Tracing ingestion of 'novel' foods in UK diets for possible health surveillance: a feasibility study.

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This is an electronic version of an article published in Public Health Nutrition, 7 (2). pp. 345-352, April 2004. Public Health Nutrition is available online at:

http://www.ingentaconnect.com/content/cabi/phn

Public Health Nutrition: 7(2), 345–352 DOI: 10.1079/PHN2003528

Tracing ingestion of 'novel' foods in UK diets for possible health surveillance – a feasibility study

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Submitted 9 April 2003: Accepted 7 August 2003

Abstract

Objective: To investigate the feasibility of using commercially available data on household food consumption to carry out food and nutritional surveillance.
Design: Taylor Nelson Sofres (TNS) collects information on foods brought home for consumption among a representative quota sample of the British population. In total, 33 177 households and 105 667 individuals provided data between 1991 and 2000. These were used to investigate sociodemographic, geographical and temporal trends in purchase patterns of the main macronutrients and four groups of marker products.
Results: Sociodemographic characteristics of the TNS sample were broadly consistent with those of the British population. Estimated energy intakes were slightly low (1667 ± 715 kcal) in comparison with other national data. However, percentage energy contributions were consistent with national trends: e.g. consumption of alcohol in the home increased between 1991 and 2000 with higher intakes among more affluent households, while fat intakes decreased slightly over the same period. Significant temporal, geographic and socio-economic trends were found for all nutrients ($P < 0.0001$). Intakes of marker products were sparse (purchased by <4% of households), but significant variations were detected in the proportion of households purchasing some or all of the marker products across temporal, geographic and socio-economic strata.
Conclusions: A prospective nutrient surveillance system could be used to trace consumption patterns of foods or nutrients to inform nutritional surveillance. However, existing data sources would require a number of modifications to increase their suitability for such a project. Increasing surveillance to consider ingredients would require the development of a central coding system, with electronically linked barcode, ingredient and nutrient information.

Keywords
Nutrition surveillance
Dietary intake patterns
Household food purchase data
Geographical variations
Temporal variations
Socio-economic variations

Novel foods are regularly introduced on to supermarket shelves in the UK. Marketing strategies promote their potential health benefits (e.g. reduction of blood lipid concentrations[1–5]), and their inclusion in the diet is well accepted[4]. However, on a case-by-case basis, the approval of such products may require post-market surveillance to assess potential health effects.

Genetically modified (GM) foods are of particular interest. Despite pre-marketing safety assessments, concerns remain over their long-term safety[6]. A recent international conference on this issue[7] emphasised the need for surveillance campaigns to assess exposure to specific foodstuffs and to monitor associated health effects. The Chief Medical Officer and the Chief Scientific Advisor in the UK reviewed the health implications of GM foods[8] and recommended that methods are developed 'for instituting population health surveillance . . . to monitor population health aspects of genetically modified and other types of novel foods' and '. . . to examine trends over time to detect any early changes in the incidence of adverse health outcomes, whilst recognising the difficulties in establishing causal relationships'. Such a surveillance system would ideally utilise existing food purchase and/or consumption data and track any adverse effects potentially caused by exposure to foodstuffs, enabling their rapid identification and minimising associated health costs[9].

With growing interest in health surveillance, a subgroup of the UK's Advisory Committee on Novel Foods and Processes considered various approaches that could be used in post-market surveillance. This feasibility study was commissioned to investigate the potential for: (1) obtaining commercially available data on British food purchasing patterns for use in medium- to long-term surveillance; (2) assessing the representativeness and validity of these dietary data through comparisons with established sources of nutrient intake data in Britain; (3) detecting patterns in intakes of specific food items over

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time, geographic area and/or socio-economic groups; and (4) linking such information on variations in dietary intakes to health outcomes. A copy of the full report is available from http://www.foodstandards.gov.uk/news/newsarchive/feasibility_study (accessed 1 August 2003).

Methods

Ten years (January 1991–December 2000) of food purchase data collected from a British-representative rolling panel of ~10 000 households were obtained from the market research company Taylor Nelson Sofres (TNS; http://www.tnsofres.com/index.cfm#). Items brought into the home for consumption (including those sold loose) were scanned using a hand-held barcode scanner, either directly from labels or from a booklet of barcodes. The cost of loose goods was entered to help estimate the quantity purchased. TNS estimate that approximately 70% of total household food intake is captured in their database.

Assessing the nutrient content of each purchased item involved considerable work, as TNS data had never previously been used for nutrition research. Some 176 724 food items (some differing only by pack weight) were grouped by TNS into one of 186 categories. Each category was assigned a coding protocol based on characteristics including the degree of nutrient diversity expected amongst products of that type (see Appendix for details). This reduced the nutrient-coding burden to 39 530 foods while retaining detailed information on the most frequently purchased items. Because of time, resource and financial constraints, accurate nutrient coding was completed only for energy, protein, fat, carbohydrate and alcohol where included.

The nutrient compositions of the 39 530 foods requiring coding were estimated by linking information obtained from food labels, manufacturers, retailers and (where necessary) informed guesswork with coding rules used in INTERMAP UK[10] and food codes contained in the fifth summary edition[11] and supplementary tables (e.g. reference 12) of *McCance & Widdowson's The Composition of Foods*. Each individual food item purchased was subsequently assigned a nutrient content estimate via their coding protocol. Estimates of total nutrient intakes per household were then split between household members in two ways:

1. 'per person' average – total weekly household energy/macronutrient estimate divided by the number of individuals; and
2. weighted 'per adult male' average – total weekly household energy/macronutrient estimate weighted by household composition using weights based on published intakes (e.g. reference 13) for each of four age/sex categories relative to that of an adult male.

The 'per person' average is equivalent to that used in the National Food Survey (NFS)[14–23], enabling direct comparisons with nutrient estimates derived here. Due to wide variation in the composition of households in the TNS panel, however, the 'per adult male' weighted average should more accurately characterise individual intakes. Average intakes were estimated weekly to account for compositional changes within households over time, then averaged over the entire time spent by households in the TNS panel, and also separately for each year (or part year).

External validity of the estimated TNS average nutrient intakes was assessed by comparisons with existing nutritional databases. Temporal, geographic and socio-economic variations were examined to determine whether or not it is feasible to detect differences in food consumption patterns over time or population subgroups. Temporal trends were considered by summarising the distribution of estimated energy/macronutrient intakes across households by year. To assess geographic and socio-economic variations, households were grouped by Local Authority District, region (corresponding to those used in the NFS reports) and socio-economic category (based on the Carstairs deprivation index of their census enumeration district[24]). Household social class was assigned by TNS using market research society categories based on the occupation of the main earner. A household composition score based on the number of adults (>18 years, or the oldest person if none was above this age) and children (<18 years) as used in the NFS reports was also calculated. The distribution of estimated energy/macronutrient intakes across households in each geographical and socio-economic group was then summarised by the mean and standard deviation (SD; weighted by time in panel, since households with many weeks-worth of data are likely to provide more reliable estimates of 'typical' intake).

The TNS data were also used to trace purchases of four novel food groups ('marker products') introduced into the retail market during the 10-year study period, and to consider temporal, geographic and socio-economic variations in these purchases. Each marker product is a composite food item (i.e. not used as an ingredient in any other processed food) and so is easily traced using barcode information. The number of households purchasing marker products was small; therefore here we only consider temporal, geographic and socio-economic variations in the *proportion* of households purchasing these foods and not in the quantities purchased.

Results

Between 1991 and 2000, TNS collected information from 33 228 households and 106 149 individuals. Households/individuals with suspect data quality (e.g. duplicate individuals; households without a valid postcode) were excluded, leaving 33 177 households and 105 667 individuals for analysis. Households remained in the TNS panel for a mean of 137 weeks (median 64 weeks;

interquartile range 19–203 weeks), generating 4 550 088 weeks of household purchase data, some 70 times more than collected by the NFS over the same time period.

Panel demographics

The demographics of the TNS panel were compared with those of the NFS samples and of the 1991 British census population (updated annually for 1992–1999 using the Registrar General's mid-year population estimates) (see Table 1). Comparisons suggest that the TNS panel is broadly representative of the British population and similar to the NFS samples, although it does have more families with children and young adults, and a smaller proportion of elderly people and households in the most deprived areas.

Validity of nutrient intake estimates

The overall mean (±SD) of the estimated average daily energy intakes per adult male was 1667 (±715) kcal for

Table 1 Demography of the TNS population (1991–2000) in comparison to those included in the NFS (1997–2000) and the estimated British population (1991–1999)

Composition by		TNS 1991–2000 Number (%) of households		NFS 1997–2000 Number (%) of households	British population 1991–1999 Person-years (%)	
Regions 1997–2000						
North East England		884 (4.76)		1307 (5.41)	23 404 599 (4.56)	
North West England		2299 (12.37)		2873 (11.90)	62 033 507 (12.10)	
Yorkshire & Humber		1618 (8.71)		2079 (8.61)	45 219 313 (8.82)	
East Midlands		1418 (7.63)		1699 (7.04)	37 063 861 (7.23)	
West Midlands		1594 (8.58)		2154 (8.92)	47 743 350 (9.31)	
East England		1595 (8.58)		2162 (8.95)	38 309 797 (7.47)	
London		2188 (11.77)		2553 (10.57)	63 379 011 (12.36)	
South East England		2822 (15.19)		2291 (9.49)	79 805 332 (15.57)	
South West England		1633 (8.79)		3484 (14.43)	43 401 316 (8.47)	
Wales		985 (5.30)		1366 (5.66)	26 244 968 (5.12)	
Scotland		1546 (8.32)		2180 (9.03)	46 0970 48 (8.99)	
Social class						
TNS	NFS					
A	A1	397 (1.20)		1468 (2.31)	–	
B	A2	3821 (11.52)		2914 (4.58)	–	
C1	B	9331 (28.12)		16 415 (25.81)	–	
C2	C	8958 (27.00)		16 685 (26.23)	–	
D	D	6151 (18.54)		4442 (6.98)	–	
E	E1	4519 (13.62)		5480 (8.62)	–	
	E2			8475 (13.32)	–	
	OAP			7729 (12.15)	–	
Carstairs quintile						
Affluent – 1		6296 (18.98)		–	109 229 847 (21.30)	
2		6804 (20.51)		–	107 707 760 (21.01)	
3		7312 (22.04)		–	104 029 642 (20.29)	
4		7284 (21.95)		–	99 346 288 (19.38)	
Deprived – 5		5451 (16.43)		–	92 239 191 (17.99)	
Unclassified		30 (0.09)		–	149 373 (0.03)	
Household composition (%)						
1 adult, 0 children		10.93		24.10	26.80	
1 adult, 1+ children		6.05		4.98	4.20	
2 adults, 0 children		24.45		33.05	31.70	
2 adults, 1 child		13.29		8.49	7.00	
2 adults, 2+ children		28.74		15.88	13.30	
3+ adults, 0 children		8.98		8.97	11.50	
3+ adults, 1+ children		7.55		4.52	5.50	
Age and sex groups (%)						
		Males	Females	Main diary keeper	Males	Females
0–4 years		10.80	9.96	–	6.79	6.31
5–9 years		10.69	9.76	–	6.85	6.35
10–14 years		8.82	8.10	–	6.58	6.09
15–24 years		13.27	14.60	(18–24 years) 5.53	13.51	12.54
25–34 years		18.1	19.89	20.26	16.58	15.58
35–44 years		15.14	14.84	19.92	14.33	13.83
45–54 years		9.89	9.88	17.75	12.91	12.65
55–64 years		6.42	6.39	14.52	10.07	10.20
65–74 years		5.43	5.20	13.07	8.14	9.51
≥75 years		1.34	1.21	8.78	4.13	6.67

TNS – Taylor Nelson Sofres; NFS – National Food Survey; OAP – old-age pensioner.

households in the TNS panel. This compares with estimates of 2450 (±593) kcal day^{-1} for an adult male reported in the Dietary and Nutritional Survey of British Adults (DNSBA)[13] and 2470 (±635) kcal day^{-1} (based on four 24-hour dietary recalls collected from 266 British men aged 40–59 years) in INTERMAP UK[25,26]. The TNS data thus appear to underestimate total energy intake for an adult male by about 32%. The mean (±SD) of the average daily energy intakes per person for TNS households was 1365 (±593) kcal, compared with 1797 kcal per person per day in the NFS (calculated as the mean – weighted by number of households – of the national average energy intake estimates in each NFS report between 1991 and 2000[14–23]; standard deviations were not reported).

In an attempt to adjust for underestimation of total energy intake in the TNS data, the distributions of estimated macronutrient intakes were considered in terms of their percentage energy contributions. The means (±SD) of the average daily percentage energy contributions per adult male for TNS households were 13.8% (±1.9%) for protein, 38.2% (±5.1%) for fat and 46.5% (±6.2%) for carbohydrate. Corresponding estimates from INTERMAP UK[25] were 15.6% (±3.2%) for protein, 33.0% (±6.5%) for fat (this estimate is notably low and may not be fully representative of typical population intakes) and 46.6% (±7.2%) for carbohydrate, while the average 'per person' estimates from the 1991–2000 NFS reports[14–23] were 14.2%, 40.0% and 45.9%, respectively (again, standard deviations were not reported).

Temporal, geographic and socio-economic patterns in nutrient intake estimates

Nutrient estimates were broadly consistent with national trends, with median percentage total energy contribution from alcohol consumed in the home increasing from 0.3% in 1991 to 0.9% in 2000 and mean percentage total fat contribution decreasing from 39.2% to 37.5% over the same time period. Statistically significant temporal, geographic and socio-economic differences were found for all nutrients (analysis of variance tests, $P < 0.0001$; see Table 2). However, these are not necessarily of substantive importance since large numbers (33 177 households) were considered here, so even small differences between mean values in each subgroup will appear statistically significant. Overall, there were no strong, systematic regional trends in energy or macronutrients, although there was evidence of heterogeneity in intakes at the district level (see Fig. 1) and, in particular, evidence of a south-east to north-west increasing trend in percentage total energy intake from alcohol brought into the home (see Fig. 2). Trends in energy and macronutrients by social class and deprivation group were more marked. Social class E (non-earners) had the highest mean energy intakes although little variation was noted between the other classes. In contrast, mean energy intakes decreased with increasing deprivation (Carstairs quintile). The most obvious differences, however, were in the percentage energy intake contributed by alcohol, which increased with increasing levels of affluence, and from fat, which was highest in the more deprived households. This may reflect differences in the amount and types of foods consumed at home by differing socio-economic groups and also in the proportion of food consumed outside the home (and hence not captured in the TNS data).

Tracing intakes of marker products

Household purchases of marker products were sparse, with fewer than 4% ever purchasing. As such, our ability to assess evidence of geographic, socio-economic or temporal variations in the *quantity* of marker products purchased is limited. Nonetheless, significant geographical variation was detected in the *proportion* of households purchasing product 1 (increasing north to south trend, with the proportion of 'ever' purchasers ranging from 2.2% (Yorkshire and Humber) to 5.8% (London); χ^2 test, $P < 0.0001$) and product 2 (proportion of 'ever' purchasers ranging from 2.9% (North East England) to 4.5% (East Midlands), no systematic geographical trend; χ^2 test, $P = 0.0006$). Strong decreasing trends with increasing deprivation were also apparent in the proportion of households 'ever' purchasing each marker product (product 1: 5.1% (most affluent areas) vs. 2.9% (most

Table 2 Summary of variations in mean energy and macronutrient intakes estimated from the TNS data by region, social class and deprivation category. Data refer to the entire study period (1991–2000)

	Variation by					
	Region		Social class		Carstairs deprivation category	
Nutrient	Lowest regional mean (SD)	Highest regional mean (SD)	Mean (SD) in social class A	Mean (SD) in social class D or E	Mean (SD) in most affluent area	Mean (SD) in most deprived area
Total daily energy (kcal)	1619 (777)	1762 (707)	1561 (613)	1933 (873)	1735 (713)	1600 (802)
% Total energy intake from						
Protein	13.3 (2.0)	14.1 (2.17)	14.2 (1.8)	13.5 (2.0)	13.9 (1.9)	13.6 (2.1)
Carbohydrate	45.6 (4.9)	47.1 (5.4)	46.0 (6.0)	47.2 (6.0)	46.6 (5.4)	46.0 (5.6)
Fat	37.7 (5.0)	39.5 (5.1)	37.6 (5.3)	38.8 (5.0)	37.6 (5.0)	39.1 (5.3)
Alcohol	1.4 (2.4)	1.9 (3.0)	2.2 (3.8)	1.2 (2.1)	1.9 (2.9)	1.3 (2.6)

TNS – Taylor Nelson Sofres; SD – standard deviation.

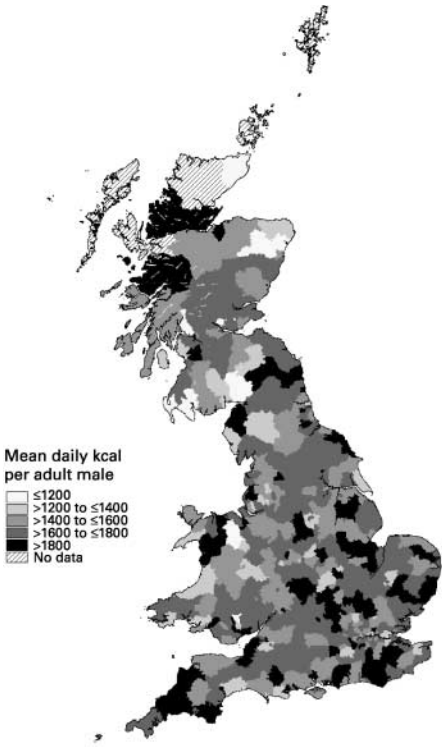

Fig. 1 Mean across households in each district of average daily energy intake (kcal) per adult male

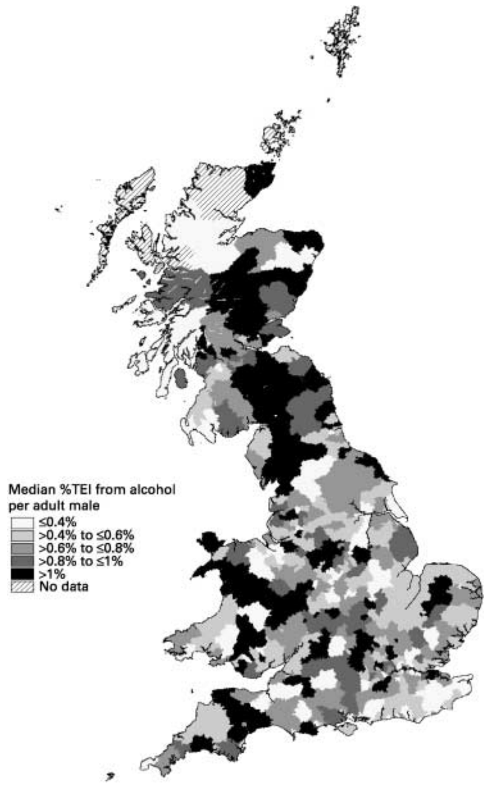

Fig. 2 Mean across all households in each district of median percentage total energy intake (%TEI) from alcohol per adult male

deprived areas), $P < 0.0001$; product 2: 5.6% vs. 2.4%, $P < 0.0001$; product 3: 1.9% vs. 0.9%, $P = 0.032$; product 4: 1.6% vs. 0.5%, $P = 0.0003$). There was also evidence of an increasing temporal trend in the proportion of households purchasing product 1 by quarter (χ^2 test for trend, $P < 0.0001$), although no such trend was apparent for the other three products (possibly because they had not been available on the market long enough to detect any such trend).

Discussion

This study examined the feasibility of carrying out population surveillance of food and nutrient intakes using a commercial database as a possible means of examining potential medium- to long-term health effects associated with the introduction of novel foods. A major advantage of the TNS database used is its sheer size, with over 33 000 households and 100 000 individuals contributing data for an average of 2.5 years, thus enabling stable characterisation of typical food purchase patterns and cumulative dietary ‘exposure’ to specific products. Furthermore, the dietary information available in the TNS database shares many similarities with that collected by the annual National Food Surveys (NFS) but provides over 70 times more data, so has the potential to offer substantial gains in the precision with which dietary variables can be estimated. However, some modifications to the sampling methods used by TNS would be needed to improve the demographic representativeness of their panel were their data to be used routinely for nutritional research and/or surveillance purposes.

Total energy estimates in both the TNS and NFS data were low when compared with those reported in the DNSBA[13] and INTERMAP UK[25]. Some underestimation is expected due to misreporting biases typical in dietary assessment work[27,28] and since information on impulse purchases and meals eaten outside the home were excluded. Even allowing for this, and if estimates of mean daily energy intake per person (rather than per adult male) are considered for comparability, energy estimates derived from the TNS data were slightly lower than those reported by the NFS. This may be caused by averaging TNS data over extended time periods (including weeks with no food purchases) whereas NFS estimates are based on only a single week of ‘shopping basket’ data that may include items not intended for immediate consumption due to bulk buys or fortnightly shopping patterns for example. There was also considerable variation in nutrient estimates between households in the TNS panel, to some extent driven by a small percentage of households with spuriously high or low values. However, comparison with the spread of values observed for middle-aged males in the INTERMAP UK study[25] suggests that estimated energy intakes for the majority of households in the TNS panel appear reasonable, and that the variability evident may reflect true differences in energy consumption.

Unless nutrient estimation errors were consistently biased towards a particular nutrient in either direction, calculating the percentage total energy intake (%TEI) contributed by each macronutrient should help to guard against systematic underestimation across households. Although differences were evident between TNS data and corresponding mean estimates from INTERMAP UK and the NFS (particularly for fat), overall distributions were sufficiently similar to support the validity of macronutrient information provided by the TNS data.

Analyses of nutrient intakes by area, social class and over time established evidence of small but statistically significant variability – possibly indicative of variations in intake patterns of underlying foods, food constituents or food products – which potentially might correlate with variations in health outcomes observed in the future. However, it is difficult to say whether these represent substantively important variations in mean values between subgroups of the population; this will depend to some extent on the nature of any health outcomes that such differences (or differences in intakes of certain ingredients correlated with the macronutrient intakes) are hypothesised to explain.

While variations in energy and nutrient intakes provide some indication of the feasibility of detecting broad differences in diet between population subgroups using TNS data, it is of particular interest to explore the feasibility of tracing and detecting variations in purchases of specific (novel) food items that do not necessarily form a regular component of every diet. Statistically significant temporal, regional and socio-economic variations were detected in the proportion of households purchasing some or all of the marker products used in this study. However, the total number of households that had ever purchased any of the marker foods was small ($<4\%$) and so comparisons of purchasing patterns *within* this subset are based on too few households and too short a time period to detect meaningful variations in the *amount* of each marker product purchased by different subgroups.

Broadly speaking, our findings indicate that the TNS database was able to yield valid, representative and precise estimates of macronutrient densities amongst temporal, geographical and socio-economic subgroups of the British population, and to provide some information on variations in purchase patterns of specific novel marker products. However, it should be emphasised that there are important limitations affecting these data that would need to be addressed before considering their future use for surveillance and/or research purposes.

First, the TNS database relies on scanned barcode information of food products purchased and does not in itself give information on nutrients or ingredients. No system is currently in place in the UK to enable barcode information to be directly linked to nutrient composition data. A major component of this study, therefore, was to develop and implement a set of nutrient-coding rules to convert food purchase data to estimates of energy and macronutrient intakes for further analysis. The accuracy of this coding system was necessarily limited by resource and time constraints. Coding was linked to a static point in time (i.e. when nutrient data were received) and therefore ignores any composition changes linked to manufacturing methods. TNS also record foods 'as purchased', limiting nutrient diversity detail linked to preparation and cooking methods for example. In our view, the only reliable and efficient way to ensure the necessary level of accuracy and consistency of nutritional coding for both dietary research and surveillance purposes in the UK is to establish a continuous electronic monitoring system such as that used in the USA[29] to identify foods entering and leaving the market place and including continual updates of the nutrient content of all available food items.

Second, TNS food purchase data were not checked for biases (e.g. incomplete scanning or variability in volumes of foods consumed outside the home) and contained no information on food waste or on who actually consumed the food purchased. Provided estimation errors are not systematic, they should not bias within-sample comparisons. However, it is possible that households in one socio-economic group (say) might be systematically more likely to correctly scan all their food purchases, have higher food wastage or consume a greater proportion of their total food intake outside the home. TNS maintain additional databases on 'impulse' and 'out-of-home' consumption that could be used to address this issue (although these data were not available for the present study). Supermarket sales data could also be used to compare the contribution of food items recorded in home purchase records against total sales.

Third, it was not possible to estimate variations in nutrient intakes by age or gender using the TNS data since purchases were recorded at the household level (individuals in a given age–sex group were assumed to consume a fixed proportion of the total household food purchases in our analyses). This is a potentially important limitation in terms of attempting to link variations in diet to health outcomes, particularly if the health outcome of interest is specific to one gender and/or age group. Additional questionnaire-based information collected on some or all of the panel members could provide a means of addressing this problem.

This feasibility study did not include an investigation of health data *per se*, or of how such data might be linked to nutritional statistics in a surveillance system. However, in the absence of an ongoing nutritional surveillance system, it would be difficult – if not impossible – to link future health trends to nutritional data or data on novel food consumption (other than immediate effects such as food allergies), since the changing product market and lack of historical information on these changes would mean that the necessary data on population dietary 'exposure' would be missing. By the same token, alternative 'reactive' approaches, such as *ad hoc* case–control studies undertaken if and when a health effect linked to the ingestion of novel foods was suspected, would in our view be extremely problematic to carry out with any accuracy, since the underlying data source on consumption of novel foods would not be available and would rely on participant recall, perhaps years later.

Conclusion

Linking putative health effects to dietary factors will only be possible if surveillance of dietary intakes is carried out *prospectively*. This study explored the feasibility of establishing such a prospective nutritional surveillance system in the UK. Our results suggest that, subject to the enhancements discussed above, it would be possible to monitor food purchasing patterns at the household level using the commercially available TNS data (or similar). As such, the data could be used to inform nutritional surveillance to provide prospective information on population dietary 'exposure' to novel composite food products. Increasing surveillance to consider ingredients such as soy protein (whether or not genetically modified) would currently not be possible without the development of a central coding system, with electronically linked barcode, ingredient and nutrient information. Such a system would require constant management, quality control checks and the co-operation of food manufacturers to provide relevant nutrient and ingredient information. However, if established, it would have considerable potential within nutrition-based research, clinical care and health promotion in the UK, as well as for surveillance purposes. The NCC database in Minnesota, USA[29] is an example of the type of system that could be envisaged (although currently this contains only nutrient and not ingredient information).

In addition to their potential for use in a prospective dietary surveillance system, the TNS data could form a continuous monitoring system, with extended periods of follow-up, providing more precise dietary information and household purchase patterns than in, say, the NFS. We therefore believe that the TNS database should be considered as a potentially viable research database for estimating national dietary trends and for addressing other nutrition-based research questions.

Acknowledgements

The authors would like to thank Taylor Nelson Sofres for providing a copy of their database and for exceptional support in helping us to understand their data and resolve issues as they arose; Frankie Robinson for her help in processing the nutrient data for this study; Sheila Bingham for expert advice; and the Food Standards Agency for funding this project (Project: G01021).

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Appendix – Nutrient-coding protocols used to match food purchase records to nutrient intakes

Protocol 1 – 23 product groups with minimal nutrient diversity between brands, e.g. vinegar, tea and cornflour, were each coded using a single food code

Protocol 2 – 22 food groups containing products that displayed little difference in nutritional content within calorie-attributed groups were coded using a single code for all products listed within that group. Milk (whole, semi-skimmed and skimmed) and fruit squashes (full-sugar and low-sugar varieties), for example, were coded this way

Protocols 3 & 4 – those products that displayed substantial nutrient diversity with brand variation had the top-10 modal selling products in each group generated by regional, social class and annual group. Any product included in *any* of the top 10 files was coded as that food directly; all other products in a particular food group were coded as described below

Protocol 3 – 11 food groups were further split by calorie attribute. Those not coded within a top-10 file were coded as the annual top-selling food item in the appropriate calorie attribute group. Canned pastas and ice creams were coded in this way

Protocol 4 – 131 food groups contained products not split by calorie attribute, and not included within any top-ten file. These items were coded as a weighted average of those that were (in the appropriate annual, regional and social class group). Plain and savoury biscuits and fresh pizzas and pizza bases were coded in this way