeches by the Planning Minister, Nick Raynsford (March 2000) and Minister for Local Government and Regions, Beverley Hughes (July 2000), DETR began both to promote the tackling of social exclusion as a new criterion for retail planning policy

“tackling social exclusion is the new main task for retail planning policy” (Raynsford, 2000),

and to stress the importance of identifying and addressing the problems of ‘food deserts’ and local solutions to those problems.

⁽¹⁾The election of the second Blair administration in June 2001 was accompanied by a major reorganization and division of responsibilities of the DETR, with planning policy becoming a function of a newly formed Department for Transport, Local Government and the Regions (DTLR). Other responsibilities have passed to the Department for Environment, Food and Rural Affairs (DEFRA).

“I want to see planners put more emphasis on developing local solutions to solve problems of social exclusion from services. This will involve defining the food shopping needs of local people within a retail strategy and identifying ‘food deserts’—areas that lack retail services within say a 500-metre radius” (Beverley Hughes, in DETR, 2000a).

The major retailers, however, for sound commercial reasons—what they freely described as ‘enlightened self-interest’ (Martin Venning, Tesco plc quoted in Brauner, 2001, page 21)—began aggressively to adopt a large-store-centred urban regeneration agenda focused, in particular, around redevelopment of former industrial ‘brown field’ sites and the increasingly derelict 1960s/70s district shopping centres serving local authority housing estates (Wrigley et al, 2002a). These urban regeneration schemes (for examples, see Carley et al, 2001) were typically based around partnerships involving local authorities, employment and enterprise agencies, and community organizations.

Yet what characterized this policy debate and, by extension, retail development proposals that positioned themselves within arguments regarding the contribution they could make to reducing social exclusion, was an almost total lack of empirical evidence supporting some of its key propositions. Although certain government departments (for example, DETR) had come, in practice, to use a definition of a ‘food desert’ as an area lacking retail services within a 500-m radius, there was a dearth of studies which systematically developed techniques for identifying areas of poor food-retail access in British cities. Indeed, the limited small-scale studies available (for example, Donkin et al, 1999; 2000) had led the Competition Commission (2000, volume 2, page 315), reporting to the Secretary of State for Trade and Industry, to express scepticism of the scale of access problems in deprived areas. Moreover, there remained a need to demonstrate that the postulated relationship between diet and access to healthy and reasonably priced foods actually held—that is, to establish the extent to which the nutritional quality of low-income consumers’ diets could be shown to be related to the quality of access to retail provision of such foods. Finally, as the Department of Health had argued in its report *Reducing Inequalities in Health: An Action Report* (DoH, 1999a), and PAT 13 had endorsed, given that the food choices people can make are shaped by the availability and affordability of food locally, there was a pressing need for some *health impact assessments* of the effect of retail-provision interventions and retail-planning proposals on local communities in deprived poor-access areas.

The need for extensive and fundamental evidence-based research was clear. In response, several major cross-disciplinary investigations were commissioned and/or funded by government departments and the research councils (these are reviewed in Wrigley, 2002). Here we concentrate upon just one of these—a cross-disciplinary project involving researchers from Geography, Public Health Nutrition, and City and Regional Planning at the Universities of Southampton, Leeds, and Cardiff running under the BBSRC/ESRC/MAFF/DoH “Eating, Food and Health” LINK programme, funded over the period 2000–03 by the Economic and Social Research Council and J Sainsbury plc, and with its investigations centred on the cities of Leeds, Bradford, and Cardiff. By adopting a multiscale approach which employs a range of methods from the quantitative to the purely qualitative, and a cross-disciplinary perspective on issues of food poverty, the *Food Deserts in British Cities* project aims to provide ‘triangulated’ insights into several of the underresearched topics outlined above. Uniquely, it offers the first ‘before/after’ study of food consumption in a highly deprived area of a British city experiencing a sudden and significant change in its food-retail access—in this case as a result of the opening of a large new superstore by the United Kingdom’s leading food retailer under a regeneration partnership with the local authority (Leeds). Using the terminology of the Department of Health

and PAT 13, this study has been seen as providing the first opportunity in the United Kingdom to assess the impact of a *non-healthcare intervention* (specifically a retail-provision intervention) on food-consumption patterns in a deprived, previously poor-retail-access community. Unusually, it is a study which has already spawned a follow-up/extension investigation—in this case a project funded by the Department of Health under its ‘Inequalities in Health’ research initiative, running from 2002 to 2004 and linking researchers from the Medical Research Council Social and Public Health Sciences Unit at the University of Glasgow and the Institute for Retail Studies at the University of Stirling (Petticrew et al, 2002). Like the Leeds study, that study will also attempt a ‘before/after’ evaluation of the impact of a non-healthcare intervention (specifically the opening of a major food store) in a deprived area of Glasgow. As such, it offers an important opportunity to complement and compare results with those for Leeds which we report here. In addition, it hopes to extend the focus of the Leeds study somewhat to consider intervention impacts on self-esteem, general well-being, and self-reported health.

Setting the scene: the research area, its food-access problems, and the form of the intervention

The Leeds retail-intervention study focuses on the area of Seacroft and Whinmoor, a local authority housing estate area of around 15 000 households (38 000 population), 6 km to the east of the city centre (figure 1, see over). The DETR (2000b) ward-level indices of deprivation place Seacroft in the top 5% most deprived wards in England and, although the research area displays some important subarea variations within the conventional markers of social exclusion, it is essentially a low-income, compoundly deprived, white (ethnically less diverse than the city as a whole) area. By the late 1990s it was regarded as emblematic of those areas of the city that had failed to share in the significant economic revitalization of the local economy during the decade—a polarization which had left Seacroft and other peripheral estates such as Middleton not only largely untouched by the vibrancy of the city’s economy but also exposed to increasingly visible affluence in other parts of the city and surrounding areas.

Traditionally, the retail facilities of Seacroft and Whinmoor had centred on a district shopping centre built by the local authority in the 1960s. By the 1990s, however, that centre and those facilities had become extremely degraded [see figure 2(a), over]. In both absolute and relative terms, as Clarke et al (2002) demonstrate in an associated paper from the wider project, parts of Seacroft and Whinmoor had become characterized by extremely poor levels of food retail provision per household (see figure 3, over). Indeed, using the 500-m criterion for defining a food desert increasingly adopted in ministerial statements, the ‘pre-intervention’ stage of our research (involving 1009 households) revealed that 70% of survey households in the area were beyond reasonable walking distance (500 m) of a retail outlet selling a modest variety of ‘healthy’ foods [specifically fresh fruit and vegetables—see ELCHA (1999a; 1999b) for comparable results in East London]. And, at worst (for respondents in postcode sector LS14 1) that figure reached almost 90%. Small stores in the area were typically of the austere boarded-up, heavily shuttered type which the report of PAT 13 (DoH, 1999b) had drawn attention to, and offered little more than ‘top-up’ purchase possibilities (figure 4, over). For ‘main’ food shopping our pre-intervention survey respondents typically had to leave the study area or to frequent one of two small limited-range discount food stores. As a result, the average distance travelled by our pre-intervention survey respondents to their main food store—in an area characterized by significantly low levels of car ownership relative to national and City of Leeds averages—typically exceeded 2.5 km, and subarea (postcode sector) averages ranged from 1.4 to 3.9 km.

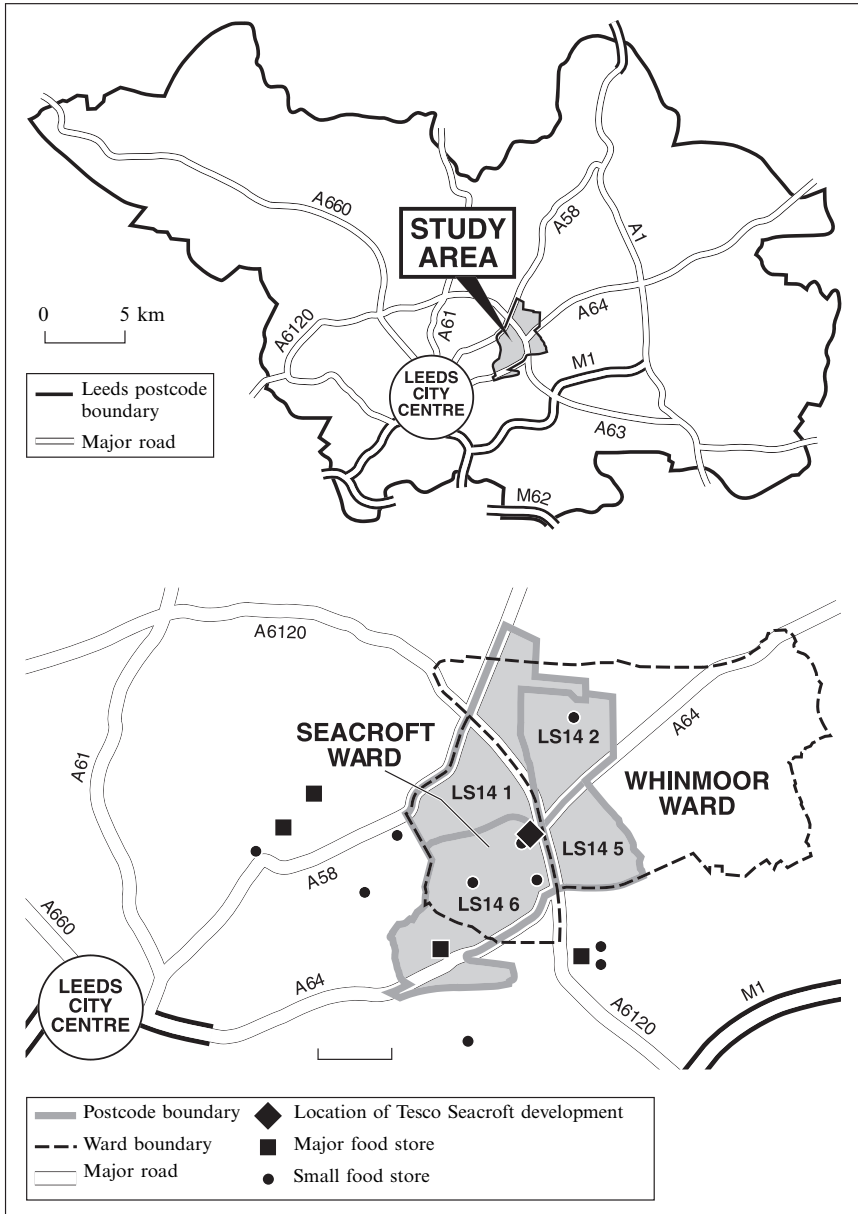


Figure 1. The research area, its context, and the site of the retail provision intervention.

In 1998, the United Kingdom's largest food retailer, Tesco, as part of a wider adoption of urban-regeneration-based schemes within its store-development strategy (Butterick, 2000; Wrigley et al, 2002a), sought planning consent to demolish the entire Seacroft district centre and to redevelop it around a 97 000 ft² gross (69 500 ft² net) superstore plus ten smaller shop units—promising the city council that priority in employment in the new store would be given to long-term unemployed residents of the area. Planning consent was granted (see Williams, 2000; Wrigley et al, 2000a) and Tesco jointly developed the Seacroft Partnership with Leeds City Council, the property developers Asda St James, the employment services agency, the shop workers' union



Figure 2. The transformation of the Seacroft centre: (a) pre-redevelopment, (b) during redevelopment, (c) post-redevelopment [sources: (a) reproduced with permission from an original photograph by the Ross-Parry Picture Agency; (b) adapted from *Yorkshire Evening Post* 21 September 1999; (c) principal author's photograph, April 2002].

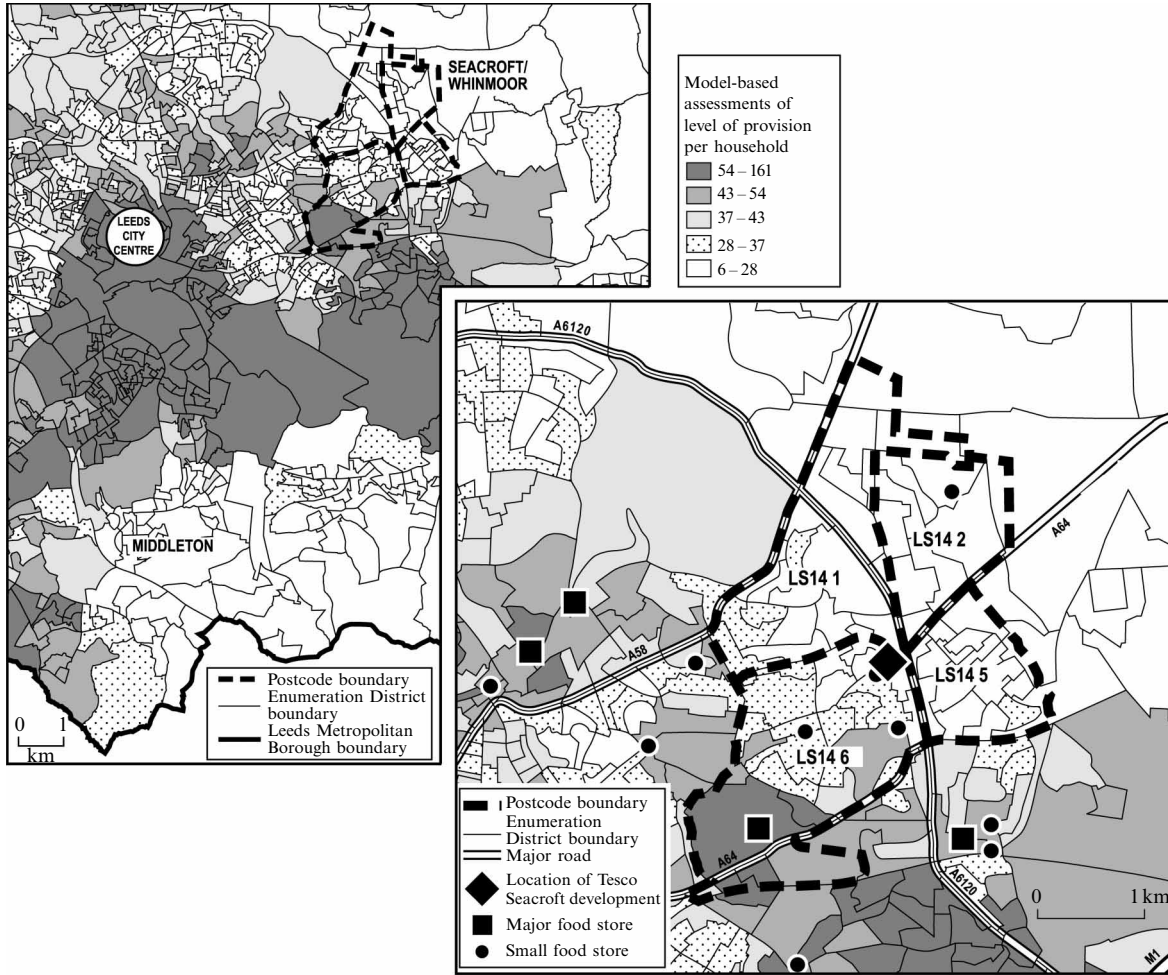


Figure 3. Model-based assessments of level of food-retail provision per household in (a) east and southeast Leeds, and (b) the Seacroft and Whinmoor research area, during the pre-intervention period (adapted and redrawn from Clarke et al, 2002).



Figure 4. Typical smaller food retail outlets in the study area (source: photographs by research assistant, ‘Food Deserts’ project, September 2001).

USDAW, and the East Leeds Family Learning Centre. During 1999 and 2000 the site was cleared, prepared, and developed [figure 2(b)] and by November 2000 the new store had opened [figure 2(c)] with 230 out of 320 jobs created going to long-term unemployed local residents. The opening of the new Seacroft centre was a high-profile event with Tesco and its partners organizing a forum for regeneration and employment-training professionals to publicize and discuss the work of the Partnership. Shortly afterwards, Prime Minister Tony Blair visited the development “and took the opportunity to under-line the Labour Party’s commitment to inner city renewal” (*Regeneration and Renewal* 2000).

The survey and its methodology

Knowledge that a major food superstore would be opening on the site of the old Seacroft centre, and that access to food-retail provision in the area would suddenly be significantly improved—allowing the opportunity for a major ‘intervention’

study—was available to us during the design stage of the Food Deserts in British Cities project. As a result, it was possible to plan and schedule a large-scale ‘before/after’ study of food consumption in the area around that anticipated opening. Wave 1 (‘before’) of the study was planned for the summer of 2000 and wave 2 (‘after’) for the summer of 2001, with the two waves being spaced exactly one year apart to minimize seasonality variation. Each wave was designed to involve a respondent-completed, but interviewer placed and collected, seven-day food-consumption diary, supplemented by a wide-ranging interviewer-administered household questionnaire exploring issues of: household composition; welfare benefits and income; education and work status; disabilities and long-term health problems; smoking habits; attitudes to healthy eating; food-store choice; mode of travel to stores; car ownership or access; perceived constraints on choice of foods bought, etc. As in the National Food Survey (NFS), the diary and questionnaire were to be completed by the person primarily responsible for the domestic food arrangements of the household.

The fieldwork was contracted to and completed by Europe’s largest market-research firm, and the survey was designed by the academic team in Southampton, with technical advice from the market-research firm and assistance from specialists in store development and planning, nutrition, and market research at our LINK-award industrial partner, J Sainsbury plc. The survey instruments and methods were piloted in February 2000 and subsequently modified and refined. The main phases of the survey were completed in June–July 2000 and 2001, approximately five months before and seven to eight months after the opening of the new superstore in November 2000. A separate ‘repeatability study’ was also undertaken during wave 2 of the main survey, involving 140 households, in order to measure the extent of random or systematic error in the information being reported by respondents within the seven-day food-consumption diaries, and to assess the likely effect of this on our findings. We report results of this repeatability study below.

The key issue to be tested in the study was the extent to which the retail-provision intervention in the area, and the improved physical access to high-quality ‘healthy’ foods for many of its residents that would follow that intervention, could be expected to lead to changes in diet. We were conscious, however, that for low-income households, physical access does not necessarily imply *economic access* and, despite the quality and range of ‘healthy’ foods that would be offered by the new store, some residents of the area might effectively see no improvement in their overall food access simply because they would not be able to afford to use the Tesco superstore. In addition, as suggested by Barratt (1997) and others, low-income customers might specifically choose to avoid exposing themselves to the variety of a large superstore, feeling that they could not afford to be tempted away from their usual pattern of food purchasing or consumption, potentially ‘wasting’ their money in the process.

Moreover, and as stressed by the Low Income Project Team of the Nutrition Task Force (DoH, 1996), we were conscious that food purchasing and consumption patterns are a function not only of economic access and physical access (affordability and availability) but also of choice, constrained in turn by social and cultural norms, food-preparation facilities and practices, nutritional knowledge, and motivation to consider health, etc. As a result, even if the retail-provision intervention were significantly to shift the pattern of sourcing of food by households in the area, we could not assume that this would necessarily shift choice and result in the increased consumption of healthy food items. It would merely open up that possibility for some households. Overall, our expectation, therefore, was that the effects (if any) of improved retail

access on the consumption of healthy food in the research area were likely to reveal themselves in rather complex and subtle ways.⁽²⁾

As a result, and in order to achieve sufficient statistical ‘power’ when assessing dietary changes of subgroups of residents across the two waves of the survey, it was our view that a minimum *achieved* post-intervention sample size of approximately 600 respondents would be necessary in wave 2. Assuming, however, that sample *attrition* between waves 1 and 2, separated by a year, was likely to present considerable difficulties in an area of compound deprivation, we calculated that this implied that an *achieved* pre-intervention sample of 1000 respondents would be necessary in wave 1. [Evidence on the likely scale of the attrition problem in such an area was rather scarce, but see the results of the Cardiff Consumer Panel Study of the early 1980s (Wrigley et al, 1985).] To obtain this size of sample in wave 1 in a highly deprived neighbourhood in which survey response rates have traditionally been low required us, in turn, to assume that we would need to establish initial contact with approximately 3000 households in the area—that is, that approximately two-thirds of the households contacted were likely to refuse to participate in what was a relatively time-consuming survey involving an implicit commitment to repeating the process one year on. These then were the guide figures and targets which we set for the survey contractors. In addition, we designed a system of monetary incentives (in the form of non-food-retail shopping vouchers) structured to maximize recruitment to wave 1 of the survey, and retention of the respondents into wave 2.⁽³⁾ In the event, our sample design and the professional efforts of the fieldwork team, ensured an achieved sample of 1009 respondents in wave 1 and 615 respondents in wave 2.

In any attempt to use these respondents as representative samples of subgroups of the population of this deprived study area, it is important to be sensitive to a number of potential biases—in particular, bias introduced by varying success in recruiting respondents of different demographic, socioeconomic, or locational categories to participate in wave 1 of the survey and, subsequently, bias introduced by differential rates of attrition between respondent groups which occurred across the two waves of the survey. Table 1 (see over) helps clarify these issues by providing summary statistics on the characteristics of the 1009 respondents who completed wave 1 of the survey, the subset of 615 who completed both waves 1 and 2, and the 394 ‘nonrespondents’ in wave 2 who had completed wave 1 but were lost to the study between the two waves. (In terms of the original 1009 respondents in wave 1, these nonrespondents were made up of 9% who had moved residence, 13% with whom no contact could be made despite

⁽²⁾ Some of our referees have questioned this expectation, arguing that opening a major new food store might be expected to have a *large* not subtle effect on the consumption of healthy food. We disagree. Opening such a store could certainly be expected to change physical accessibility significantly (and we show the impacts of that change in accessibility below). However, (a) diet, as we argue above, is mediated by a myriad of factors, hence shifting of food sourcing as a result of improved accessibility would, at best, in our view only remove previous access-related constraints and open up the possibility of change in consumption patterns; (b) the link between diet and physical access to healthy and reasonably priced food, although frequently assumed to exist, was not in our view at the time of the Seacroft intervention study an empirically proven relationship; (c) we suspected that local-level heterogeneity in diet and risk of poor health within the ‘food desert’ was likely to be considerable—and that, reflecting this heterogeneity, the impacts of changing physical accessibility would clearly not be uniform across groups of respondents.

⁽³⁾ It is important to stress that these vouchers were given to respondents only *after* completion of the seven-day food-consumption diary and household questionnaire in each wave. Deferred payment in this fashion, ensured that the available household budget for food during each wave was not increased by substitution from household non-food expenditure covered by the incentive vouchers (that is, we believe that food consumption in each wave of the survey was unlikely to be contaminated by the incentives).

Table 1. Survey respondent characteristics, and assessment of attrition bias between waves 1 and 2 of the survey (percentages given in parentheses).

Characteristic	Wave-1 respondents <i>n</i> = 1009		Wave-1 and wave-2 respondents <i>n</i> = 615		Wave-2 non- respondents <i>n</i> = 394	
<i>Gender</i>						
Male	183	(18.1)	98	(15.9)	85	(21.6)
Female	826	(81.9)	517	(84.1)	309	(78.4)
<i>Age (years)</i>						
17–24	91	(9.0)	51	(8.3)	40	(10.2)
25–34	200	(19.8)	119	(19.3)	81	(20.6)
35–44	227	(22.5)	145	(23.6)	82	(20.8)
45–64	270	(26.8)	165	(26.8)	105	(26.6)
≥ 65	221	(21.9)	135	(22.0)	86	(21.8)
<i>Employment status</i>						
Full-time work	202	(20.0)	116	(18.9)	86	(21.8)
Part-time work	189	(18.7)	119	(19.3)	70	(17.8)
Unemployed	55	(5.5)	33	(5.4)	22	(5.6)
Retired	279	(27.7)	171	(27.8)	108	(27.4)
Full-time education	11	(1.1)	6	(1.0)	5	(1.3)
Housewife/househusband	249	(24.7)	157	(25.5)	92	(23.4)
<i>Children under 16 in household</i>						
Yes	434	(43.0)	280	(45.5)	154	(39.1)
No	534	(52.9)	314	(51.1)	220	(55.8)
<i>Educational attainment</i>						
GCSE or below	732	(72.5)	441	(71.7)	291	(73.9)
Above GCSE	277	(27.5)	174	(28.3)	103	(26.1)
<i>Household income (£)</i>						
< 5000	166	(16.5)	101	(16.4)	65	(16.5)
5 000–9 999	249	(24.7)	145	(23.6)	104	(26.4)
10 000–14 999	139	(13.8)	93	(15.1)	46	(11.7)
15 000–19 999	105	(10.4)	67	(10.9)	38	(9.6)
≥ 20 000	131	(13.0)	80	(13.0)	51	(12.9)
Refused to say	177	(17.5)	104	(16.9)	73	(18.5)
<i>Benefit levels</i>						
No benefits	326	(32.3)	188	(30.6)	138	(35.0)
On benefits for less than one year	67	(6.6)	39	(6.3)	28	(7.1)
On benefits for more than one year	616	(61.1)	388	(63.1)	228	(57.9)
<i>Housing tenure</i>						
Own out-right	166	(16.5)	117	(19.0)	49	(12.4)
Own—paying mortgage	228	(22.3)	138	(22.4)	90	(22.8)
Rent	597	(59.2)	350	(56.9)	247	(62.7)
<i>Car/van access</i>						
Yes	588	(58.3)	352	(57.2)	236	(59.9)
No	421	(41.7)	263	(42.8)	158	(40.1)
<i>Smoking status</i>						
Never	302	(29.9)	195	(31.7)	107	(27.2)
Ex	235	(23.3)	141	(22.9)	94	(23.9)
Light	178	(17.6)	109	(17.7)	69	(17.5)
Heavy	279	(27.7)	161	(26.2)	118	(29.9)
<i>Household deprivation</i>						
0 (least deprived)	257	(25.5)	159	(25.9)	98	(24.9)
1	297	(29.4)	185	(30.1)	112	(28.4)
2	305	(30.2)	181	(29.4)	124	(31.5)
3	120	(11.9)	75	(12.2)	45	(11.4)
4 (most deprived)	15	(1.5)	9	(1.5)	6	(1.5)
<i>Postcode area</i>						
LS141	295	(29.2)	160	(26.0)	135	(34.3)
LS142	145	(14.4)	95	(15.4)	50	(12.7)
LS145	242	(24.0)	165	(26.8)	77	(19.5)
LS146	327	(32.4)	195	(31.7)	132	(33.5)

four attempts to establish contact, 13% who were contacted but refused to participate further in the survey, and 4% who agreed to participate but returned an unsatisfactorily completed food-consumption diary.)

As can be anticipated by the use of the NFS definition of the appropriate respondent within the household to complete the diary and questionnaire, this is a dominantly female respondent sample. In addition, it is a sample in which most of the respondents are not in full-time employment (only 19% of those completing waves 1 and 2, with a further 19% in some form of part-time employment), in which almost three quarters have only minimum (GCSE level) or no educational qualifications, in which 69% draw some form of state benefit, and who are located in households that largely rent their properties (57%), have low self-reported incomes, and have some degree (74%), often a large degree, of material deprivation based on a Townsend index. Our suspicion (though this has yet to be confirmed by 2001 Census information) is that the wave 1 sample underrepresents to a degree younger respondents, particularly those under 25 years of age (although we have 91 cases in wave 1 of respondents in that age group). In addition, there is evidence of some relatively slight differential attrition bias being introduced between waves 1 and 2—with nonrespondents in wave 2 being slightly skewed towards what we will subsequently describe as the most 'at risk' groups in nutritional terms (the youngest age groups, those with the lowest educational attainment, the heaviest smokers, etc) and towards those who rent their properties and live in one of the more deprived subareas (LS14 1). However, as a result of intense efforts to minimize attrition-bias problems by the survey design and fieldwork teams, the notable feature of table 1 is how limited these problems appear to be. Moreover, it should be noted that there is simply no equivalent sample, which approaches this size and detail, of the dietary and household characteristics of low-income residents of a compoundly deprived area of a British city. As such, the Seacroft survey, of itself, represents an important national resource which is likely to be reutilized and extended in numerous ways for fundamental research in public health and social policy analysis (for an early example of this, see Margetts et al, 2002).

Dietary indicators, benchmarks, and pre-intervention food-consumption patterns

Following conventional practice in current research in public health nutrition, the proxy measure for a healthy diet used in this paper is the level of fruit and vegetable consumption. There are two potential benchmarks against which we can compare the consumption levels of respondents in the Seacroft survey. The first is the National Diet and Nutrition Survey (NDNS) of British adults aged 16–64 years (Gregory et al, 1990)—a national representative cross-sectional study of these groups conducted during 1986 for the Ministry of Agriculture, Fisheries and Food (MAFF) based on seven-day dietary records from over 2000 respondents. The second is the annual National Food Survey (NFS)—the longest running continuous survey of household food consumption and expenditure in the world which involves approximately 6000 households each year and is based on a seven-day diary of household food and drink purchases.

Reflecting some important methodological differences between these two surveys, the national average fruit and vegetable consumption (excluding potatoes and potato products) of British adults calculated from the 1986 NDNS is three portions per day (21 portions per week), whereas based on the 1999 NFS it is approximately 3.9 portions per day (approximately 27 portions per week). However, when benchmarking the average fruit and vegetable consumption of the Seacroft-survey respondents against these national averages, it is important to bear in mind that those respondents are dominantly female and biased somewhat towards the older age groups in the study area.

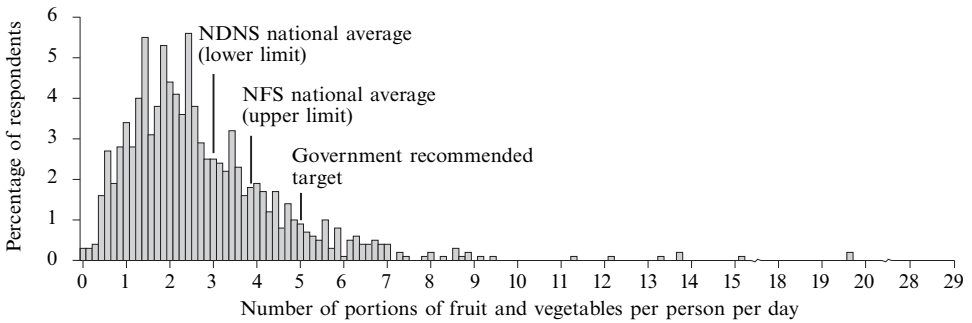


Figure 5. Distribution of fruit and vegetables consumption among 1009 respondents in pre-intervention period (NDNS, National Diet and Nutrition Survey; NFS, National Food Survey).

Evidence from the NFS and NDNS, and from other studies in the United Kingdom (Margetts et al, 1998; Thompson et al, 1999) have shown that men are more likely than women to be lower consumers of fruit and vegetables and that there is also a strong age gradient in such consumption, with the 55 to 64 year age group eating twice as much fruit and vegetables as those under 25 years. As a result, we can expect the average fruit and vegetable consumption levels reported by our Seacroft respondents to be upwardly biased in relation to the NDNS average. That is to say, we believe that the appropriate national averages to compare our survey results against lie somewhere between the NDNS (lower) and NFS (upper) limits. On that basis, as figure 5 demonstrates, in the pre-intervention period around 70% of respondents in this deprived poor-food-retail-access area reported fruit and vegetable consumption below the national average (78% below the NFS upper limit, 64% below the NDNS lower limit). Moreover, as figure 5 shows only 10% of respondents met the government's national *target* (as recommended by the Department of Health) of at least five portions per day. Conversely, about 10% of respondents reported eating less than one portion of fruit and vegetables per day. Particularly striking (figure 6) is the consumption of fruit

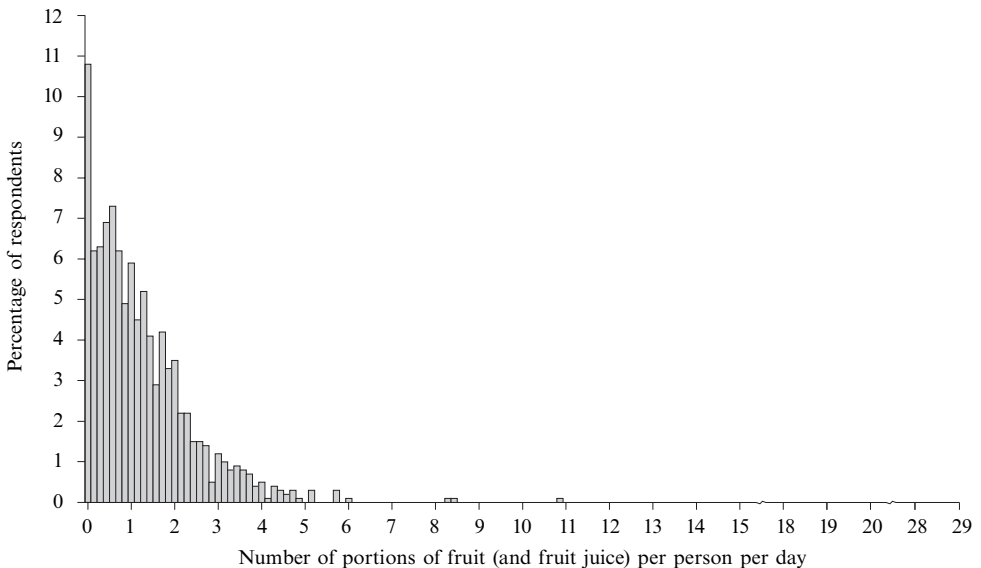


Figure 6. Distribution of fruit (and fruit juice) consumption among 1009 respondents in pre-intervention period.

(including fruit juice) where almost 50% of respondents in the pre-intervention period are shown to have consumed less than one portion per day and where the modal consumption is shown to be *zero*. Indeed, 11% of our sample reported eating no fruit and drinking no fruit juice whatsoever in the week of the wave 1 survey.⁽⁴⁾

Detailed analysis of dietary patterns in the pre-intervention period (reported in Wrigley et al, 2002b) shows poor diet (proxied by low fruit and vegetable consumption) to be associated with respondents who are young, heavy smokers, typically with children in the household, characterized by one or more markers of deprivation, and expressing negative attitudes to the importance of healthy eating. It also reveals evidence that respondents with the poorest diets were more highly concentrated amongst those who used limited-range or budget stores as their main source of fruit and vegetable purchasing, and that both physical and economic access constraints may have been important in the use of such stores by those respondents. More generally, a range of complex coping mechanisms were shown as being used by respondents during the pre-intervention period to alleviate access problems.

Interesting as these findings are, however, in terms of advancing the knowledge base regarding the nutritional quality of low-income consumers' diets in deprived areas, and aspects of the relationship between those diets and access to food-retail provision, the policy significance of the Seacroft study rests fundamentally on what it reveals of shifts (if any) in dietary patterns in the post-intervention period. It is to this issue, links to the retail-provision intervention, and the extent to which we can demonstrate that what was observed in the post-intervention period was more than an artefact of the survey instrument, that we now turn.

The impact of the intervention on patterns of food purchasing behaviour

Before considering the impact of the retail intervention on dietary patterns, it is important first to outline some of the changes in food-purchasing behaviour among our respondents that accompanied the opening of the new store.

Of the 615 respondents completing both waves of the survey, 45% (276 respondents) switched to the new Tesco superstore as their 'main' food retail source, with 35% (218) claiming the new store as their main fruit and vegetable source. As might be expected, those who had switched to the new store were drawn differentially from those living closest to it and from the two adjacent postcode sectors LS14 1 and LS14 6 (see figure 1). Given that these sectors were, relative to the rest of the research area, characterized by a higher incidence of household deprivation, respondents who switched to the new store were also drawn differentially from the more deprived households. Overwhelmingly, the reasons those respondents suggested for their switch to the new store concerned accessibility—'easy to get to' (79%), 'near to home' (67%)—and convenience (including the store's late opening hours). Those who did not switch expressed concerns about the relative 'expensiveness' of food shopping at the new store (28%), and the store's large size and layout (21%).

The travel behaviour of all respondents in the area, and particularly those who switched to the Tesco superstore, was altered quite substantially by the opening of the new store. The average distance travelled to their 'main' food store by the 276

⁽⁴⁾ Those respondents with lower consumption of fruit and vegetables in the pre-intervention period also ate less portions of food in total (an average of 89.7 portions per week for the 423 with 'lower' consumption of fruit and vegetables, compared to an average of 148.7 portions per week for the 361 with 'higher' consumption) and were significantly heavier smokers. In addition, as a percentage of their total food intake, 'lower' fruit and vegetable consumers ate less cereal, brown bread, poultry, and boiled or mashed potatoes, but higher percentages of fatty foods—notably chips, crisps, meat pies, processed red meat, and white bread.

Table 2. Transport mode (percentage split) to ‘main’ food store pre-intervention and post-intervention of those respondents ($n = 276$) who shifted to the new Tesco store as their main food-purchasing source in the post-intervention period.

Travel mode	Pre-intervention		Post-intervention	
	to store	from store	to store	from store
Own car	47.5	47.5	43.8	44.2
Other’s car ^a	8.3	9.1	5.8	5.4
Taxi	7.6	18.5	1.8	11.6
Bus (standard)	20.3	15.6	17.0	15.2
Bus (free shuttle) ^b	1.8	2.2	0.7	0.7
Walk	12.3	6.5	30.8	22.8
Missing observations	2.2	0.4	—	—

^a Shared use (that is, ‘lift’) in friend’s or neighbour’s car.

^b Designated bus serving a major retailer’s store only.

respondents who switched to the new store fell from 2.25 km in the pre-intervention period to 0.98 km in the post-intervention period. In addition, as table 2 shows, the main travel mode used by those respondents shifted significantly towards walking—increasing approximately threefold between the pre-intervention and post-intervention periods from 12.3% to 30.8% when trips *to* the ‘main’ food store are considered, and from 6.5% to 22.8% when trips home *from* that store are considered. Conversely, car usage fell—particularly in proportional terms amongst those respondents who had coped with poor access problems in the pre-intervention period by relying on friends’ or neighbours’ cars to access their food source. In particular, the use of taxis—a critical coping mechanism in the pre-intervention period by residents of this food desert—declined substantially.

These findings on modal shift are important in their own right in policy terms. In addition, they correct an impression given by Carley et al (2001), in their high-profile review of retailing and neighbourhood regeneration for the Joseph Rowntree Foundation, that the local community may have been somewhat excluded from the Seacroft development by its ‘L-shaped’ car-park-facing design which

“for security and servicing reasons... turns its back on the surrounding community, with no point of entry from anywhere but the car park” (Carley et al, 2001, page 58).

Although the rear of the Seacroft development [figure 7(a)] can undoubtedly be portrayed in these terms, “standing over the existing community with the appearance of a prison” (Carley et al, 2001, page 58), closer inspection [figures 7(b) and 7(c)] shows a rather more ‘porous’ design in terms of local community access than Carley et al would suggest. In turn, this is reflected in relatively high levels of pedestrian usage of the new store, and in the important shift to walk-based food shopping in the post-intervention noted in table 2—levels which increase (see table 3, over) with closeness to the store, particularly for those living within 1 km of the store.

We stress, however, that these findings relate *only* to shifts in food shopping by the local residents of the Seacroft and Whinmoor research area. We accept the validity of the DETR argument that large-scale urban regeneration stores, like that in Seacroft, may seek to “piggyback on a local centre but, in practice, have all the characteristics of a free-standing superstore relying predominantly on car-borne shoppers diverted from other out-of-town stores” (Raynsford, 2000, page 5). As a result, the overall reduction in car (both private and taxi) usage for food shopping by the local residents which resulted from the intervention may have been offset by increased car-based food



Figure 7. Conflicting impressions of the ‘porousness’ of the Seacroft development to local community pedestrian access (see text for discussion) (sources: principal author’s photographs, April 2002).

Table 3. Percentage of respondents ($n = 276$) who shifted to the new store as their main food-purchasing source who walked to their main food store in the pre-intervention and post-intervention periods.

Distance, d , to new Tesco store (m)	Walk to main store		Walk from main store	
	pre-intervention	post-intervention	pre-intervention	post-intervention
$d \leq 500$	23.3	67.4	16.3	55.8
$500 < d \leq 1000$	11.4	36.2	7.6	26.7
$d > 1000$	9.4	14.1	2.3	8.6

shopping in east Leeds in aggregate terms. In turn, this raises the related issue of whether the improvement in food-retail accessibility experienced by Seacroft and Whinmoor residents may have been achieved at the expense of other low-income deprived communities elsewhere in Leeds whose local stores may have been adversely affected by trade lost to the new Seacroft development. In other words, does the amelioration of the accessibility problems of a major 'food desert' by such an intervention create in turn, several microscale 'food deserts' in other parts of the city? This issue is currently being investigated as part of the wider project and we will report the results elsewhere. Here we simply note that the *relative* underprovision of food retail in parts of east and southeast Leeds (for a comparison to levels in Cardiff see Clarke et al, 2002) may significantly reduce the potential of such negative impacts, allowing the new retail provision in Seacroft to be absorbed without major loss of retail provision in the wider area.

In terms of shifts in the retail sources used for food shopping which resulted from the intervention, table 4 shows the patterns for respondents who both switched and did not switch to the new Tesco superstore in the post-intervention period. Comparing the two groups, it can be seen that those who switched to the new store were drawn differentially more frequently from other Tesco stores outside the research area (at Cross Gates and at Roundhay Road). That is to say, the new store, as might be expected, 'cannibalized' to a certain extent existing customers of the chain. In addition, the 'switchers' were also drawn differentially from those who used limited-range or budget stores in the pre-intervention period. Conversely, they were drawn less frequently from the major retailer store which was closest to the study area in the pre-intervention period (Asda at Killingbeck). That store was clearly able to maintain (aided by competitive marketing responses) at least part of its established customer franchise in the area.

Table 4. Shifts in the retail sources used for main food shopping which resulted from the intervention.

Store or store type frequented in pre-intervention period	Switched to new Tesco store in post-intervention period ($n = 276$)		Did not switch to new Tesco store in post-intervention period ($n = 339$)	
	n	%	n	%
Asda, Killingbeck	110	39.9	196	57.8
Other major retailer stores (of which: Tesco stores)	99 (87)	35.9 (31.5)	70 (45)	20.6 (13.3)
Limited-range or budget stores	48	17.4	49	14.5
'Other store' or missing observations	19	6.9	24	7.1

The differential switching to the new store by respondents who used limited-range or budget stores in the pre-intervention period is an intriguing finding. We had originally felt (following an analysis of the pre-intervention survey) that there was a possibility that these respondents, who as a group were heavily represented amongst those with the poorest diets, might remain untouched by the retail-provision intervention. That is to say, there was an argument that the severe economic constraints experienced by this group might result [following the arguments of Barratt (1997) and others] in avoidance of exposure to the variety, and 'money-wasting' opportunities of a large superstore. Clearly, as table 4 shows, and as analysis of similar tables for main fruit and vegetable purchasing sources confirms, this is not the case.

Dietary patterns in the post-intervention period—univariate appraisals

Despite the quite substantial impact of the opening of the new store on the food-purchasing behaviour of our respondents, at first glance and in purely aggregate terms, the retail intervention appears to have had little impact on diet. Across the 615 respondents who completed both waves of the survey, mean consumption of fruit and vegetables increased insignificantly from 2.88 to 2.92 portions per day. However, it rapidly becomes clear that these aggregate statistics mask a picture of both large and more subtle changes in dietary patterns in the post-intervention period.

In particular, a significant upward shift in fruit and vegetable consumption in the post-intervention period is observable amongst those who had the poorest diets in the pre-intervention period (the most 'at risk' group in nutritional terms). As table 5 indicates, of those respondents classified as having poor diets in the pre-intervention period (those who consumed two or fewer portions per day), 60% increased their fruit and vegetable consumption in the post-intervention period, and the mean consumption of the group increased by a third from 1.31 to 1.75 portions per day (with mean fruit and fruit-juice consumption of the group increasing almost two thirds). In addition, of the subgroup with the worst diets in the pre-intervention period (those who consumed less than one portion per day), three quarters increased their fruit and vegetable consumption, with the mean

Table 5. Dietary change among respondents with poor diets in the pre-intervention period.

Change between pre-intervention and post-intervention periods	Poor diets in pre-intervention period (<i>n</i> = 239)			Worst diets in pre-intervention period (<i>n</i> = 60)		
	fruit and vegetables	vegetables	fruit and fruit juice	fruit and vegetables	vegetables	fruit and fruit juice
Increased	143	129	130	45	37	37
No change	24	38	36	8	14	15
Decreased	72	72	73	7	9	8
Increase in average consumption (portions per day)	0.44	0.18	0.26	0.82	0.37	0.45
Percentage change	34	20	65	139	77	409

Table 6. Change in fruit and vegetable consumption for those respondents who switched or did not switch to the new store as their main food-shopping source in the post-intervention period.

	Fruit and vegetable consumption		Change in consumption	Paired sample <i>t</i> -test
	pre-intervention	post-intervention		
Switched to new Tesco store (<i>n</i> = 276)	2.66	2.89	0.23	<i>t</i> = -2.136 <i>p</i> = 0.034**
Did not switch to new Tesco store (<i>n</i> = 339)	3.07	2.94	-0.13	<i>t</i> = 1.349 <i>p</i> = 0.178

** Significant at 5% level.

consumption of the group more than doubling from 0.58 to 1.41 portions per day and fruit and fruit-juice consumption increasing fivefold.⁽⁵⁾

There are also important indications (table 6) that respondents who switched to the new Tesco store as their main food-shopping source, significantly increased their fruit and vegetable consumption between the pre-intervention and post-intervention periods, and differentially increased that consumption relative to those who did not switch to the new store. As a group, the respondents who switched to the new store increased their consumption by 0.23 portions per day and eliminated the significant gap in consumption levels relative to the other group which had existed in the pre-intervention period.

Moreover, within the group who switched to the new store, table 7 shows that a relationship exists between dietary change and source used for food shopping in the pre-intervention period. In particular, and in line with our discussion above, those who switched to the new store from limited-range or budget stores significantly increased

Table 7. Change in fruit and vegetable consumption among those respondents who switched to the new store by retail source used for main food shopping.

Store or store type frequented in pre-intervention period	Fruit and vegetable consumption of those who switched to new Tesco store			Paired sample <i>t</i> -test	
	<i>n</i>	pre-intervention	post-intervention		
Asda, Killingbeck	110	2.62	2.87	<i>t</i> = -1.181	<i>p</i> = 0.240
Other major-retailer stores (of which: Tesco stores)	99 (87)	2.79 (2.83)	2.88 (2.90)	<i>t</i> = -0.702 (<i>t</i> = -0.484)	<i>p</i> = 0.484 <i>p</i> = 0.630
Limited-range or budget stores	48	2.43	2.87	<i>t</i> = -1.748	<i>p</i> = 0.087*
'Other store' or missing observations	19	2.76	3.06	<i>t</i> = -1.219	<i>p</i> = 0.239

* Significant at 10% level.

⁽⁵⁾ We have been asked by one of our referees to comment on the possible effect on this latter finding of the 'Sunny Delight' phenomenon taking place in the United Kingdom during the period of our intervention study—Sunny Delight being a heavily advertised fruit 'drink' (with only low fruit-juice levels). In our view, the results we report are robust to this phenomenon. Our survey instrument carefully separated out 'fruit drinks and squashes' from '100% real fruit juice' and our measures of fruit and fruit-juice consumption *exclude* 'fruit drinks and squashes'. Moreover, we remind readers that it is the fruit and vegetable consumption of the person primarily responsible for the domestic food arrangements of the household that we are reporting. Sunny Delight was targeted at children. Hence, even if purchased by our respondents, it is likely that in the economically constrained households typical of those with poor diets in our study area, consumption of the product would discretionarily have been restricted to the children of the household.

Table 8. Change in fruit and vegetable consumption by distance from the new store.

	Distance, d , from new Tesco store (m)				
	$d \leq 750$ ($n = 176$)	$750 < d \leq 1000$ ($n = 113$)	$d > 1000$ ($n = 326$)	$d \leq 500$ ($n = 65$)	$500 < d \leq 1000$ ($n = 224$)
Pre-intervention	2.56	3.02	3.00	2.60	2.77
Post-intervention	2.81	3.05	2.93	3.13	2.84
Paired sample t -test	$t = 1.779$ $p = 0.077^*$	$t = 0.204$ $p = 0.839$	$t = 0.756$ $p = 0.450$	$t = 1.570$ $p = 0.121$	$t = 0.650$ $p = 0.517$

*Significant at 10% level.

their fruit and vegetable consumption (an 18%, 0.44 portions per day rise). In contrast, those who switched to the new store from other Tesco stores (that is, via a process of within-chain ‘cannibalization’) as might be expected, given that they had already been exposed to a similar range and quality of these items to that found in the new store, showed the least increase in fruit and vegetable consumption.

Finally, it appears (table 8) that some form of relationship exists between physical accessibility to the new store (proxied by straight-line distance) and dietary change. In particular, those respondents living within 750 m of the new store significantly increased their fruit and vegetable consumption—an increase which was particularly marked in the case of those who lived within 500 m of the new store (although the latter was not statistically significant at the 10% level because of smaller sample size).

Many of these univariate associations with dietary change are present, but subtly modified, in bivariate analysis. In particular, table 9, which shows a stratification by consumption level in the pre-intervention period *and* by switching – nonswitching to the new Tesco store, is useful in examining a possible ‘regression to the mean’ effect in reported consumption. Respondents who did not switch to the new store (right-hand columns in table 9) display evidence of such an effect—a pattern in which those with low fruit and vegetable consumption in the pre-intervention period report an increase in the post-intervention period and vice versa for those with higher

Table 9. Mean fruit and vegetable consumption levels in pre-intervention and post-intervention periods, stratified by consumption level in pre-intervention period and switching or nonswitching to new Tesco store.

Pre-intervention fruit and vegetable consumption	Switched to new Tesco store			Did not switch to new Tesco store		
	pre-intervention	post-intervention	paired sample t -test	pre-intervention	post-intervention	paired sample t -test
Lower ≤ 2 portions per day	1.25	1.72	$t = -5.775$ $p = < 0.001^{***}$ $n = 124$	1.37	1.78	$t = -4.237$ $p < 0.001^{***}$ $n = 115$
Intermediate 2–3 portions per day	2.44	2.51	$t = -0.405$ $p = 0.687$ $n = 52$	2.45	2.43	$t = 0.152$ $p = 0.879$ $n = 82$
Higher ≥ 3 portions per day	4.51	4.52	$t = -0.059$ $p = 0.953$ $n = 100$	4.78	4.20	$t = 2.863$ $p = 0.005^{**}$ $n = 142$

** Significant at 5% level; *** significant at 1% level.

consumption in the pre-intervention period. However, this is *not* the case for those (276) who switched to the new Tesco store.

Nevertheless, useful and potentially important as these analyses and the results are, what is clearly required is a *multivariate* appraisal of the shifts in dietary patterns in the post-intervention period and of the links between those shifts and that intervention. It is to that task which we now turn.

Dietary patterns in the post-intervention period—multivariate appraisal

We have established, therefore, that some potentially important associations appear to exist between the retail-provision intervention and improvements in diet—evidence suggestive, for the first time in the United Kingdom, that a retail-provision intervention may have a positive impact on the diets of some (indeed some of the more ‘at risk’) groups in a ‘food desert’. The issue now is to what extent those associations, statistically significant in a univariate context, hold *simultaneously* within a multivariate context?

To answer this question we modelled dietary change among our respondents in the form of a standard multivariate regression model, in which absolute change (positive or negative) in fruit and vegetable consumption levels between the pre-intervention and post-intervention periods formed the dependent/response variable and the explanatory variables included the factors identified in the univariate analyses (tables 5–8) plus a range of other potentially important influences on dietary change, such as household/respondent event indicators. We experimented with a wide range of potential explanatory variables (including both individual respondent and household characteristics) and several model specifications. We also tested our models for misspecification using standard tests (for example, Breusch–Pagan for heteroskedasticity⁽⁶⁾) and diagnostic procedures, including those for the identification of ‘high-leverage’ observations (Belsley et al, 1980; Cook and Weisberg, 1982). Our models were fitted on 598 rather than 615 observations, as 17 of our respondents had partially missing information relating to some of the variables included in the models, and we used backwards stepwise elimination of potential explanatory variables within SPSS Version 11 to obtain ‘best fitting/most parsimonious’ forms of the various specifications we considered.

Ordinary least squares (OLS) parameter estimates and their standard errors for respondent and household characteristics that affect dietary change between the pre-intervention and post-intervention periods are shown in table 10. What is important is that, in each of these models, the parameter estimates for the factors identified in the univariate analysis (pre-intervention consumption level, switching to the new store in the post-intervention period, proximity to the new store, and switching to the new store from a limited-range or budget store in the pre-intervention period) have the appropriate signs (positive or negative) and are statistically significant at conventional levels. That is to say, each of the factors identified in the univariate analysis continues to be an important determinant of dietary change between the pre-intervention and post-intervention periods whilst the other factors are simultaneously considered and held constant in a statistical sense.

Many of the other potential household/respondent-characteristic explanatory variables which we experimented with in our model specifications (for example, change in household composition between the pre-intervention and post-intervention periods, change in the respondent’s employment status, switch to walking as the main travel mode in the post-intervention period, attitudinal persistence (appendix A), etc had

⁽⁶⁾ The tests revealed no evidence of heteroskedasticity.

Table 10. Determinants of dietary change (proxied by absolute change in fruit and vegetable consumption) between pre-intervention and post-intervention periods—ordinary least squares parameter estimates and standard errors (in parentheses).

Explanatory variable	Model	
	1	2
Constant	0.727 (0.147)	0.708 (0.147)
Pre-intervention fruit and vegetable consumption	−0.281*** (0.034)	−0.282*** (0.034)
Switched to new Tesco store	0.248* (0.142)	0.252* (0.141)
Distance to new store ≤500 m	0.440** (0.227)	0.409* (0.226)
Switched from limited-range or budget store in pre-intervention period	0.386** (0.188)	0.343* (0.188)
Effect of household living in postcode sector LS14 1	−0.426*** (0.160)	−0.429*** (0.159)
Respondent quit smoking	—	0.929*** (0.383)
<i>N</i>	598	598
<i>R</i> ²	0.133	0.141
Adjusted <i>R</i> ²	0.125	0.132

*Significant at 10% level; **significant at 5% level; ***significant at 1% level.

parameter estimates with the expected signs, but did not achieve significance at conventional levels and were therefore removed from the models in the backwards stepwise elimination procedures. Two of these potential additional variables did, however, remain and are shown in table 10. The first is a significant positive effect on increased fruit and vegetable consumption in the post-intervention period associated with the respondent claiming to have stopped smoking between the two waves of the survey—although considerable caution needs to be exercised with this result as the number of respondents claiming this behavioural shift is relatively small (20). The second is a significant area effect associated with households living in postcode sector LS14 1—after taking account in the model of the higher levels of switching to the new store by respondents in that area, their proximity to the store, and so on. We have considered several possible underlying determinants of this apparent area effect—for example, a possible clustering of important household composition events (marriage, separation, new baby, children leaving home, etc), localized employment status changes, and so on which might impact on diet. However, we can offer little in the way of a breakdown of the effect and, at this stage, leave it simply as an unexplained residual area effect.

Clearly, with such parsimonious models as those in table 10, there are potential problems relating to missing variables. In particular, an issue of concern to us was that these omitted variables might simultaneously determine both dietary change between the pre-intervention and post-intervention periods (proxied by change in fruit and vegetable consumption) *and* pre-intervention consumption levels, potentially altering the conclusions we have drawn on the basis of the OLS estimates in table 10.⁽⁷⁾

⁽⁷⁾ Another way to express this is to say that we were concerned that pre-intervention consumption level might not be the exogenous variable we initially assumed it to be in the models in table 10, that it might be correlated with the error terms in the equations, and that the parameter estimates produced using OLS might be biased and misleading.

To check this possibility we conducted a test [described by Maddala (1988, pages 440–441) and Pindyck and Rubinfeld (1991, pages 303–305), and essentially an omitted variables/exogeneity interpretation of the more general Hausman (1978) misspecification test] which basically allows us to determine whether there are instrumental (omitted) variables which might potentially call into question the OLS estimates in table 10 as a result of simultaneity. The potential candidates as instrumental variables were some of those that we had found to be important determinants of diet in our analysis of the pre-intervention survey (respondent age, number of children in the household, household deprivation level, and so on) but which we had not considered for inclusion in our initial models of dietary change between the pre-intervention and post-intervention periods.

Using the expanded regression methods outlined by Maddala and Pindyck and Rubinfeld and the instrumental variables noted above, we found evidence of simultaneity.⁽⁸⁾ As a result, we reestimated models 1 and 2 in table 10 using an instrumental variable/two-stage-least-squares (2SLS) approach and with different sets of instrumental variables. The results are discussed in appendix B. Here it is sufficient to note that all the 2SLS parameter estimates retain the same signs as the OLS estimates in table 10, and that the statistical significance of the relationships between change in diet and switching to the new store, proximity to the new store, and switching to the new store from a limited-range or budget store in the pre-intervention period is marginally increased. However, when simultaneity is taken into account, the influence of pre-intervention consumption level is less significant. Given the essentially exploratory nature of our multivariate analysis, we believe that the appropriate way to interpret these results is as supplementary evidence regarding the validity of the general conclusions we draw from the models in table 10.

As is common in cross-sectional demand analysis, our large sample size and parsimonious model (more than 590 degrees of freedom remain), ensures that the adjusted R^2 -values in table 10 are low (0.13). However, as the applied econometric literature stresses (Berndt, 1991; Lardaro; McGuirk et al, 1993) a low R^2 in this situation is *not* an indication that the model is not appropriate in a statistical sense (see Peterson et al, 2001, page 451).⁽⁹⁾ Indeed the p -values for the overall model F -tests are all significant at the 1% level. Given the significant within-sample heterogeneity and the absence of detailed information on the relative prices for food items faced by our respondents, it is not surprising that our parsimonious models explain only 13% of the overall variance in dietary change between the pre-intervention and post-intervention periods in this size of sample. What is far more important is that each of the factors identified in the univariate analysis is shown in table 10 to remain an important determinant of dietary change when considered simultaneously in a multivariate context. What our multivariate analysis is confirming then is that, *ceteris paribus*, diet (proxied by fruit and vegetable consumption) improved with switching to the new store, switching to the new store from a limited-range or budget store in the pre-intervention period, proximity to the new store, and for those with

⁽⁸⁾ That is to say, evidence that pre-intervention consumption level cannot be treated as exogenous.

⁽⁹⁾ Lardaro (1993, page 186), for example, notes that: “time series equations almost always generate higher R^2 values than cross-section equations. In fact, the coefficients of determination in numerous published articles with well-specified cross-sectional equations are below 0.3. This arises because cross-sectional data contain a great deal of random variation, or ‘noise’, which makes the explained variation small relative to TSS.”

poor diets in the pre-intervention period.⁽¹⁰⁾ That is to say, we find evidence of both direct and indirect positive impacts of the intervention on diet. As far as we are aware, no previous evidence exists in the United Kingdom of these associations between a retail-provision intervention and improvements in diet. As a result, we believe that these findings may have considerable policy relevance.

Policy implications—why might the Seacroft findings be important?

Beyond their purely scientific significance to ongoing and multidisciplinary debates on issues of food access and food poverty in the broader context of what Mohan (2002, page 69) terms a “second rediscovery of poverty”, the findings of the Seacroft study have, we suggest, immediate relevance for at least two important areas of policy debate.

Local retail solutions and the ‘appropriate size store’ debate

As noted above, the consultation report of PAT 13 (DoH, 1999b) strongly favoured local-community-based and small-scale-retailer-oriented solutions to the problems of food deserts. It outlined examples of community-based and community-run initiatives which might serve as models of good practice and proposed the setting up of ‘local retail forums’ which would involve the local community and its key stakeholders working in partnership to develop local retail strategies

“for improving access to shops and services, in the context of district, town, city and regional wide plans, and in the context of achieving a longer term health gain” (DoH, 1999b, page 4).

⁽¹⁰⁾ Clearly, respondents who lived within 500 m of the new store were also more likely than not to be ‘switchers’ to the new store. In that context, Dr Christina Goodacre of DEFRA has questioned whether ‘switched to the new store’ and ‘proximity to the new store’ should enter the models in table 10 as *separate* explanatory variables and/or whether collinearity is a problem if the two variables are entered in this way. Although 43 of the 65 respondents who lived within 500 m of the new store were also ‘switchers’ to the new store, for technical reasons (essentially because the two columns representing the ‘switch’ and ‘proximity’ variables in the matrix of explanatory variables are made up of columns of ones and zeros—276 ones and 339 zeros in the case of the ‘switch’ variable and 65 ones and 550 zeros in the case of the proximity ≤ 500 m variable) collinearity between the two columns is less than might be suspected. However, Dr Goodacre does raise an important point—to which we have responded by experimenting with ‘multiplicative’ formulations of the ‘switch’ and ‘proximity’ variables. In the first of these we removed the original ‘switch’ and ‘proximity’ variables and substituted an alternative variable which captures whether the real effect on dietary change that we are observing is amongst those who live close to the new store *and* who also switch to the new store. This, as might be expected, produced a positive coefficient, statistically significant at the 10% level. In the second, we retained the original ‘switched to the new store’ variable and also included the previous variable which captured those respondents who lived close to the new store *and* also switched to it. In this case, although there is some weak evidence that living close to the new store *and* also switching to it might have an *additional* positive impact on dietary change, above and beyond that associated with switching to the new store alone, the latter variable was not retained in the model during the backwards stepwise elimination procedure, leaving only the original ‘switched to the new store’ variable in the final model (with a positive coefficient and statistically significant at the 5% level). We take this to indicate, as table 10 is suggesting and our subsequent ‘robustness’ testing confirms, that ‘proximity’ is of secondary importance to ‘switching to the new store’ in terms of impact on dietary change. And we suspect that in any subsequent ‘causal’ analysis ‘proximity’ might be expected to be shown to have a less important role than ‘switching to the new store’ in terms of the dietary change associated with the intervention.

In the subsequent *Policy Action Team Audit Report* (Social Exclusion Unit, 2001b) and *National Strategy Action Plan* (Social Exclusion Unit, 2001a), the government committed itself to this proposal. Specifically, it promised that

“local retail forums and retail strategies will feature in the neighbourhood path-finder programme” (Patricia Hewitt, Minister for Small Business and e-Commerce, in Social Exclusion Unit, 2001b, page 170),

that programme being a £45 million scheme over three years from 2001 to test alternative models of neighbourhood management in deprived areas.

In addition, and as noted above, ministerial statements on planning policy by the DETR began to emphasize the development of ‘local solutions’ to solve problems of social exclusion from services in general, and the problems of ‘food deserts’ in particular. Specifically, and in response to pressure coming from the major retailers who had begun to marshal a strong social inclusion rationale for large-store development proposals in areas of urban deprivation, ministerial statements began to remind local planning authorities of the need to encourage retail developments

“that are appropriate in scale to the role of the centre and the size of the community it serves”,

arguing that

“we should try to meet the needs of local communities, rather than expect local communities to adjust to large formats” (Beverley Hughes in DETR, 2000a).

However, and particularly in the context of the severe access problems of many large local authority housing estates—typically focused on increasingly derelict 1960s/1970s district shopping centres—there was a growing body of pro-development opinion in the United Kingdom which believed that the concept of community-based small-scale-retailer-oriented solutions to the problems of these areas promoted by PAT 13 was arguably naïve and overprecious. This view is best summarised in the words of Huw Williams, a former planning manager for J Sainsbury plc and now director of the Town Planning Consultancy. In an interview with the journal *Regeneration and Renewal*, and in response to statements by Planning Minister Nick Raynsford that some of the district centres

“are now experiencing the problem of large supermarkets seeking to piggyback on a local centre, arguing that they are in a town centre but, in practice, having all the characteristics of a free-standing superstore” (Raynsford, 2000, page 5),

Williams retorted that

“there are notions about large supermarkets coming in and swamping existing centres. But if you go and visit the local district centre, which might be falling apart at the seams, a new store with all the bells and whistles, in qualitative terms, is exactly what is required. My criticism is that those people get a little bit precious about these district centres where really development is the only option ... Isn’t the prospect of a multi-million pound investment, with the prospect of local employment and training, as good a way as any to kick-start regeneration” (Williams, quoted in Willis, 2001, page 19).

And clearly, not least in the case of the Seacroft development, this comprehensive redevelopment approach to the problems of increasingly derelict and stigmatised district centres, plagued by antisocial behaviour, was very attractive to local authorities.

It is not our purpose here to argue from the perspective of one or other of these positions. Both in our view have their merits, and we note that large-scale corporate retail-provision intervention is clearly not a feasible or necessarily attractive solution across the considerable number of poorly served areas which exist within

British cities⁽¹¹⁾—concerns for which had, by December 2001, resulted in The Food Poverty (Eradication) Bill (a cross-party motion on food poverty signed by 198 MPs) gaining its first reading in parliament (Cummins and Macintyre, 2002). In addition, we note that the boundaries between the two positions are not rigid. For example, it is not inevitable that large-scale intervention must solely take the form of major fixed investment by corporate retail. Other initiatives—for example, the active encouragement of regular local urban markets (with a fresh food emphasis) through a much more modest local authority investment on suitable sites—may have the potential in combination to produce a large-scale intervention. Rather, it is our purpose to note that an important connection was drawn by PAT 13 between its proposals and the need to *monitor* the impact of such initiatives. That is to say, to test the effectiveness of interventions in improving shopping access for people living in deprived neighbourhoods and, in particular, to monitor

“the effectiveness of such interventions on improving the health of the community and on reducing health inequalities” (DoH, 1999b, pages 62–63; Social Exclusion Unit, 2001b, page 180).

Yet, so far, little evidence has been produced of the effectiveness and/or scale of impact of community-based small-scale-retailer-oriented interventions on diet and health in ‘food deserts’ [although some initial work on community retail enterprises (CREs) in Glasgow is reported by Hibbert et al (1999) and Piacentini et al (2001)]. In contrast, the findings of the Seacroft study reported here suggest that a large-scale corporate intervention can significantly change shopping access and travel mode for large numbers of residents of such areas. [Recall here that 45% of our respondents in this large deprived area of 15 000 households switched to the new store as their main food source—in the process, more than halving the average distance travelled (from 2.25 to 0.98 km) to that source, tripling their use of walking, and significantly reducing their dependence on complex, and often hard-to-manage, coping mechanisms to access food shopping.] In addition, our findings provide evidence of both direct and indirect positive impacts of the large-scale intervention on the diets of some (indeed some of the more ‘at risk’) groups in the food desert. Beyond the obvious need to replicate these findings in other studies of large-scale retail interventions elsewhere in the United Kingdom, the challenge must be for those who advocate community-based small-scale-retailer-oriented interventions to demonstrate similar impacts on access, diet, and, by extension, health in such a community. And more generally, as both Wrigley (2002) and Cummins and Macintyre (2002) have suggested, the need is for evidence-based research to guide more strongly the formulation of policy responses designed to improve the food access problems of disadvantaged groups in deprived areas.

Nevertheless, although our findings suggest dietary impacts of the intervention on some of the vulnerable groups in our food desert, it is important that we caution that the changes in diet reported here are relatively small in absolute terms (typically less than half a serving a day), and that average consumption levels of the majority of

⁽¹¹⁾ Tesco currently has developed, or is in the process of developing, twelve such urban regeneration schemes across the United Kingdom (primarily in the north and Scotland). Together with those associated with the other major retailers, the total number of these schemes is unlikely to exceed twenty-five stores by 2003. Yet, Dorling has suggested to us that there may be more than 3000 poor-food-retail-access areas identifiable across the United Kingdom [although we note that findings of the Competition Commission (2000, volume 2, pages 312–317) would suggest significantly lower numbers than that]. We also acknowledge that large-store-based corporate retail interventions may not be a particularly ‘robust’ solution. In contrast to the multistore 1960s district centres which degraded slowly over a decade, a retail centre essentially based around one large urban regeneration store is clearly more vulnerable to the possibility of failing catastrophically if that store (for economic trading reasons) is closed down.

residents in this deprived area remain at least two portions per day below current government recommended levels. Clearly other factors, such as those we considered in our analysis of the pre-intervention-period food-consumption patterns, play a larger role in establishing dietary patterns and determining whether people will (can) change their consumption habits. It should not be inferred from our results, therefore, that an intervention-based policy focused solely on improving retail access is likely to have a profound effect on changes in diet and health—any changes are likely to be at the margin. Nevertheless, it is important to assess, as in this paper, whether there is *any* evidence of dietary impact from a large-scale intervention and, if so, the approximate scale of that impact.

Area-based policy responses to social exclusion

In policy debates on deprivation, social exclusion, and health inequalities, there is a long history of divergence between those who advocate area-based versus individual-based policy responses. As Mohan (2000) notes, the intense concern with issues of social exclusion within the post-1997 Labour governments has contained elements of three broad discourses identified by Levitas (1998; 1999)—a redistributive discourse, a social integrationist discourse, and moral underclass discourse—but, above all, it has also been characterized by “an apparent renaissance of area-based policy” responses to social exclusion (Mohan, 2000, page 296).

The food-deserts debate provides a good example. It clearly encouraged a shift towards an area-based focus for health-promotion activity relating to diet and nutrition in the United Kingdom. Indeed as Lang and Caraher (1998, page 203) observed,

“There is little point in encouraging low-income consumers to eat more healthily if their district has inadequate local food suppliers and if shops which do offer a choice are located inconveniently for socially disadvantaged groups such as single parents, women, the elderly, disabled individuals and the poor who tend to have worst access to cars and transport.”

And that shift in focus clearly filtered into the policies of local health authorities—for example, the East London and The City Health Authority (ELCHA) published a report strongly supportive of the need for an integrated approach to the tackling of food poverty in what it broadly viewed as ‘food deserts’ and committed itself to tackling the issue within an action zone partnership structure (ELCHA, 1999a; 1999b). Moreover, it was a shift in focus which was clearly incorporated into the approach adopted by health ministers—although not to the total exclusion of individual-based policies which were recast to be supportive and facilitative rather than prescriptive. An interview by *The Times* (2001) with Yvette Cooper, Minister for Public Health, is illustrative. In that interview Cooper combines a message about the Labour government moving away from a previously prescriptive ministerial approach to advice on diet (“Ministers should not be telling people how to live their lives”) and towards a focus on offering people better information, support, and opportunities, with a message about improved opportunities often being conceived in terms of area-based policy responses:

“Ministers’ approach to diet is focused now on issues such as how low-income families living two bus rides from a grocery get access to fresh fruit and vegetables... school pupils in some poor areas [will] also be offered fresh fruit daily” (*The Times* 2001).

Nevertheless, the food-deserts debate is also illustrative of some of the potential fragilities of area-based policy responses to social exclusion—not least the perennial problems of identifying and targeting priority areas with precision given inevitable within-area variability in critical markers of exclusion, and of designing appropriate policy instruments. By simply assuming that ‘food deserts’ existed, and using the term

as a convenient metaphor in policy debate in advance of developing systematic methods of assessing local access to food retail provision, both the concept and the proposed area-based policy responses were opened to scepticism. The views of the Competition Commission (2000, volume 2) which claimed that it could find little evidence across the United Kingdom of significantly poorer access in low-income urban areas to the large supermarkets of the major food retailers, and which fed through to the Department of Trade and Industry, were particularly influential [although there were also occasional academic statements of similar views (Cummins and Macintyre, 1999)]. Indeed, by the time the second Labour government took office in 2001, there were clearly hints of a possible divergence of interpretation between government departments on ‘food deserts’ and food-access issues.

The importance of the Seacroft intervention study and the wider investigation of food-access issues in Leeds, Bradford and Cardiff of which it forms part, is, first, that it confirms the intensity of food-access problems in some of the large local authority housing estate areas in British cities and, second, that it suggests the potential malleability of some of these problems to large-scale area-based intervention. The fact that this is not the type of area-based policy response favoured by PAT 13 is relatively unimportant in the context of a debate in which the alternative is to assume either that there is little problem of poor access in deprived low-income urban areas, and/or that even if such problems exist they are not amenable to area-based interventions and can only be tackled effectively by conventional individual-focused health-education programmes.

The Seacroft study also highlights, however, the importance of local-level heterogeneity—small pockets of people within the deprived area relatively better and worse off in terms of diet and risk of poor health. In turn, this argues for the need to balance area-based with targeted individual-based policy responses. Any approach that ignores this local heterogeneity is likely to fail in improving diet-related health. Equally, any approach that shifts responsibility for action solely onto the individual, and assumes that change can be achieved by encouraging people to eat a healthy diet through nutrition education (in the narrowest sense of the term) alone is also likely to fail. Indeed, the inability of health promotion in the United Kingdom over the past decade to achieve any substantial beneficial change in dietary patterns of the worst off groups in society is evidence that this approach has not been effective. Rather, it has been most successful in helping to improve the diets of those already better off, thereby contributing to widening social inequalities in diet-related health. Overall then, from the perspective of the Seacroft intervention study, we have considerable sympathy with the notion, expressed in the ELCHA report, of exploring action-zone-partnership approaches to the tackling of food poverty, and bringing

“food access issues to the forefront of decision-makers, especially those responsible for urban planning and regeneration” (ELCHA, 1999b, page 4), particularly if those approaches remain sensitive to the issue of local heterogeneity and the need to balance area-based with targeted individual-based policies.

But are the Seacroft findings ‘real’?: evidence from the repeatability study

Finally, we are sensitive to the fact that the possibly controversial nature of the findings we report in this paper will lead inevitably to questions about the quality of the data collection and the sensitivity of the survey instrument. Indeed, in informal discussion of the early results from the post-intervention survey, it has been suggested to us that respondents’ participation in the study might of itself have resulted in heightened awareness of desirable consumption patterns (‘correct behaviour’) and stimulated more of the same even without the intervention.

We can respond in general to such questions by reiterating that the two waves of the survey were conducted to the highest professional standards by experienced field-workers and project managers in Europe's leading market-research firm with the data being extensively and repeatedly cross-checked in subsequent analysis by the academic team. More specifically, we can respond by arguing that it is highly improbable that any learning effect of desirable consumption ('correct behaviour') by the respondents through participation in the study could be *differentially* distributed across respondents in such a way that it would of itself produce the univariate–multivariate associations that we focus on in tables 5–10. However, in addition, we can also respond to such issues by reporting, briefly, the major results of a 'repeatability' (sometimes referred to as reliability or reproducibility) study which we conducted immediately after wave 2 of the main survey. Essentially, this was a study of the degree to which our survey instrument (specifically the seven-day food-consumption diary) was yielding similar results on two different occasions (Margetts and Nelson, 1997)—given the presumption that our dietary assessment measure should be capable of producing the same result when used repeatedly in the same circumstances. By checking 'reproducibility' in this way, we are able to assess the extent to which differences in consumption found between the two waves of our survey are a reflection of 'true' variation in consumption rather than measurement error inherent in the survey instrument.

Details of the repeatability survey are contained in appendix C. Here we note that it involved 140 of the respondents who took part in wave 2 of the main survey, stratified in such a way that the extremes of fruit and vegetable consumption were well represented. Those respondents completed another identical seven-day food-consumption diary shortly after completing the wave 2 diary. Overall, the results show that the survey instrument (the food-consumption diary) produced highly 'repeatable' results. At the simplest level this is shown in high (0.75) and statistically significant correlation between reported wave 2 and 'repeatability study' fruit and vegetable consumption levels, both overall and when respondents are stratified by age and smoking status. It is also shown in the low degree of misclassification between levels (low, medium, high) of fruit and vegetable consumption reported in wave 2 versus the 'repeatability' survey. (Kappa statistics measuring agreement between the two classifications are high and significant—and of those respondents differently classified between the two surveys there are no significant differences in demographic or household characteristics, indicative of differential bias, between those who underreported or overreported in one or other of the surveys.) However, the issue can also be approached, as in figure 8, using the Bland–Altman (1986) method of assessing the extent of agreement between the reported wave 2 and 'repeatability study' fruit and vegetable consumption of the 140 respondents. Bland–Altman plots essentially display the difference between two measures against the mean of the two measures.

If there was the same level of agreement between the wave 2 and 'repeatability study' measures of fruit and vegetable consumption at both low and high levels of consumption, we would expect the least squares line which summarizes the plot to be horizontal and to pass through the origin. In the case of figure 8 a slight negative gradient is observed which indicates that respondents with higher consumption of fruit and vegetables were likely to report a higher intake in the 'repeatability study' than in the wave 2 survey. However, as figure 9 demonstrates, by excluding just those with the very highest mean consumption levels across the two surveys ($n = 4$), the least squares line shifts into a horizontal/through-the-origin position.

We interpret figures 8 and 9 as suggesting that some care might be needed in our analysis of shifts in diet between the pre-intervention and post-intervention periods in the case of respondents with the highest mean consumption levels across the two main

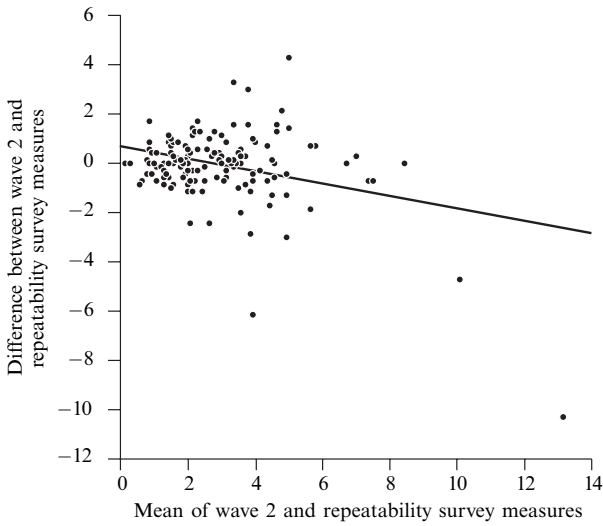


Figure 8. Bland–Altman plot—mean of wave 2 and repeatability survey measures against difference between those measures.

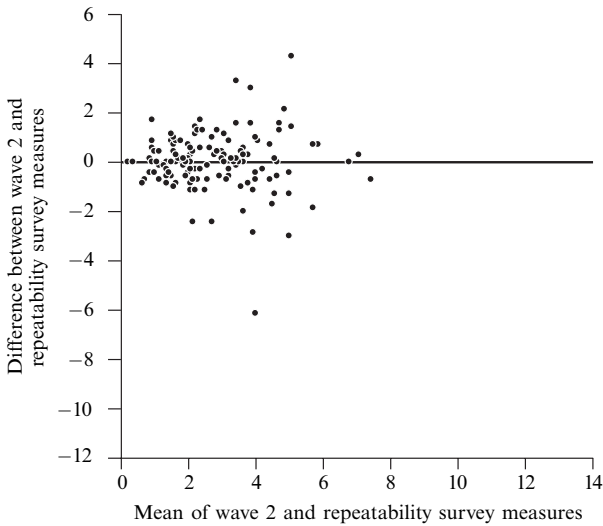


Figure 9. ‘Robust’ Bland–Altman plot removing 4 respondents with highest mean wave 2 and repeatability survey measures.

waves of the survey. As a result, we have reestimated both models in table 10 *deleting* the six respondents with the highest mean consumption levels across the two main waves of the survey, in an attempt to assess the ‘robustness’ of our multivariate model findings to these concerns. What we discover on doing this is that the finding in which we had least confidence (because of small numbers reporting the behavioural shift)—that relating to a positive impact on increasing fruit and vegetable consumption in the post-intervention period associated with the respondent claiming to have stopped smoking between the two waves of the survey—no longer holds. However, the other factors (pre-intervention consumption level, switching to the new store, proximity to the new store, switching to the new store from a limited-range or budget store in the pre-intervention period, and the unexplained area effect) all retain the same signs, and all but the proximity effect remain statistically significant at conventional levels.

Removing these six high mean consumption level respondents also improves (as might be anticipated) the overall fit of the model ($R^2 = 0.201$, adjusted $R^2 = 0.194$).⁽¹²⁾

On the basis of our repeatability study, therefore, we remain confident that our findings reflect ‘real’ variations in consumption between the pre-intervention and post-intervention periods and are not merely an artefact of the survey instrument. We are also able to reconfirm our view that evidence exists of both direct and indirect positive impacts of the intervention on diet. Together with the evidence we report on significant changes in shopping access and travel mode, but keeping in mind our caution that the changes in diet we report here are relatively small in absolute terms and that the dietary intakes of residents of this deprived area remain significantly at variance from current government recommended levels, these we suggest are potentially important and policy significant findings. In summary, we have offered evidence for the first time in the UK of a positive but modest impact of a retail intervention on diet, associated with significant shifts in access. That suggests the need to continue the exploration of the potential value of action-zone-type partnership approaches to the tackling of food poverty and the encouragement of a wider debate on the potential social inclusion role of retail planning policy. However, the significant local-level heterogeneity in diet and risk of poor health which we also observed within the ‘food desert’, suggests the need for a balanced approach between area and individual-based policy responses to ensure that the critical barriers (rate-limiting steps) in improving dietary intake and diet related health are appropriately targeted.

Elsewhere in the wider Food Deserts in British Cities project, we have attempted to triangulate the findings from the essentially quantitative food-diary/household questionnaire-based ‘before/after’ study reported here, with purely qualitative ‘before/after’ focus-group studies of individual/household experiences of poor food retail access, and the consequences for those experiences of an amelioration of the area’s accessibility problems. The insights from these focus groups, together with further investigations of the heterogeneity in diet and risk of poor health in the research area—topics which we will report in subsequent papers—will enable us to deepen understanding of the nature of this type of intervention on the nexus of interlinkages between food access, food poverty, and poor health. And it will allow us to unpack further the metaphor⁽¹³⁾ of the ‘food desert’ that so captured the imagination of those involved in policy development in the United Kingdom during the late 1990s.

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⁽¹²⁾ Interestingly, the form of deletion produces virtually the same result as we obtain by removing a small number (4) of different observations from the models fitted in table 10 on the basis of their combined anomalous high leverage, studentized residual, and DFIT values—that is, on the basis of conventional regression diagnostic methods (Belsley et al, 1980). As such, it reinforces our view of the robustness of the core results we obtain from the multivariate analysis.

⁽¹³⁾ Cummins and Macintyre, adopting a similar argument about the metaphor of the ‘food desert’, describe it as a ‘factoid’—an assumption reported and repeated so often that it becomes an imagined fact.

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Appendix A

The attitudinal persistence explanatory variable

We were attempting via the use of the attitudinal persistence variable to approach and proxy the issue of ‘habit persistence’. Using two ‘attitude to healthy eating’ variables found to be significant in our analysis of the pre-intervention survey (Wrigley et al, 2002b), we constructed table A1.

Table A1. Deriving the variable.

Pre-intervention attitudes to healthy eating	Post-intervention attitudes to healthy eating			
	positive	mixed	negative	total
Positive	286	43	18	347
Mixed	88	48	28	164
Negative	34	31	39	104
Total	408	122	85	615

We then defined the respondents ($n = 373$) on the diagonal of this table as those exhibiting ‘attitudinal persistence’ between the pre-intervention and post-intervention periods, and those in the lower left (153) and upper right (89) quadrants as having, respectively, more ‘positive’ and ‘negative’ attitudes to healthy eating in the post-intervention period. Following this, we experimented with several methods of scoring these categories and entering the ‘attitudinal persistence’ variable into the model. However, although the parameter estimates of the variables formed in this way typically had the expected signs, they failed to achieve significance at conventional levels. Nevertheless, we note the potential of this approach and leave it open for further exploration by readers.

Appendix B

Instrumental variable/two-stage-least squares reestimation allowing for simultaneity

Models 1 and 2 in table 10 were reestimated using an IV/2SLS approach, with different sets of instrumental variables drawn from those that had been found to be important determinants of diet in the analysis of the pre-intervention survey but which had not been considered for inclusion in the initial exploratory models of dietary change. Respondent age, however, although an important determinant of fruit and vegetable consumption level in the pre-intervention period, was not considered an appropriate instrumental variable to use in this process as it was likely to be correlated with the error terms in models 1 and 2. (In addition, for obvious reasons, smoking level in the pre-intervention period was not used as an instrumental variable for the IV/2SLS reestimation of model 2 which included the 'respondent quit smoking' variable.)

As an illustration of the results of this reestimation process, table B1 gives the IV/2SLS parameter estimates and their standard errors for model 1 using three different specifications of the instrumental variables. The results for model 2 follow a virtually identical pattern. (Note that in all three versions the explanatory variables assumed to be exogenous in model 1 were also included by the SPSS 2SLS routine within the IV set.) R^2 -values for the IV/2SLS estimations are not considered here as they are known (Maddala, 1988, page 307) to be incompatible with those from the OLS estimation, always lower, and because there is no unique measure of R^2 in such models.

Table B1. Reestimation of model 1—IV/2SLS parameter estimates and standard errors.

Explanatory variable	Instrumental variables		
	number of children in household; deprivation level; smoking level	number of children in household; deprivation level	number of children in household
Constant	0.396 (0.383)	0.166 (0.422)	0.215 (0.439)
Pre-intervention fruit and vegetable consumption	-0.174 (0.116)	-0.097 (0.132)	-0.114 (0.138)
Switched to new Tesco store	0.303** (0.152)	0.308** (0.155)	0.317** (0.155)
Distance to new store ≤500 m	0.476** (0.232)	0.492** (0.235)	0.480** (0.233)
Switched from limited-range or budget store in pre-intervention period	0.386** (0.194)	0.431** (0.195)	0.407** (0.193)
Effect of household living in postcode sector LS14 1	-0.477*** (0.164)	-0.463*** (0.165)	-0.447*** (0.164)
N^a	583	592	598

Significant at 5% level; *significant at 1% level.

Note. Standard errors are given in parentheses.

^aSample size varies because of partially missing information for some respondents on some variables in pre-intervention survey.

Appendix C

Design and recruitment of the 'repeatability survey' sample

The repeatability survey involved a sample of respondents who had completed wave 2 of the main survey being asked by the fieldworkers—at the point of collection of the wave-2 seven-day food diary—to complete an additional seven-day diary. If a respondent agreed they were then supplied with an additional diary and asked to mail it back on completion directly to the market-research company. Information on the determinants of fruit and vegetable consumption from wave 1 of the survey was used to stratify the sample—the aim being to ensure adequate representation at the high and low extremes of consumption. Stratification was based on respondent age (which wave 1 had shown to be strongly positively associated with fruit and vegetable consumption), and the design of the repeatability survey attempted to ensure that at least 50 respondents in each of two groups (34 years and under and 45 years and over) were included in the sample. Initial estimates suggested that (using a mail-back of diary technique) approximately 200 repeatability survey diaries would need to be placed with potential respondents.

In the event, 143 completed food-consumption diaries were returned, from which three were omitted because of incompleteness. Analysis of the characteristics of the repeatability sample shows it to be statistically representative of the sample from which it was drawn (that is, those respondents completing wave 2 of the main survey). However, given the nature of the stratification procedure used, younger respondents (under 45 years of age), with children and who are smokers, are slightly overrepresented, but not to a significant level.