

Conference on 'Translating nutrition: integrating research, practice and policy' Symposium 1: Innovation in diet and lifestyle assessment

Innovations in national nutrition surveys

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The aim of this paper is to describe innovations taking place in national nutrition surveys in the UK and the challenges of undertaking innovations in such settings. National nutrition surveys must be representative of the overall population in characteristics such as socio-economic circumstances, age, sex and region. High response rates are critical. Dietary assessment innovations must therefore be suitable for all types of individuals, from the very young to the very old, for variable literacy and/or technical skills, different ethnic backgrounds and life circumstances, such as multiple carers and frequent travel. At the same time, national surveys need details on foods consumed. Current advances in dietary assessment use either technological innovations or simplified methods; neither lend themselves to national surveys. The National Diet and Nutrition Survey (NDNS) rolling programme, and the Diet and Nutrition Survey of Infants and Young Children (DNSIYC), currently use the 4-d estimated diary, a compromise for detail and respondent burden. Collection of food packaging enables identification of specific products. Providing space for location of eating, others eating, the television being on and eating at a table, adds to eating context information. Disaggregation of mixed dishes enables determination of true intakes of meat and fruit and vegetables. Measurement of nutritional status requires blood sampling and processing in DNSIYC clinics throughout the country and mobile units were used to optimise response. Hence, innovations in national surveys can and are being made but must take into account the paramount concerns of detail and response rate.

Dietary assessment: National survey: Innovation: Response rate: Population

There are two major nutrition surveys currently or recently conducted in the UK, the National Diet and Nutrition Survey (NDNS) and the Diet and Nutrition Survey of Infants and Young Children (DNSIYC). Although conducted on different age groups in the population and with rather different sampling designs and organisational structure, the two surveys experience similar challenges in terms of achieving acceptable response rates in all aspects, and in designing optimal instruments and delivery methods for both dietary assessment and measures of nutritional status. This paper will describe some of the innovations introduced into the surveys to optimise response rates and to obtain complete data in order to produce as accurate a picture as possible of the dietary intakes and nutritional status of the population.

Background

The NDNS rolling programme began to collect nationally representative dietary data in 2008 from 1000 individuals per year aged 18 months and over in private households. The survey is funded by the Department of Health and Food Standards Agency and conducted by a consortium of NatCen Social Research (responsible for survey coordination, sampling, fieldwork and reporting), MRC Human Nutrition Research (responsible for dietary assessment, nutrient database management, blood and urine sample collection, processing and analysis and field laboratory coordination) and the Department of Epidemiology and Public Health, University College, London (responsible for the survey doctor's role and physical activity). There is a

Abbreviations: DNSIYC, Diet and Nutrition Survey of Infants and Young Children; NDNS, National Diet and Nutrition Survey.

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core survey and a child boost to result in the 500 adults and 500 children per year required, and boosts in Scotland, Northern Ireland and Wales to have sufficient numbers to enable comparisons to be made between those countries individually and the UK population as a whole. The sampling frame is the post code address file of small users (less than twenty-five items of post per day) from the Post Office. Interviews and biological measurements are all undertaken in the home in a series of interviewer visits. There is a doubly labelled water component which is conducted on a subset of the sample to obtain measures of energy expenditure and there are also measures of physical activity, with methods appropriate to each age group. To date, 3 years of results have been reported for NDNS⁽¹⁾ and a more detailed report of the first 4 years, covering the period from April 2008 to June 2012 is due in 2013.

Unlike NDNS, DNSIYC is not a rolling programme but a single survey of infants and young children throughout the UK. The survey is conducted by a consortium of MRC Human Nutrition Research (responsible for coordination, dietary assessment, blood and urine collection and analysis, the clinic visit and reporting), the NatCen Social Research (responsible for sampling and fieldwork), the MRC Epidemiology Unit (responsible for the survey doctor's role) and the Human Nutrition Research Centre at Newcastle University, which conducted pilot work on the dietary assessment methodology. The sample age is from 4 to 18 months, and the original goal was to achieve a sample size of 1800 individuals, although the final sample is larger than this. The sampling frame for DNSIYC is the Child Benefit Register which currently reflects virtually all children born in the UK, since each child born can be registered to enable parents to receive Child Benefit. DNSIYC has boosts for Scotland and for recipients of Healthy Start vouchers to enable comparison between these individuals and the entire UK population. There is a stable isotope component where the 'dose-to-mother' method⁽²⁾ is used to estimate breast milk volume taken in by the infant. Unlike NDNS where blood and other biological measurements are made in the home, DNSIYC utilises NHS and other paediatric clinics where there is expertise in infant phlebotomy, and it also acquired two mobile units to enable mothers in rural locations and others unable to travel to a clinic to have blood taken and processing to be carried out in or near the home. DNSIYC fieldwork was conducted between January and August 2011 and the final report will be completed in 2013.

Critical features of national nutrition surveys

There are two major aspects of national nutrition surveys that must be taken into account for every aspect of data collection, cost and organisation. These are that the data are as nationally representative as possible, and that the data are as accurate and complete as possible. National representation is achieved by having coverage of the entire UK, by sampling the entire population, having sampling throughout the year to take account of any seasonal

changes in data or other circumstances and to have a high response rate so that those who actually complete the survey are similar to the total sample. Accurate and valid data are achieved by having optimal methods for collecting dietary intakes, physical activity and anthropometric data, by having a contemporaneous food composition database and by having uniform and rigorous blood and urine collection, processing and analysis procedures.

The sampling design for NDNS is shown in Fig. 1(a) and for DNSIYC in Fig. 1(b). In both surveys, the regions to be covered were chosen at random as post code areas. In NDNS, these provided the addresses to be chosen as the starting point for the survey, while in DNSIYC, these areas provided the frame for selection at random from the Child Benefit Register, infants born such that their ages would range from 4 to 18 months at the time of fieldwork. In NDNS, there are 120 Primary Sampling Units per year, ten per month, and distributed such that for every 3 months they are nationally representative⁽¹⁾. In this way, the entire country is represented every 3 months and seasonal variation is thus accounted for. In each Primary Sampling Unit, twenty-seven addresses are selected at random, giving a total of 3240 addresses in the core sample; for nine of these, both an adult and a child can be selected from the household, while the other eighteen addresses are termed the 'child boost' and in these, only a child under 18 years is selected. This is done to account for the fact that many households do not have children, and hence enables achievement of the target of 500 adults and 500 children per year. In DNSIYC, twenty-one children are selected from the Child Benefit recipients in each post code area, giving a total of 3528 children to achieve the 1800 required in the core sample.

The response rate to a survey is a key component of its representativeness and requires diligence and attention to detail to maintain at a high level. Response rates to surveys have diminished over the last few decades. The Diet and Nutrition Survey of British Adults, carried out in 1986–87, had a response rate of 70%⁽³⁾ and the NDNS surveys which followed were similar but these began to reduce over time. NDNS of preschool children aged 1.5–4.5 years had a response rate of 81%⁽⁴⁾, for the home dwelling component of NDNS of older people, the response rate was 59%⁽⁵⁾ and for children 4–18 years it was 64%⁽⁶⁾. Since these surveys were of different age groups, there are varying factors that influence response, and hence the best comparison of changing response over time is that between the surveys of the same age group, namely of adults, from the Diet and Nutrition Survey of British Adults in 1986–87 and of NDNS of adults conducted in 2000–01, where the response was 47%⁽⁷⁾. The drop from 70% to 47% is worrying in terms of representativeness and for this reason, it is required that the response rate in the NDNS rolling programme must be 55% of the eligible sample or greater for continuation of the survey⁽¹⁾ and the target for DNSIYC was 57%.

The vulnerability of response rates is well known to those currently conducting surveys in the UK and containing participant burden is a paramount consideration. Hence, in making decisions about inclusion of questionnaires in surveys or about dietary assessment

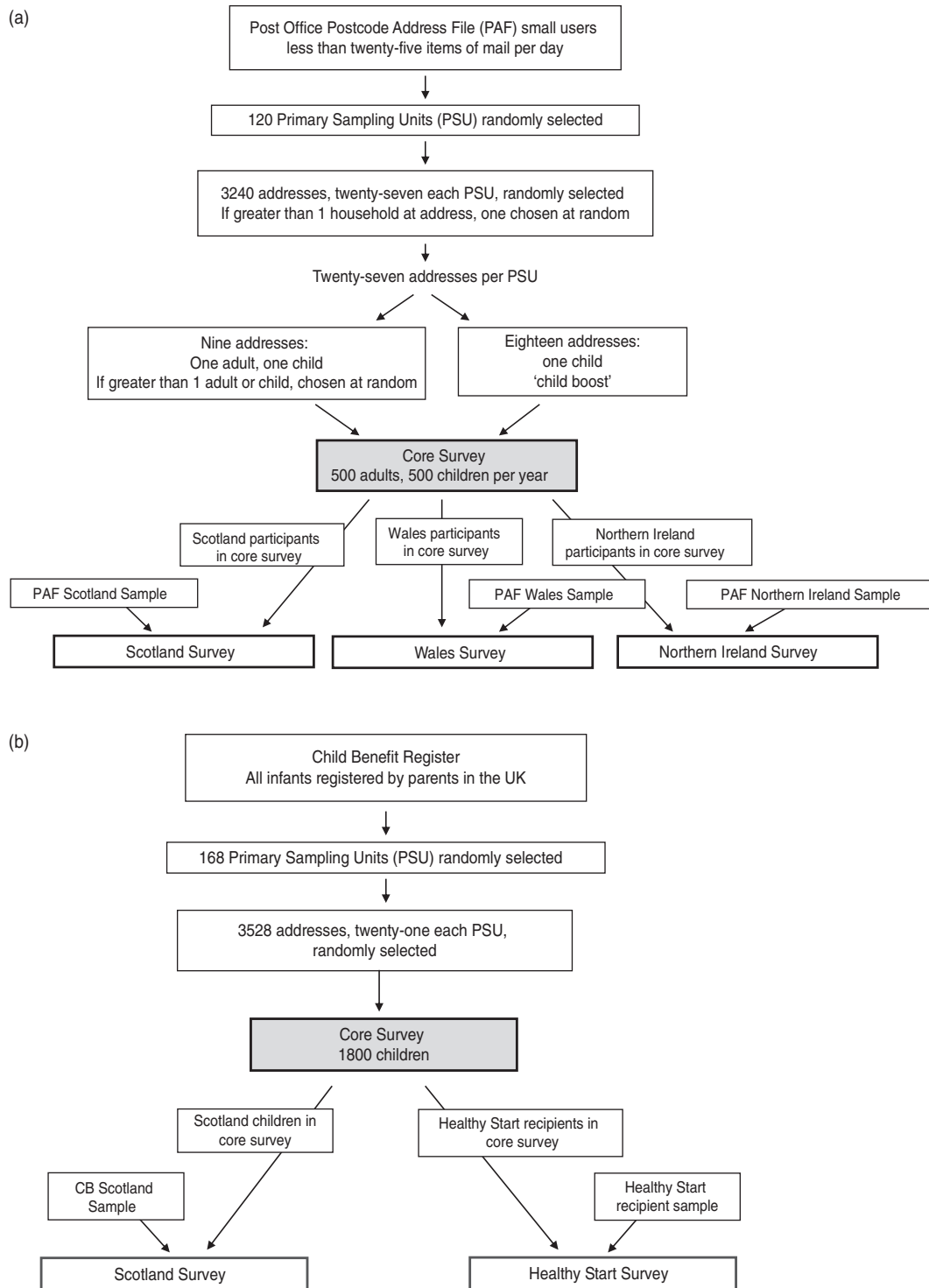


Fig. 1. Sampling in (a) National Diet and Nutrition Survey and (b) Diet and Nutrition Survey of Infants and Young Children.

methods, the impact on response is a primary consideration. This is unlike studies of volunteers, even those which are of large cohorts studied longitudinally; the design of a representative survey like NDNS is one where addresses are identified and individuals are then persuaded to parti-

cipate. This is quite different from inviting participation from willing candidates. Many of the new methodologies developed to advance dietary assessment are conducted in willing individuals and the translation of these to national surveys is not straightforward. Added to this is the wide

age range in the NDNS rolling programme, which requires certain capabilities for all age groups, or their carers.

Dietary assessment in the National Diet and Nutrition Survey and the Diet and Nutrition Survey of Infants and Young Children

The dietary assessment method used in both NDNS and DNSIYC is an estimated diary of four consecutive days. In the first year of NDNS, the four days included two weekend days; thereafter the design was on four random days⁽¹⁾. The diaries have various versions, designed for the different age groups participating in the surveys, with different examples of foods to guide participants and of different sizes to address varying writing and vision capabilities. For NDNS, there is a diary for parents and carers of those aged 1.5–3 years, and one for those aged 4–18 years; there is an adult diary and the same but in larger format and font for older people. In the DNSIYC, there are two versions, one for those aged 4–8 months and another for those aged 9 months and over.

The decision to use estimated diaries was made after conducting a large study in a semi-national survey setting to compare a diary of 4 d with 24 h recall, repeated four times over a two week period. This study, termed the ‘Comparison Study’, compared results from 500 people for each method, aged 4 years and over around the country in terms of response rate and data quality, as well as acceptability in the field⁽⁸⁾. There was a doubly labelled water component to assess the extent of misreporting by each method. The estimated diary has been used in a number of studies in the UK, such as the MRC National Survey of Health and Development (1946 British Birth Cohort)⁽⁹⁾, the EPIC Norfolk study⁽¹⁰⁾ and the UK Women’s Cohort Study in Leeds (over 35 000 women)⁽¹¹⁾. The method is also used in children, most notably in the Avon Longitudinal Study of Parents and Children cohort at ages 4, 8 and 18 months, 3, 7, 10 and 14 years⁽¹²⁾. The repeat 24 h recall method is used in the National Health and Nutrition Examination Survey in the United States and in the Low Income Diet and Nutrition Survey, conducted in 2004–05⁽¹³⁾.

Results showed that there was no difference in response rate between the repeat 24 h recall and the 4 d estimated diary, that the energy intake was similar for both methods, except for one age group of men, those aged 35–49 years, where energy intake for the diary was somewhat lower than that for recall. There were few differences in misreporting between methods, although both methods showed substantial under-reporting⁽⁸⁾. The 24 h recall showed slightly more over-reporting in young children, as has been seen in other studies, acknowledging that children find the time concept of the 24 h period rather challenging. There were some challenges in the field for both methods; most of these could have been addressed in the survey itself, but there was a problem of conducting the survey on weekends which was an insurmountable issue for recall. Neither interviewers nor interviewees wanted to have interviews on weekends, and hence Fridays and Saturdays would be underrepresented if recall was used. This is not an issue for the diary since it can always be given out on a weekday,

and weekend consumption days were recorded without interference from the fieldwork team. For this reason, and because of a greater familiarity with diaries by those responsible for dietary assessment, the diary was chosen for use in the NDNS rolling programme⁽¹⁾. For DNSIYC, the estimated diary is universally a more commonly chosen method because of the multiple carers of young children who would be expected to contribute to the record. Hence, the NDNS diary was modified for use with infants and young children for DNSIYC.

Innovations in the National Diet and Nutrition Survey and the Diet and Nutrition Survey of Infants and Young Children dietary assessment

The paper diary with handwritten entries as used in NDNS and DNSIYC is an established method, much used in past studies. It has a number of advantages over other methods such as the fact that participants can write freely about the foods consumed and are not constrained by pre-determined groups or lists of foods, and hence it is suitable for different ethnic groups. Different carers can enter foods consumed for different occasions in a day, which is useful when children are being assessed. Diaries can be modified for different age groups to account for writing skills and poor vision. However, written diaries are perceived to be ‘old-fashioned’ and there is enthusiasm for newer methods using technology to assist in the acquisition of dietary intake information.

There are currently many advances being made in dietary assessment, making use of smart phones^(14–16), web-based systems^(17,18) and the use of images to assist in identification and portion size assessment^(14,19,20). There are more advanced computer-assisted technologies to automatically identify foods and determine the size of portion on a plate⁽²¹⁾. All these types of advances are in development and testing stages and hold great promise for dietary assessment in the future. In some cases, they have been shown to work well in specific age groups⁽¹⁴⁾, primarily those groups with greater familiarity with technology generally⁽²⁰⁾.

The reality for NDNS is that there are constraints on the introduction of new technologies and for the most part these are not yet ready for the survey setting. As indicated earlier, the response rate (completed diet diaries) must remain at 55% of the eligible sample or higher for NDNS, and hence any changes to the existing method must be ones which will not impact on response rate, which means that they must not incur any greater participant burden than the current methods. While in many cases, the new technologies are intended to reduce burden, not increase it, the effect on response rate is not clear, but there are other considerations as well. NDNS prefers to use the same method for all age groups and hence the method must be suitable for those as young as 1.5 years and also be capable of being used by older adults. While many technologies may be suitable for teenagers or young adults, they may not suit an older person or busy parent recording the intake of a toddler. The method must be capable of being used by more than one carer. Both young children and older people

are looked after by multiple individuals in a day and these must be capable of coping with the method of the survey. Grandparents often care for young children and hence the considerations for older people apply even when considering the youngest age group. As a nationally representative survey, NDNS must be able to capture the diets of different ethnic groups; hence the method used for dietary assessment must be open to the inclusion of a wide variety of foods and not limited to specific items. NDNS also covers the entire range of socio-economic circumstances and therefore must be capable of being performed by those with little education or poor technology skills. The method in NDNS also has to be suitable for all locations; it must be capable of being taken to school or to work or to a playgroup or the childminder's house. It must be suitable for the park or an outing, a picnic, at a friend's house or at a party and for use when travelling.

All these considerations must be taken into account when introducing modifications to the existing method in NDNS. While there is considerable enthusiasm for introducing new technology, the challenges of addressing the concerns listed earlier have to date prevented any radical change in the method used for dietary assessment in the surveys.

Portion size estimation

In NDNS, a number of advances have been made to assist with portion size estimation, one of the greatest challenges of assessments which use estimates, not weights, of foods eaten. In today's society in the UK, the 'ready meal' has become commonplace. Such meals are a challenge for dietary assessment since they vary with region of the country and they are on the market for short periods, and then are gone again, making it difficult for those coding dietary data. Participants in NDNS and DNSIYC are therefore requested to provide packaging for unusual foods and ready meals to assist coding. Provision of packaging by participants has helped with identification and of portion sizes of foods eaten, thus improving the accuracy of the dietary information.

NDNS has also made use of the Children's Food Atlases developed by Newcastle University for three ages of children, pre-school, primary and secondary. These are similar in design to the Food Atlas for adults developed by Michael Nelson and colleagues at King's College some years ago⁽²²⁾. Originally designed for the 24 h recall method, the atlases are used alongside the diary at the time of collection, when the interviewer checks the dietary intakes recorded and checks the portion sizes of children using photographs in the food atlas. These have seven pictures of varying portion sizes to choose from for each food item presented and then the same number for amounts left over.

Disaggregation

Traditionally, in NDNS, mixed meat dishes are assigned intact, as a lamb, beef or chicken dish, for example, or as a pasta dish, or a meat pie or a pizza containing meat. When describing meat intake, this is often reported as intake of

'meat and meat dishes', and so includes all the other components of the mixed dishes, such as pastry or sauce or pasta or vegetables, and it therefore represents an over-estimation of meat intake. On the other hand, vegetables and fruit included in mixed dishes are not included in the estimates of vegetable or fruit consumption and hence lead to an underestimation of intake of vegetables and fruit. There are recommendations for vegetables and fruit, in the form of the 5-a-day recommendation⁽²³⁾, and for meat the World Cancer Research Fund has suggested a maximum consumption of meat of 400 g per week⁽²⁴⁾. In order to provide accurate intakes of meat and vegetables and fruit in NDNS, a project was undertaken to quantify the components of composite dishes.

In the NDNS nutrition databank, 3216 food codes contained the ingredients of interest. Each of these was systematically examined for the content of the components and these were calculated using a number of approaches⁽²⁵⁾: manufactured product information, obtained either directly from manufacturers or from websites or packaging; standard recipes from McCance and Widdowson's 'The Composition of Foods'; homemade recipes from participants' food diaries; haem Fe content of composite dish; vitamin A content to assess tomato puree content; fructose content.

The resulting intakes from years 1 to 3 of NDNS are shown in Fig. 2(a) for fruit and vegetables and Fig. 2(b) for meat. The difference between the non-disaggregated and the disaggregated intakes was about 20% for fruit and vegetables with the disaggregated being higher than the non-disaggregated. However, the difference for meat was much larger and ranged between 35 and 50% in over-estimation of meat intake using non-disaggregated intake. The large difference between non-disaggregated and disaggregated intakes indicates that for accurate consumption estimates for meat and fruit and vegetables, disaggregation is required and this is now the approach taken for all foods consumed by NDNS participants. All foods are subdivided into ingredients and these are entered into the dietary assessment system.

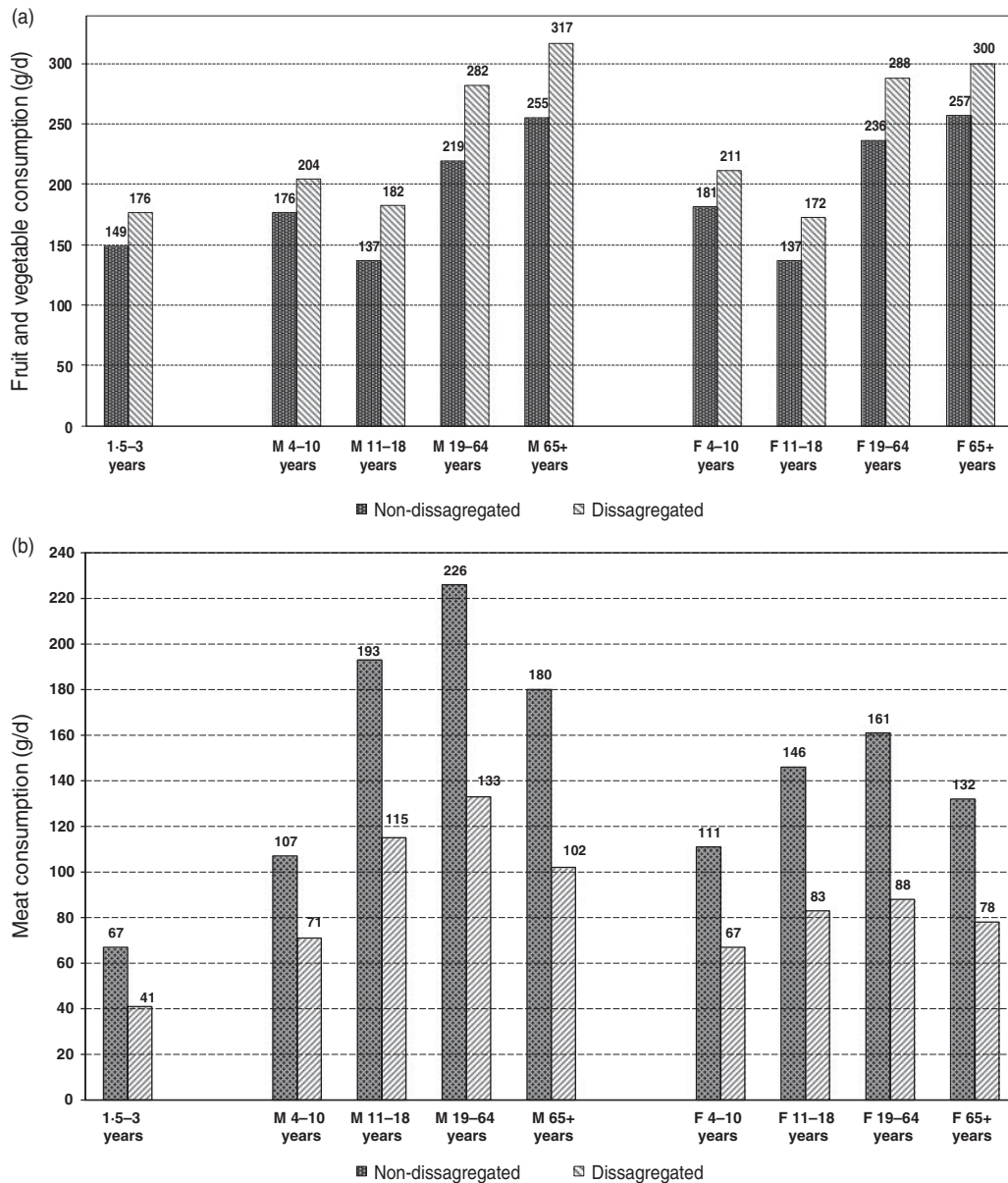
The proportion of participants achieving the 5-a-day recommendation using disaggregated data is shown in Table 1 and indicates that adult men and women are not far from achieving the 5-a-day recommendation, with an intake of over four portions for these age groups. However, teenage boys and girls are consuming far less, with three portions or less per day and only 8% of girls and 11% of boys aged 11–18 years achieving the recommended intake⁽¹⁾.

The eating context

There is growing interest in the environment in which food is consumed, and the factors associated with where food is consumed, who else is present at the time of eating, whether or not the television is on and whether the food is being consumed at a table or not, are all thought to play a role in the types of foods consumed and hence in diet quality^(26,27). Most information about the role of such factors on food consumption is based on data derived from questionnaires about the eating environment collected separately from the dietary information. In order to collect

Table 1. National Diet and Nutrition Survey year 1 to year 3: fruit and vegetable consumption in terms of 5-a-day

	11–18 years		19–64 years		65+ years	
	Girls	Boys	Women	Men	Women	Men
'5-a-day' portions (portions/d)	2.8	3.0	4.1	4.1	4.3	4.6
% Achieving '5-a-day' guideline	8	11	30	32	36	37

**Fig. 2.** National Diet and Nutrition Survey year 1 to year 3: disaggregated and non-disaggregated consumption of (a) fruits and vegetables and (b) meat M, male; F, female.

this information in a more systematic and consistent way, an additional column was added to the food diaries, including those used in NDNS and DNSIYC. A diary page is shown in Fig. 3 and indicates the extra column, where participants record, for each eating occasion, where food was eaten, with whom, if the television was on and whether or not they were at a table.

It has taken some time to establish the methods to analyse these data and the results that follow are the work of Tsz Ning Mak⁽²⁸⁾. The first task was to consolidate the possible answers to the factors. Table 2 shows the way this was achieved for the 'where' variable, consolidating the many potential places that food can be eaten into a small number of broader groups. The distribution of eating

Day 1	Day Tuesday	Date 8th December 2009		
Time	where? with whom? TV on? Table?	what	Brand Name	Amount eaten
<i>6am to 9am</i>				
8.05	IN KITCHEN WITH WIFE AT TABLE NO T.V.	JAM SANDWICH COFFEE MILK SUGAR	REDUCED SUGAR STRAWBERRY STREAMLINE HOVIS WHOLE MEAL NO BUTTER NESCAFE GOLD BLEND DEMERA A WHOLE MILK.	2 TEASP JAM 2 THIN HAND CUT. 1 MUG 1 TEASP 3 TEASP 3 SPLASH.
<i>9am to 12 noon</i>				
12.00	NO TV. AT TABLE IN DINING ROOM WITH WIFE	SQUASH NOT NAS	ROBINSONS HI JUICE ORANGE	500 ml. 1 pint orange 3 pint Tap Water
<i>12 noon to 2pm</i>				
12.15	IN KITCHEN WITH WIFE AT TABLE NO TV.	SOUP CHICKEN & LEEK. SQUASH. NAS	BACHELORS DRIED. ROBINSONS SUMMER FRUITS.	230 ml. WATER. 1 small BOWL 500 ml 1 pint SQUASH 5 pint Tap Water.

Fig. 3. National Diet and Nutrition Survey; example of diary page.

occasions according to these broader groups is shown in Table 3 for the first 2 years of the NDNS rolling programme (2008–2010) for children aged 4–10 years. This indicates that most eating occasions for children of this age were at home, with much smaller proportions consumed at school, at a friend’s or relative’s house, at care outside the home, at other eateries or at other places. The impact of where food was eaten on intake for fruits and vegetables is shown in Fig. 4(a) for fruit and Fig. 4(b) for vegetables. Using at home as a reference, there were larger portions of fruits eaten in care outside the home, for the youngest age group (1.5–3 years) and at school for those aged 4–6 years and for the entire age range together. The same is true for vegetables for those aged 4–6 years and for all age groups combined. The results suggest that messages to increase fruit and vegetable consumption are being taken up by schools and organised care settings and less so at home, which is important for targeting future health promotion initiatives. The details of the methods used to derive these data and determine the odds of consumption are provided in a number of forthcoming publications.

Dietary feedback to participants

Dietary assessment has traditionally been conducted following the completion of a study or survey. With the rolling nature of NDNS, the survey is always in the field, and the aspects of the survey which tend to follow field-work are also being conducted in an ongoing manner. There is also a move to provide more information to participants in studies as a token of appreciation for participation and even a stimulus to participation. For these

Table 2. Consolidating ‘where’ variables in National Diet and Nutrition Survey

At home	Home – Bedroom Home – Dining room Home – Garden Home – Kitchen Home – Living room Home – Other
At school (Age 4–10 year only)	School – Canteen – Bought food School – Canteen – Food from home School – Canteen – Other School – Classroom School – Other School – Playground
Friend’s/Relative’s house	Friend’s or Relative’s house
Care outside home (Age 1.5–3; 4–6 year only)	Community centre/Day centre/ Drop in Carer’s home Nursery/Kindergarten
Other eateries	Coffee shop, café, shop, deli, sandwich bar Fast food outlet Restaurant, pub, night club
Other places	Bus, car, train Holiday accommodation Leisure activities, shopping, tourist attraction Other place Outside – Other Place of worship Public hall/function room Sports club, sports leisure venue Street
Unspecified	Participant did not specify

Table 3. Distribution of eating occasions by 'Where' for children aged 4–10 years in National Diet and Nutrition Survey rolling programme year 1 and year 2.

Where	All ages		1–5–3 year		4–6 year		7–10 year	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
At home (ref)	12 020	72.9	4835	80.3	3315	68.6	3870	68.8
At school	1466	8.9	–	–	669	13.9	775	13.8
Friend's & relative's house	893	5.4	299	5.0	251	5.2	343	6.1
Care outside home (and school)	495	3.0	400	6.6	83	1.7	–	–
Other eateries	340	2.1	111	1.8	106	2.2	129	2.3
Other places	1265	7.7	376	6.2	407	8.4	510	9.1
Total	16 479	100	6021	100	4831	100	5627	100

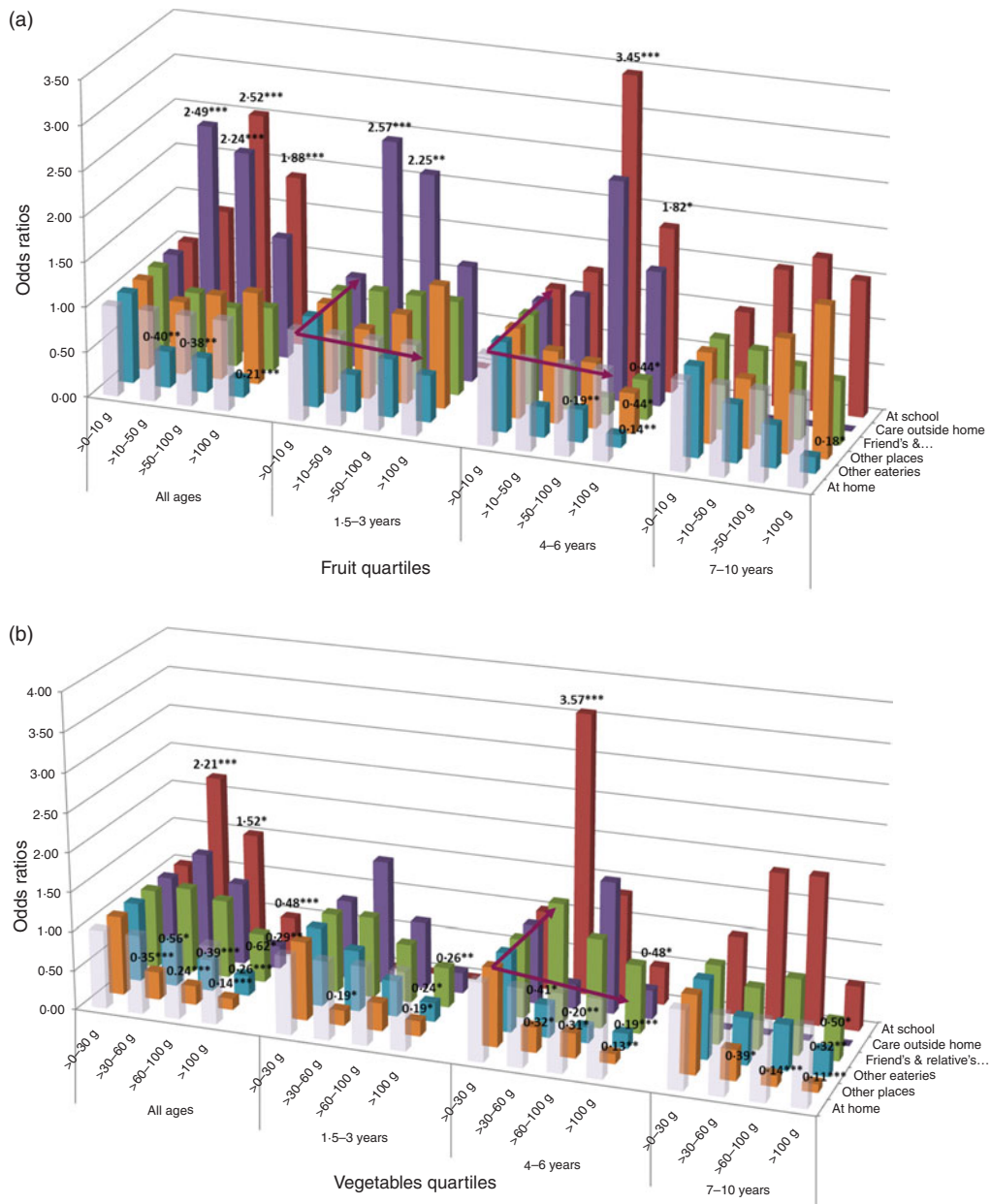


Fig. 4. Likelihood of consuming (a) fruits and (b) vegetables in quartiles by 'where' food was eaten in National Diet and Nutrition Survey years 1 and 2. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$. Adjusted for age, sex, meal time slot, weekday/weekend.

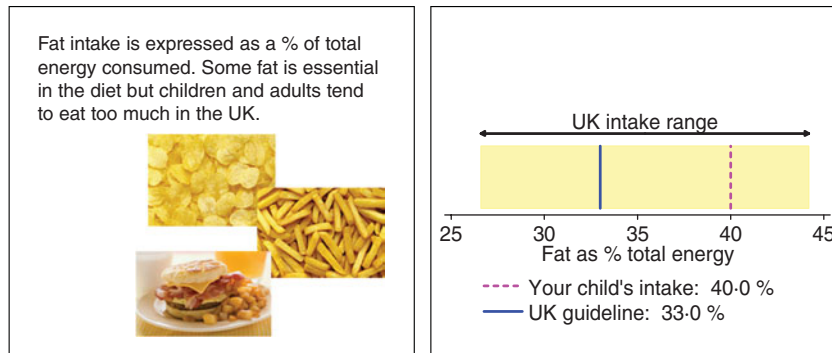


Fig. 5. National Diet and Nutrition Survey dietary feedback.

reasons, it was decided to introduce dietary feedback into NDNS, to give participants some indication of their own dietary results. There was no intent to provide dietetic advice, but simply to supply results and to place these in the context of recommendations and usual intakes for the relevant age group. A number of key nutrients were identified (total fat, saturated fat, non-milk extrinsic sugars, dietary fibre, vitamin C, folate, Ca, Fe and energy) to be included in the feedback and the layout for each of these is demonstrated for total fat in Fig. 5. The usual intakes (obtained from the Comparison Study⁽⁸⁾) and recommendation for fat intake are provided in a graphical representation which also shows the intake of the participant, from which the quality of the diet in relation to the recommendation should be clear.

Innovations to improve blood response rate in the Diet and Nutrition Survey of Infants and Young Children

The dietary assessment component is only one aspect of national surveys. They are also intended to capture information to assess the nutritional status of the population, largely through the collection and analysis of blood and urine samples. Blood collection from children is very challenging, and in NDNS successful blood response rates for young children are not as high as for older children and adults. When designing DNSIYC, it was decided to take a different approach from the blood collection component, and to optimise the blood sample response rate by using paediatric departments and clinics where the phlebotomy of infants and young children was common practice, with nearby laboratory facilities for immediate blood processing. What is required is not only training and qualification to take blood from young children but also day after day experience. NHS sites with paediatric departments were recruited around the country to be part of DNSIYC. In addition, two mobile units were purchased and fitted out and staffed with paediatric phlebotomists to enable blood taking and processing near the home for those parents in rural areas or where there was a preference to be seen at home. One unit was based in Cambridge and went to locations in the Southwest, Wales and East Anglia, the other was based in Edinburgh and went to the Northwest of England, Scotland, including the Outer Hebrides

and Northern Ireland. Fig. 6(a) shows the overall study protocol for DNSIYC and Fig. 6(b) the procedure for blood and urine samples. Blood samples were analysed for: full blood count, C-reactive protein, measures of Fe status (Hb, ferritin and transferrin receptors) and 25-hydroxyvitamin D. The response rate to the clinic stage of DNSIYC was as high for young infants aged 4–6 months (51%) as for those aged 7–9 months (45%), 10–11 months (42%) and 12–18 months (42%), with roughly half of these taking place in hospital clinics and half using the mobile unit. Importantly, although 51% of visits were allocated to hospitals and were attended at hospitals, 39% of visits were allocated for hospitals but were attended by the mobile units and an additional 15% were allocated for the mobile units and attended by the mobile units. Hence, in DNSIYC, a higher proportion of participants than expected agreed to blood sampling, and it was clearly seen that the availability of paediatric phlebotomy expertise in the field is critical to the success of surveys of infants involving blood samples^(29,30).

The future

Both NDNS and DNSIYC have been successfully carried out in terms of acceptable response rates and thorough dietary information. The success of the mobile units described earlier provides good evidence that such an approach would be useful in other surveys in the future where blood sampling and/or processing is required in rural locations. In terms of dietary information, while the methods used can continue into the future, the advances being made in this area indicate that improvements are possible even in the survey setting with the challenges outlined earlier in terms of age range and capabilities of participants, and ongoing requirements for high response rates. One of the easiest additional elements that could be incorporated is to obtain images of foods consumed. Many of the proposed new approaches using technology include taking images with cameras or smart phones. These provide additional information to enable identification of foods consumed and the portion sizes of those foods.

A pilot study of digital cameras has been carried out in a group of eighty-six UK children aged 9–10 years from five schools in Wandsworth, South London as part of the CHASE study, a large cohort of children from different

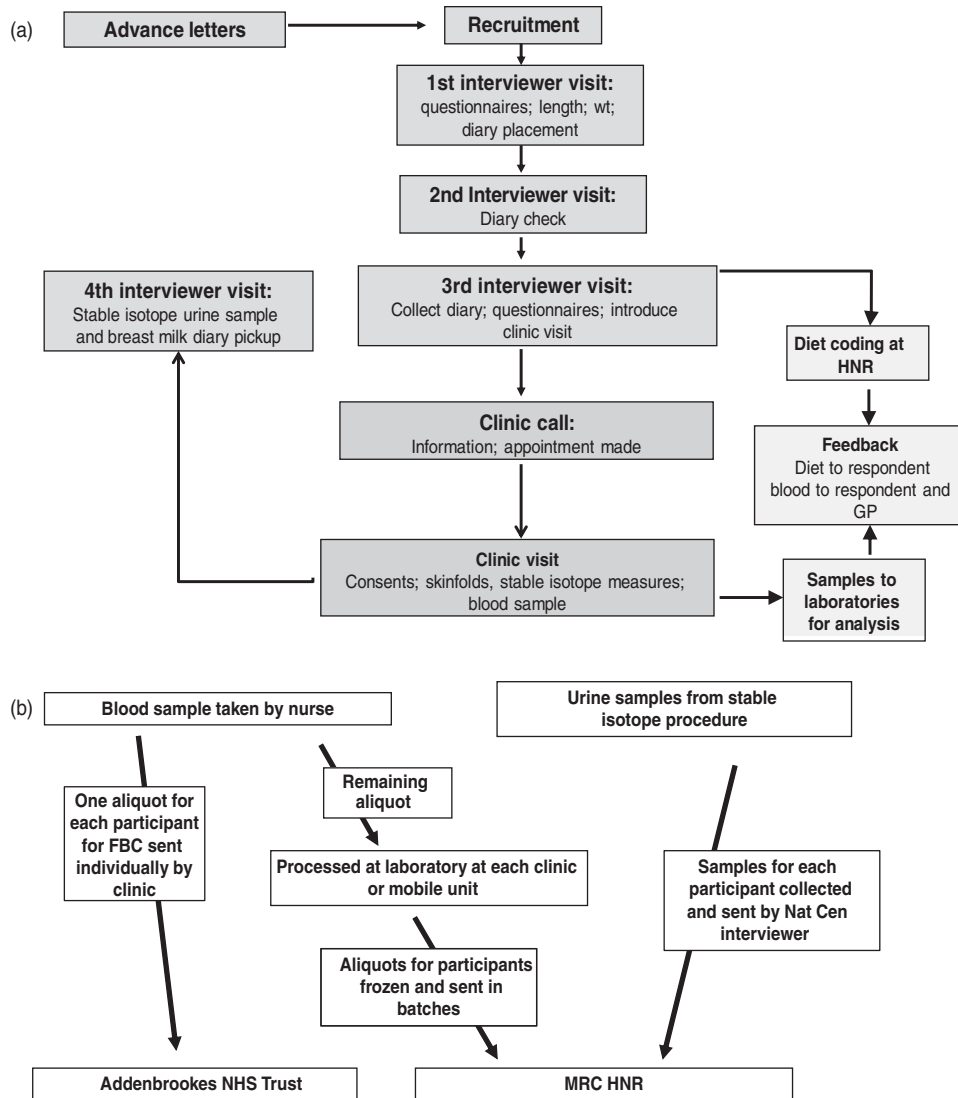


Fig. 6. (a) Diet and Nutrition Survey of Infants and Young Children (DNSIYC) survey design and (b) DNSIYC sample destinations.

ethnic backgrounds⁽³¹⁾. Children were provided with a 4 d diary, quite similar to that used in NDNS, and were also given a digital camera to photograph their food, an opaque ruler to place beside the food before taking each image and a supply of stickers to place one each in the diary against the food where they had an image. Children were instructed in the use of the camera, the ruler and the stickers. Following the return of the diaries and camera cards, the diaries were coded with and without the images, in random order. Overall, 81% of eating occasions were photographed, more so during the week than on weekends. 75% of the time the ruler marker was used correctly. Image quality was variable and indicated that additional training would be required in this age group. The images did not alter the time taken for coding; without images, work had to be done to identify the foods from what was written, whereas with the image a food would be clearly identified but might not be on the food composition database,

requiring work to find details about it; nor were the energy intakes different with and without the images. However, the number of coding queries overall were reduced and these were solved more easily with images available than when not available⁽³²⁾.

This pilot study demonstrated that including images along with the diary is a useful additional tool to assist in food identification and portion-size estimation. It is a modification that could be introduced to the survey protocol relatively easily and most age groups would probably be able to carry it out with little additional burden. In fact, images might reduce the amount of written description required. In the short term, images would seem the simplest addition that could be made to the survey methodology without altering the data obtained. In the future, as the new approaches using technologies are refined and applied to wider age groups and types of individuals, they too may be taken up in national surveys in the

future. At the moment, they are still too much in their infancy for adoption into national surveys, but progress is fast and we are likely to see quite different methods adopted in national surveys in the decade to come.

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