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The use of supermarket till receipts to determine the fat and energy intake in a UK population

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Abstract

Objectives: To validate the use of supermarket receipts as an index of fat and energy intake in a population that buys most of its food from supermarkets.

Design: Cross-sectional, prospective dietary survey – feasibility study.

Setting: Households situated within a 20-mile radius of a large (Tesco) supermarket in Leeds.

Subjects: Two hundred and fourteen households who spend $\geq 60\%$ of their food purse in (Tesco and other) supermarkets.

Results: Mean daily household purchase of fat, energy and percentage energy from fat contained in food from supermarkets were 185 g, 19.2 MJ and 35.9%. Mean daily household intakes of fat and energy were 190 g and 20.7 MJ, and 35% of energy was derived from fat. Mean household size was 2.4 persons. The association between the amount of fat and energy purchased from supermarkets and the amount of fat and energy consumed by households was strong. 0.90 MJ (95% confidence interval (CI): 0.8–1.0) of energy were consumed for every 1 MJ purchased from supermarkets and 0.76 g (95% CI: 0.64–0.87) of fat were consumed for every 1 g of fat purchased.

Conclusions: The results show a strong association between estimates of the intakes of fat and energy and percentage energy from fat using 4-day food diaries and 28 days of receipts, in populations who buy most of their food from supermarkets. They also show that the fat content of total food purchases from supermarkets is 35.9% energy from fat compared with 33% energy from fat recommended by the Department of Health. This preliminary research indicates the feasibility of and potential for utilising large quantities of readily available data generated from supermarket checkouts in dietary surveys.

Keywords
Till receipts
Fat
Energy
Supermarkets
Household dietary assessment

Over the course of the last three decades the proportion of household food purchased from supermarkets has increased. A recent survey showed that 90% of UK households purchase most of their food through this route^{1,2}. As supermarkets have come to dominate the supply of food in the UK, developments in information technology and marketing have provided the impetus for competing retailers to develop efficient systems for the electronic generation of itemised receipts at the point of sale. Itemised receipts record a detailed prospective list of household food and drink purchased for home consumption, and as such may provide valuable data on the nutritional composition of the family diet, expenditure on food and food purchasing behaviour. The sales data appearing on the receipt also provide the retailer with information that can be used for marketing purposes^{3,4}. Products in

a supermarket are allocated a unique bar code that enables related information to be held in a database, for example its weight, price and nutritional content. Access to this information can facilitate coding and nutritional analysis of food items on household supermarket receipts and hence most of a household's domestic food supplies.

Nelson and Bingham have reviewed established methods of collecting data for household-based surveys⁵. These authors point out that aggregated data based on surveys of groups of people rather than individuals can be economical to collect and used in ecological, geographical and community trial studies to assess diet–disease relationships. The widespread availability of itemised receipts provides an opportunity to collect large amounts of quality data on household food purchases that could be used in studies of this type.

As the prevalence of obesity continues to rise in the UK, high levels of fat in the diet, together with other lifestyle factors favouring the development of this condition, remain of concern to those charged with the responsibility for public health. Recent figures from the National Food Survey (NFS) report that 38.8% of energy is derived from fat^{6,7}. Clearly there is a continuing need to monitor the fat and energy intakes of the UK population and study in more detail the food purchasing patterns and dietary behaviour which lead to the over-consumption of dietary fat. Although eating out is gaining in popularity, latest figures from the NFS show that 80% of the household dietary intake still occurs at home⁶.

Given that food purchased from supermarkets now constitutes a major part of the diet of UK families, we hypothesised that supermarket till receipts could provide an index of the fat and energy content of the diet of supermarket shoppers. If till receipts can be used to estimate household intakes of fat and energy, the methodology could be further developed for use in nutrition intervention programmes and for epidemiological research.

Subject and methods

Recruitment of subjects

A random sample of 837 active Tesco Clubcard members, shopping at a large Tesco supermarket in Leeds, was invited by post to take part in the study. Of these 454 (52%) registered an interest in taking part. Two hundred and eighty-four (63%) of these households met with the following recruitment criteria:

- claimed to spend $\geq 60\%$ of the household food purse at Tesco or predominantly at Tesco and another supermarket; and
- all household members willing and able to take part in the study for a 28-day period.

A completion rate of 75% (223 households) was achieved.

Dietary assessment methods

Estimates of the fat and energy composition of household food purchased using till receipts

One eligible person, known as the diary keeper, was selected to:

- collect supermarket till receipts for the 28-day period of the study; and
- complete a shopping diary for purchases from independent retailers for which there was no receipt available.

Estimates of household nutrient intake

- Food diary – a 4-day food diary was completed for each member of the household (apart from fully breast-fed babies) over three weekdays and one

weekend day. Food eaten at home was weighed using digital scales (Soehnle Vita).

- Pocket books – a pocket book was used to record food eaten outside the home.

Householder absences from meals and meals eaten by visitors. A record was made of the number and type of meals missed by household members and meals eaten by visitors.

Coding and processing data. Nutritional analysis of food diaries, pocket books and foods itemised on till receipts and shopping diaries was undertaken using the Weighed Intake Software Program (WISP) for Windows, version 1.2, produced by Tinuviel Software, Warrington, UK.

Coding – Tesco till receipts. Databases of all food and drink sold at the Tesco (Roundhay Road) store in Leeds were supplied to the Public Health Nutrition Unit from the Information Technology Department at Tesco Stores Ltd at approximately three-month intervals. These databases were used for coding receipts prior to nutritional analysis of food and drink purchased.

Statistical methods. A sample size of 225 households was required to estimate the relationship between household fat consumption and supermarket shopping basket fat content with sufficient precision to estimate the regression slope within ± 0.10 . Regression analysis was used to determine the relationship between fat and energy composition of foods itemised on household supermarket receipts and the fat and energy intake of households. The linear regression for energy and fat was performed using robust variance estimates.

Agreement between the two methods of estimating the fat and energy content of the diet was undertaken using the technique described by Bland and Altman⁸. The outputs from energy and fat were log-transformed to ensure constant variance. Data were analysed using the following software: Microsoft Access and Excel 1997, SPSS version 8 and Stata 6.

Waste. An assumption was made that 10% of all foods and hence all nutrients were lost through either wastage or spoilage, or fed to domestic pets or livestock⁶.

Table 1 Sex and age of individuals in the sample

Age (years)	Responding sample					
	Males		Females		Total	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
Children						
0–4	11	(2.1)	11	(2.1)	22	(4.2)
5–15	38	(7.3)	49	(9.4)	87	(16.7)
16–19	9	(1.7)	12	(2.3)	21	(4.0)
Adults						
20–29	19	(3.6)	32	(6.1)	51	(9.8)
30–59	110	(21.1)	141	(27.0)	251	(48.1)
≥ 60	45	(8.6)	45	(8.6)	90	(17.2)
	232	(44.4)	290	(55.6)	522	(100.0)

Table 2 Social class of households

Social class	Responding sample	
	Frequency	(%)
I	36	(17)
II	113	(53)
III	44	(21)
III	12	(6)
IV	9	(4)
All households	214	(100)

Household net balance. To make a realistic comparison between food purchased and eaten in a household, a net balance was calculated taking into account meals eaten out and by visitors. The weighting factors used in the calculation were based on those used in the NFS⁶.

Characteristics of the sample

This sample contained a slightly higher proportion of 30–59 year olds and fewer males than would be expected in a nationally representative sample (Table 1)⁹.

The sample was representative of Tesco shoppers as demonstrated by a chi-squared test of association, which showed no significant difference between the social and lifestyle characteristics of those who took part in the study and those who did not ($\chi^2 = 16.18$; $df = 11$; $P < 0.05$)⁴.

Table 2 shows that 31% of the sample was classified as social classes III–V and 69% as social class I or II. Social class II is over-represented compared with nationally representative samples; however, this is to be expected as the sample was recruited from one specific supermarket⁹.

Levels of underreporting are shown in Table 3. The percentage of households underreporting their energy intake was approximately equal to the number of households underreporting their supermarket shopping. This figure is in line with or slightly better than levels of underreporting energy intake in other national studies¹⁰.

Table 4 shows that the mean spend on food purchased from supermarkets was 90% of total household spend on domestic food. This confirms that the sample spent the majority of their ‘food purse’ in supermarkets, and this figure corresponds with 91% of total purchase of fat and energy attributable to supermarket food.

Results

Table 5 shows the mean, median and interquartile range of intakes for fat and energy, and percentage energy from fat, estimated by the two methods used in the study. The means, medians and interquartile ranges for each of the estimates for fat, energy and percentage energy from fat are close. The mean values are lower than those reported by the NFS, which used a large, nationally representative sample⁶.

Figures 1 and 2 show that there is a strong linear association between the content of the supermarket food and household intake for both total energy and fat. Figure 1 shows a slope of 0.90 (95% confidence interval (CI): 0.80–1.0) and indicates almost a 1:1 relationship. Figure 2 shows that for every additional 100 g of fat purchased in supermarkets, households would consume an additional 76 g. Figure 1 shows that 59% of the variation in energy content of the household diet is attributable to supermarket food purchases. Similarly, 48% of the variation in fat content of the household diet can be explained by supermarket purchases. The strength of the association between percentage energy from fat in supermarket food and percentage energy from fat in the household diet, as shown in Fig. 3, is linear but weaker than that for energy and fat. This may be explained by the variation in the measurement of fat and energy separately, which is compounded when deriving the percentage of energy from fat.

A comparison of low versus high social class households in this study shows that, in social classes III and IV, more of the variation in fat intake was due to the fat content of supermarket food ($R^2 = 0.59$). In addition, there was a closer association between household fat intake and fat purchased from the supermarket in this group (slope = 0.85, 95% CI: 0.66–1.04) than in higher socio-economic groups. This may be explained by the more careful purchasing behaviour of this group, where the fit between what is purchased and what is consumed is closer.

Bland–Altman analysis

The purpose of the following analysis was to assess the agreement between estimates of individual household intake of fat, energy and percentage energy from fat using the till receipt method and the 4-day weighed intake. For fat and energy, the difference between supermarket food

Table 3 Low energy reporting households* according to energy purchased from supermarkets and energy intake

	Household (weighed intake)		Household (supermarket food)	
	Frequency	%	Frequency	%
Low energy reporting households	64	29.9	66	30.8
Normal	150	70.1	148	69.2
Total	214	100	214	100

* Low energy reporting is defined by ratio of energy intake (EI) to basal metabolic rate (BMR), EI/BMR < 1.2.

Table 4 Percentage household fat, energy and spend in supermarkets

	% (SD)
Fat (g) purchased in supermarkets	91 (9)
Energy (MJ) purchased in supermarkets	91 (8)
Spend in supermarkets	90 (9)

and the 4-day weighed intake was plotted against the average of the two estimates (Figs 4–6). The values of two standard deviations (2SD) above and below the mean were then used to assess the limits of agreement between the methods in accordance with the method outlined by Bland and Altman⁸. The values in Figs 4 and 5 were log-transformed to ensure constant variance. These can be interpreted by inverting the log value and reading as a percentage.

These results show that, in terms of population averages, the agreement between the two methods of estimating household fat intake is close. The weighed intake method overestimates intake of fat by 0.99% (95% CI: 0.94–1.05) compared with the till receipt method. Figure 4 also shows that the limits of agreement between the two methods of measuring fat at the household level will lie in the range from 43% to 231% of the estimate of fat intake derived from the 4-day weighed intake method. These are wide limits of agreement between the two methods and indicate that one method cannot be used as a proxy for the other at the individual household level.

Figure 5 shows that the weighed intakes estimate energy intake to be 0.94% (95% CI: 0.90–0.99) more than the till receipt method. This is a similar result to the measurement of fat using these two methods. Again the limits of agreement between the two methods of estimating individual household intake of energy are wide and range from 49% to 183% of the estimate using the 4-day weighed intake.

Figure 6 shows that the till receipt method overestimates percentage energy from fat by 1.87% compared with the weighed intake method. For an individual household the agreement between the two methods is not close. Results obtained using the till receipts method may differ by between an additional 11 percentage points below and 15 above the estimate of percentage energy from fat in the diet using the 4-day weighed intake method.

Discussion

The findings of this feasibility study demonstrate the potential for using till receipts to estimate intakes of energy and fat and percentage energy from fat in a population that purchases most of its food from supermarkets. The association between the amount of fat and energy purchased from supermarkets and the amount of fat and energy consumed was strong. 0.90 MJ (95% CI: 0.8–1.0) of energy was consumed for every 1 MJ purchased and 0.76 g (95% CI: 0.64–0.87) of fat was consumed for every 1 g of fat purchased (Figs 1–3). The findings also demonstrate that a high proportion of the variation in household fat and energy intakes can be explained by supermarket food purchases (Figs 1–3). These results show clearly that supermarket food makes a substantial contribution to household diet.

The methodology devised to analyse supermarket receipts is novel, straightforward, inexpensive and applicable to large sections of the UK population. It involves a minimum of intrusion and burden on households and reduces the 'boredom effect' of recording food intake, completing food diaries or lengthy questionnaires. The method allows the collection of data from respondents who have difficulties with other methods of dietary recall due to lack of time, low levels of literacy, or poor eyesight, co-ordination and dexterity. Till receipts provide up-to-date and accurate information on the cost of food, and the method has the possibility of being developed to estimate micronutrient intake and patterns of household food consumption.

Data in Table 6 show a closer association between household fat intake and fat purchased from supermarkets in low-income households than in higher socioeconomic groups. Approximately 31% of the households in the study were in social classes III–V. This close association may reflect more careful buying to meet the needs of the family, less wastage and less food eaten out of the home in this group. Low-income groups tend to be price-sensitive when shopping for food and may use a wider variety of retail outlets compared with higher-income groups. In cases where receipts are not issued, a shopping diary can be used to record additional purchases.

Questions have been raised about how useful till

Table 5 Comparison of two measures of household energy and fat intake, i.e. itemised supermarket receipts and 4-day weighed food intake

	Itemised receipts			Weighed intake		
	Mean (SD)	Median	IQR*	Mean (SD)	Median	IQR*
% Energy from fat	35.9 (7)	36.0	31.5–40.4	34.0 (6)	34.7	31.2–37.5
Daily purchase or intake of fat (g)	185 (94)	170	109–251	190 (102)	173	111–263
Daily purchase or intake of energy (MJ)	19.2 (8.7)	17.8	12.8–25.4	20.7 (10.2)	18.67	13.7–27.8

Mean household size = 2.4 people.

* IQR = interquartile range.

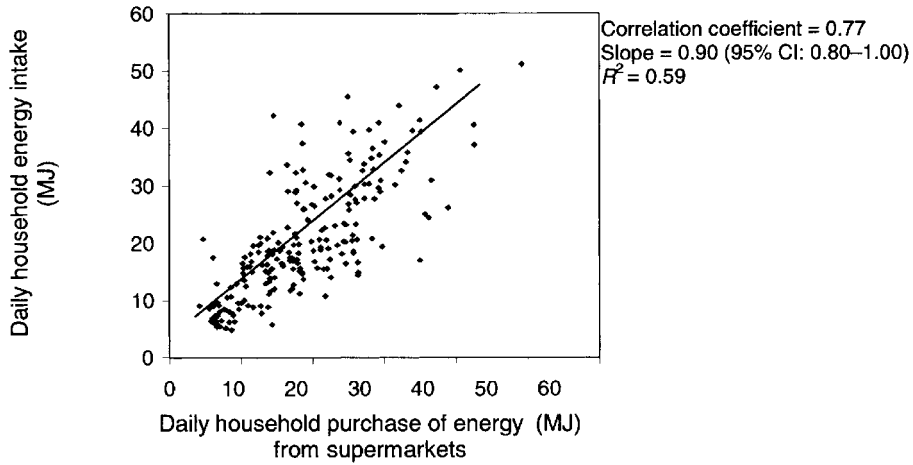


Fig. 1 Household mean daily energy (MJ) purchased from supermarkets and household energy intake

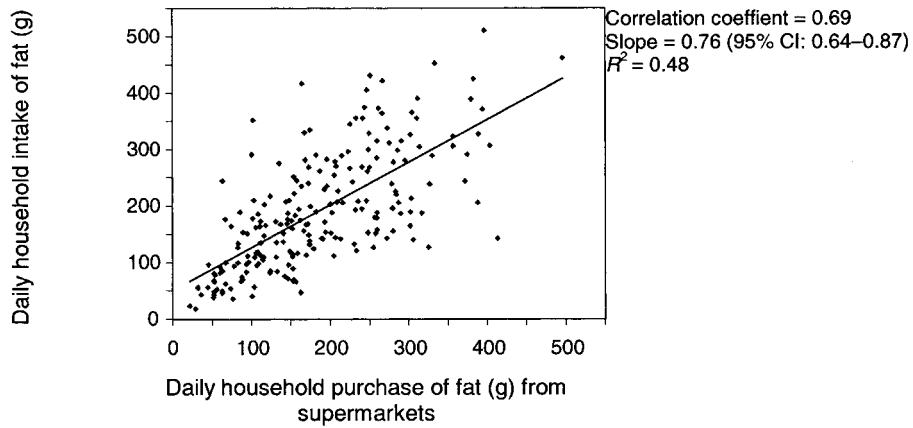


Fig. 2 Household mean daily fat (g) purchased from supermarkets and household fat intake

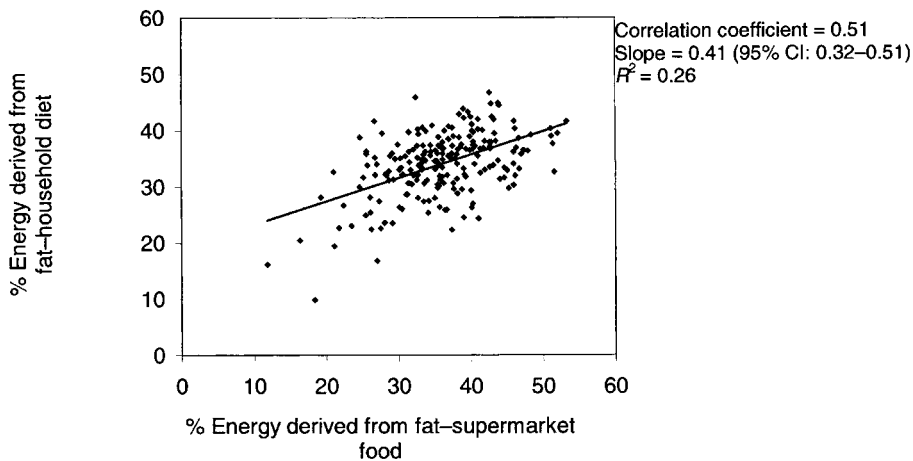


Fig. 3 Percentage energy from fat contained in supermarket food compared with household diet

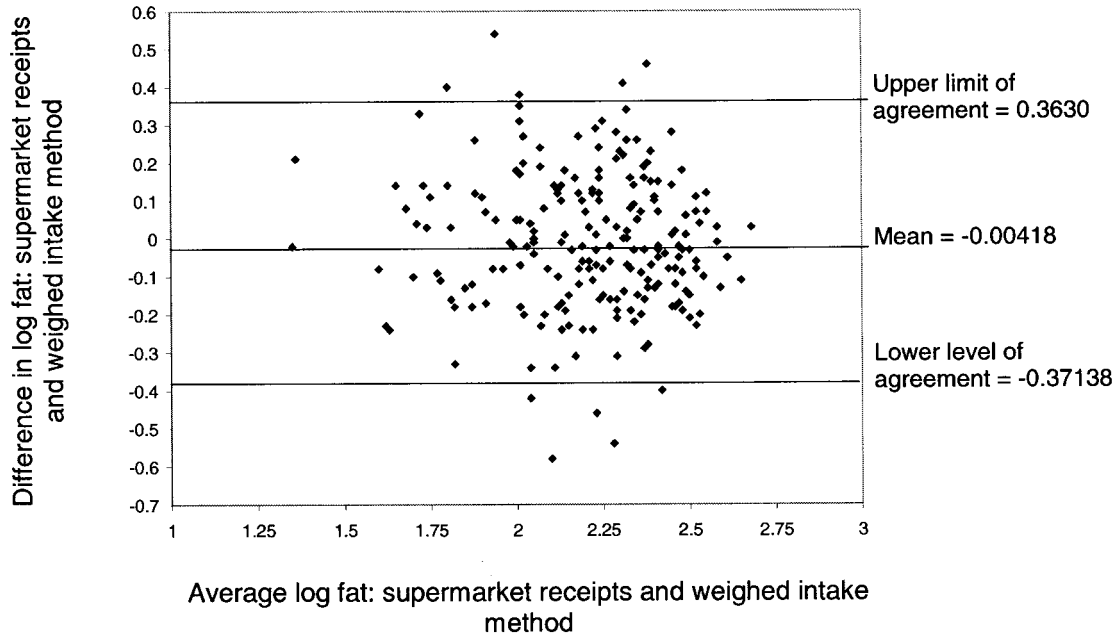


Fig. 4 Measurement of fat (g): supermarket till receipts and weighed intakes

receipts are when considering the fat and energy composition of the diet of individual members of the household. Recently, statistical techniques have been used for modelling intra-household food and nutrient distribution^{11,12}. The results from the modelling exercises have been compared with existing data on food consumption and nutrient intake in nationally representative samples of individuals, and there has been good agreement^{13–15}. However, the data set generated from this study is too small to be used for modelling of this type. Further research involving a larger sample may enable food purchase data derived from till receipts to indicate

the nutritional intake of individual person types and demographic subgroups.

In line with other household food consumption surveys, this method has potential as a powerful, yet economical tool for obtaining food consumption data for use in epidemiological investigations which compare diet–disease relationships between different geographical regions and even different countries⁵. A recent study in Finland has shown similarity between regional sales of dairy products, fats and oils, and reported dietary habits of adult populations¹⁶.

For the majority of the UK, supermarkets dominate the

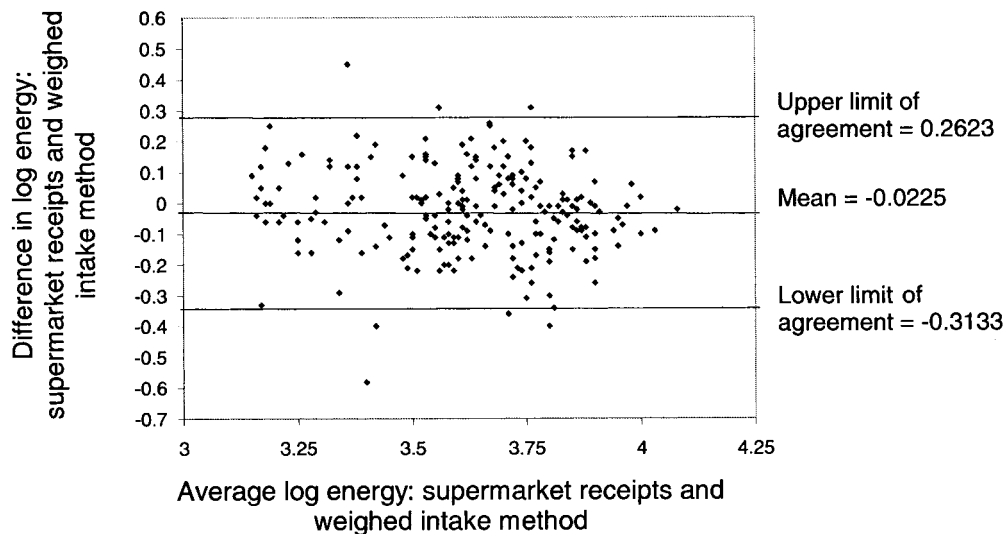


Fig. 5 Measurement of energy (MJ): supermarket till receipts and weighed intakes

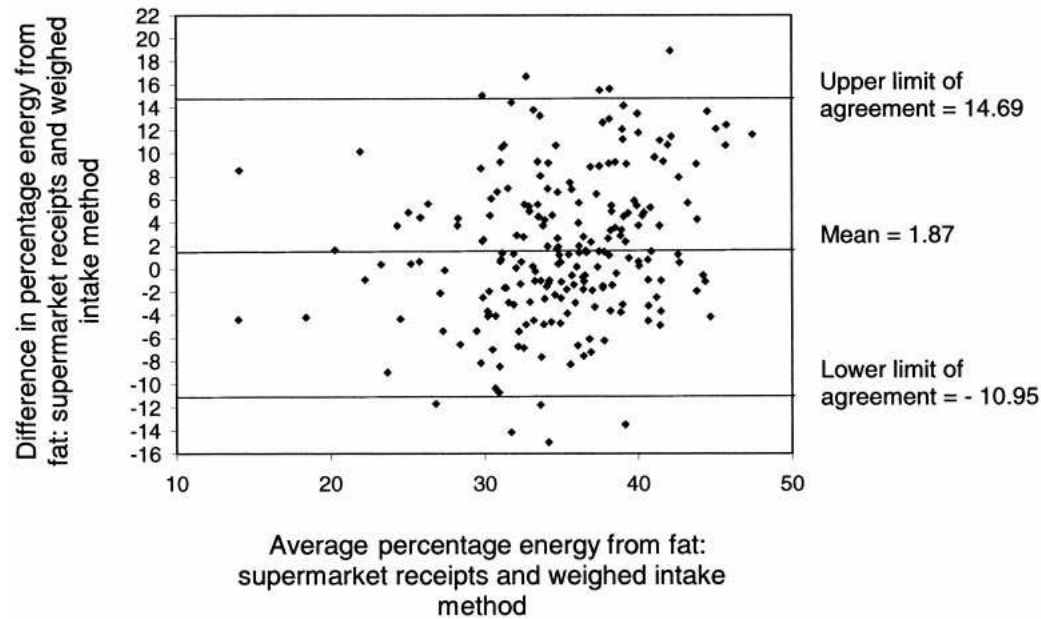


Fig. 6 Measurement of percentage energy from fat: supermarket till receipts and weighed intakes

supply of domestic food and as such have a key influence on the nutritional content of the diet. This study has shown that the fat content of the supermarket shop is 36% energy from fat, which is above current guidelines recommending that total food intake should contain no more than 33% energy from fat⁷. The supermarket trolley is therefore an ideal vehicle to target in intervention studies that aim to reduce the fat content of the household diet. Consumers could use a scanner to calculate a 'fat tally' of the foods placed in their trolley or basket as they shop. This information could be printed in a simple graph format, against the UK recommended levels, on the receipt. Analysis of till receipts could be used to monitor the effects of interventions on shopping behaviour and the nutritional profile of products purchased. A key feature of supermarket interventions could be targeting the food purchasing behaviour of the family gatekeeper (the person who has the major responsibility for purchasing household food) who

exerts a strong influence on the family's attitude to food choice and eating behaviour^{17,18}. A recent initiative in Spain involved a partnership between public health physicians and supermarkets and used 'healthy foods' as 'loss leaders' in selected areas of deprivation¹⁹.

Assessing the agreement between measurements of individual household intake of fat and energy by the weighed intake method and the till receipt method has produced findings that appear paradoxical (Figs 4–6). The findings show that till receipts have the potential for representing mean behaviour of a population group but if the weighed intake is the benchmark, till receipts do not always represent the short-term intake of *individual* households. There may be several reasons for the discrepancy. The comparisons of intakes of fat and energy are derived from different time frames, i.e. the 4-day period used for intakes and the 28 days used for the collection of receipts. There may have been closer agreement if a 14-day record of household intake were used, or two 7-day records. Inevitably there is variation in the diet over time²⁰, as well as variation in the selection of food and drink items bought from the supermarket. The period of 28 days may not be long enough to make a fair comparison. The proximity of the mean values for both fat and energy suggest that, over time, there would be closer agreement between the fat and energy contained in supermarket food and domestic intake.

The use of the weighed intake method as a benchmark against which to measure the results of till receipt analysis is open to question because it is an indirect way of measuring dietary intake, relying on a self-reported diary record. High levels of underreporting in dietary surveys have been well documented; however, the weighed

Table 6 Regression analysis: household intake of fat (g), energy (MJ) and percentage energy from fat compared with till receipts, for social classes I and II compared with III and IV

	Slope (CI)	R^2	Correlation coefficient
Social classes I & II ($N = 149$)			
Fat (g)	0.71 (0.56–0.86)	0.42	0.65
Energy (MJ)	0.86 (0.73–0.99)	0.55	0.74
% Energy from fat	0.41 (0.26–0.56)	0.23	0.48
Social classes III & IV ($N = 65$)			
Fat (g)	0.85 (0.66–1.04)	0.59	0.77
Energy (MJ)	0.97 (0.83–1.12)	0.67	0.82
% Energy from fat	0.43 (0.26–0.59)	0.33	0.57

intake method currently represents the most practical benchmark to use in studies of this type^{10,21,22}.

Missing receipts could have an impact on the relationship between what is purchased and what is eaten at the individual household level and may account for some of the discrepancies. Although possible, it was beyond the resources of this study to undertake a crosscheck of household till receipts against super-market sales data.

Discrepancies between what is purchased and eaten at the individual household level may be further explained by contemporary shopping patterns. Households now make fewer visits to buy food, preferring to stock up on food rather than buying what they want at the point they need it².

This feasibility study has shown the fat and energy intakes of households who shop regularly at super-markets can be estimated by using itemised till receipts, which could be used as a proxy for the food diary method in this population group. In addition, this innovative study has developed an effective protocol for the collection and analysis of the receipts, and could provide valuable insights into food purchasing behaviour. Further work is needed to establish the wider use of this novel methodology in nutrition research.

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