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ORIGINAL ARTICLE

Validation of a self-completion measure of breakfast foods, snacks and fruits and vegetables consumed by 9- to 11-year-old schoolchildren

GF Moore, K Tapper, S Murphy, R Clark, R Lynch and L Moore

School of Social Sciences, Cardiff Institute of Society, Health and Ethics, Cardiff University, Cardiff, UK

Objective: To evaluate the validity and reliability of a dietary recall questionnaire, designed for group-level comparisons of foods eaten at breakfast and intake of fruits, vegetables, sweet items and crisps.
Design: Validity was assessed relative to 24-h dietary recall interviews, and reliability by comparing the baseline data with 4-month follow-up data.
Subjects and setting: Fifty-eight schools took part in the validity assessments, with 374 children completing both measures. Reliability was assessed using 29 schools, with 1233 children at baseline and 1033 at follow-up. Children were aged 9–11 years and schools were located in socio-economically deprived areas of Wales.
Results: Results indicated moderate to substantial agreements for most foods eaten at breakfast on the day of reporting and fair to moderate agreements for breakfast foods the previous day. For items throughout the rest of the previous day, agreement was fair to substantial during school hours, but slight after school. Correlations were moderate in terms of 'healthy' items and 'unhealthy' items consumed at breakfast on the day of reporting, but weaker for the previous breakfast. Correlations between measures in terms of fruits, vegetables, sweet items and crisps throughout the rest of the previous day were fair to moderate. The measure demonstrated fair to substantial group-level reliability.
Conclusions: The questionnaire, while subject to a number of limitations, gives an adequately valid and reliable overview of selected aspects of children's diet. It is likely to be of value at group-level in randomized controlled trials of school-based interventions.
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Introduction

Breakfast is commonly referred to as the most important meal of the day. Indeed, there is substantial evidence to indicate that eating breakfast acutely improves aspects of cognitive performance, such as concentration and memory (Pollitt *et al.*, 1978; Pollitt, 1995; Rampersaud *et al.*, 2005). Recent research also suggests that skipping breakfast may have a variety of other detrimental effects, such as dental caries (Bruno-Ambrosius *et al.*, 2005), dysmenorrhoea (Fujiwara, 2003) and reduced weight control (Berkey *et al.*, 2003). Furthermore, breakfast eating appears to contribute significantly to the overall nutritional adequacy of the diet (Nicklas *et al.*, 1993; Sjoberg *et al.*, 2003a) and may provide an opportunity to consume foods such as grain products and fruits, widely regarded as important in the prevention of chronic disease (US Department of Health and Human Services, 2000; Liu *et al.*, 2003).

In recent years, efforts to facilitate change in dietary behaviours have been directed towards schoolchildren (James *et al.*, 2004; Moore *et al.*, 2005). Habitual behaviours developed in childhood may track into adulthood, with

Correspondence: GF Moore, Cardiff Institute of Society, Health and Ethics, Cardiff University, 53, Park Place, Cathays, Cardiff CF10 3AT, UK.
E-mail: mooreg@cf.ac.uk
Guarantors: GF Moore and K Tapper.
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potential consequences for health later in life (Mikkila *et al*., 2004), and repeated exposure to healthier foods at an early age has been shown to increase the intrinsic rewards associated with their consumption (Birch and Marlin, 1982; Birch *et al*., 1987; Sullivan and Birch, 1990; Wardle *et al*., 2003). Furthermore, there is evidence that childhood nutrition impacts upon adult health status independent of adult behaviours (Geleijnse and Grobbee, 2002). Hence, identifying and modifying inappropriate health behaviours early in life may not only contribute to habitual behaviour change, but might also reduce the negative long-term health impact of exposure to poor nutritional practices. In addition, childhood health behaviours may be easier to change than adult behaviours, as children can be reached in large numbers through school settings, and habits may be less fully formed than in adulthood.

Evaluations of school-based interventions typically take the form of cluster randomized controlled trials (James *et al*., 2004; Moore *et al*., 2005) as randomization at the individual level is not practicable. Large numbers of participants are therefore required in order for effects to be statistically detectable with appropriate validated measures of dietary behaviour. Although several measurement techniques exist, a number of factors restrict their suitability for large-scale studies with children. For example, although 24-h dietary recall methods (Blum *et al*., 2005) can offer a good assessment of children's dietary intake (Lytle *et al*., 1993; McPherson *et al*., 2000), the amount of time and resources required to gather data limit their usefulness for large-scale evaluations. Likewise, food records and weighed food intake measures involve a high level of respondent burden and are prone to under-reporting and alterations in diet (Macdiarmid and Blundell, 1998). Food diaries may be accurate when completed by a third party such as parents (Hill and Davies, 2001), but this is only true for time periods when the parent and the child are together, which is problematic when evaluating school-based interventions. Finally, food-frequency questionnaires are commonly used to assess diet in large-scale evaluations with adult populations, but are not suitable for use with children, as children's estimates of portion sizes and frequency are limited by their cognitive abilities (Baranowski *et al*., 1997).

This study therefore examines the validity of a brief self-completion dietary measure designed for large-scale use with 9- to 11-year-old children. The measure was based upon the Day in the Life Questionnaire (Edmunds and Ziebland, 2002), previously validated with 7- to 9-year-old children as a measure of fruits and vegetable intakes. The new, modified measure was developed as part of the evaluation of the Welsh Assembly Government's Free School Breakfast Initiative (see, Tapper *et al*., in press) and hence its main focus was on breakfast eating behaviours. Details are requested of breakfast eaten that morning in addition to breakfast eaten the previous day. As well as giving an extended overview of breakfast eating behaviour, this allows exploration of the extent to which recall errors vary between the two periods, and whether children can record foods eaten over 24 h earlier with an acceptable degree of accuracy.

In developing the measure, a number of further aspects of childhood nutrition merited consideration. Intakes of fruits and vegetables are worryingly low among young children (Department of Health, 2000), particularly among less affluent groups (Northstone and Emmett, 2005). High intakes of sugary and salty snacks among children are also of particular concern. Although these are seemingly disparate aspects of dietary behaviour, changes may not occur in isolation. Breakfast skipping has been linked with high intakes of fatty and sugary snacks later in the day and lower intakes of fruits and vegetables (Sjoberg *et al*., 2003a). Interventions that directly influence breakfast eating behaviours may therefore indirectly influence eating habits throughout the rest of the day. Exploration of such trends is important in fully evaluating the potential long-term benefit of such an intervention. In order to examine such effects, it is first necessary to establish the accuracy with which these multiple aspects can be assessed simultaneously by a single measure. For these reasons, the current measure also included questions relating to all food items consumed throughout the day. This study examines the validity and reliability of this measure in terms of foods consumed at breakfast and intakes of fruits, vegetables, sweet items and crisps throughout the rest of the day.

The validity of children's individual responses will be examined by comparing these to responses on a previously validated 24-h recall interview (Lytle *et al*., 1993). Although the measure only collects details of one day's food intake, and is therefore designed for use at group (school) level, validity was assessed at the individual level, as only six participants from each school completed the interview. Reliability however was assessed at the group-level, by comparing mean intakes for groups defined by the school at baseline and 4 months later.

Although little research has been conducted with this age group, studies demonstrate that female participants typically report food consumption more accurately on self-report measures (Sjoberg *et al*., 2003b), with implications for exploration of trends relating to gender differences. Therefore, this study will test not only the validity and reliability of the measure for the whole group, but will also present separate analyses for boys and girls.

Methods

Participants

Participants were Year 5 and 6 (i.e. 9–11 years old) primary school children from 58 schools in nine Local Education Authorities across Wales. These were all 'Communities First' schools, that is, schools located in socio-economically deprived areas. In each school, one class from Year 5 and one from Year 6 were randomly selected to complete the recall questionnaire (2395 children in total; 1168 males,

1221 females, gender details missing for six children). Three to five pupils from each of these classes were also randomly selected to undertake the recall interview (378 children in total; 157 males; 219 females, gender details missing for two children). Three children asked to be excluded from the interviews, as they did not want to miss a particular lesson. A further three children were randomly selected in their place. Of the 378 children participating in the interviews, four had not filled out the questionnaire in the morning. Validity was therefore assessed using the sub-sample of 374 children who completed both measures (157 males, 215 females, gender details missing for two participants).

The dietary recall questionnaire was administered again 4 months later with the same classes who completed baseline measures. For the purposes of examining reliability, the sub-sample of children in schools assigned to the control condition of the Free School Breakfast Evaluation was used (1232 children in total from 29 schools at baseline, 1033 children at follow-up).

Measures

Dietary recall questionnaire. Children were asked to list all foods and drinks consumed at chronologically ordered time points throughout the day. Food-related questions were embedded within items related to the child's activities (e.g., 'What did you do at lunchtime yesterday?' preceding the item 'Did you have anything to eat or drink at lunchtime yesterday?'). Activity-related items served a twofold purpose, firstly acting as prompts to enhance recall and secondly as distractions from the researcher's interest in eating behaviours, thereby minimizing social desirability biases.

The questionnaire initially focused upon foods and drinks consumed before classes started on the day of reporting, opening with the question, 'Did you watch television at home this morning?' with tick boxes for the child to indicate a response of 'yes' or 'no'. The following question asked 'Did you have anything to eat or drink at home this morning?' As with all subsequent food-related questions, a flow diagram format was constructed, whereby if the child ticked 'yes' to indicate that it had eaten or drunk something, it was directed to a box headed 'What did you have to eat or drink?' This box contained several blank lines for the child to list items consumed and an arrow at the bottom of the box directed the child to the next question. If the child responded 'no' to indicate that he or she had not eaten or drunk anything at home that morning, the child was directed straight to the next question asking how they travelled to school that morning. Two remaining time points for the morning of reporting were included, enquiring about food and drinks consumed on the way to school, or at school before the start of classes.

The questionnaire then moved onto enquiring about the previous day, with a section headed 'What did you do yesterday?' The format of all previous questions was repeated, this time enquiring about 'yesterday morning' as opposed to 'this morning'. After requesting details of items eaten before classes started the previous day, the questionnaire asked about foods and drinks consumed throughout the rest of the previous day. The child was asked to recall foods consumed at five different time points (morning break, lunch time, between the end of school and evening meal, evening meal and after evening meal). Each of these items was preceded by activity-related questions relevant to the specific time point, as discussed previously. A final question was included asking the child if he or she could remember any other food or drink items not already reported. The measure was illustrated throughout with food- and activity-related cartoons, and prompts were placed at the bottom of each box where the child was asked to record food and drinks, with a cartoon character asking if the child had remembered everything.

Children's accounts of portion size are generally unreliable (Lytle *et al*., 1993; Livingstone and Robson, 2000) and these details were therefore not requested. This helped to keep the questionnaire brief and easy to administer in large group settings with minimal supervision. The questionnaire requests details of little more than 1 day of dietary intake and is therefore most likely to be of use at group rather than individual level.

Twenty-four-hour dietary recall interview. Fully structured multiple-pass dietary recall interviews were used as the point of reference for validation. These interviews were conducted using a standardized protocol (Lytle *et al*., 1993), which was modified to include two breakfasts rather than just one. In other words, as with the dietary recall questionnaire, details of foods eaten on the morning of reporting were gathered before details of foods eaten during the course of the previous day. Details of serving size were requested using photographic visual aids (Nelson *et al*., 2002), from which the child selected the picture that most closely resembled their serving.

Procedure

Parents were informed of the research in advance by means of a letter and information sheet sent home with children and were asked to contact the school if they did not wish their child to participate in the study. At each data collection, children were also informed that they were under no obligation to participate. Parents of 15 children requested that their child be excluded.

The recall questionnaire was completed in the morning as a supervised classroom exercise with a maximum class size of 40 children. The researcher read out the instructions and asked children to complete the questionnaire independently from one another. Children were asked to put their hands up when they had finished or if they needed help with spelling, or further clarification of questions. Three members of the research team were present to assist children.

When a child put up his or her hand to indicate that he or she had finished, a researcher read through the questionnaire to ensure that all questions had been answered and that responses were legible. Where vague responses such as 'school dinner' had been recorded, the child was asked to expand upon these and to write down exactly what he or she had eaten. The interviews were conducted in the afternoon. The questionnaire was administered again approximately 4 months later, following the same procedures.

Item coding

All items consumed at breakfast according to the dietary recall questionnaire and interview were coded into nine categories. These were 'fruits', 'vegetable', 'cereal' (including cereal bars), 'bread', 'milk/milk products' (i.e. milk, milkshakes, yogurts), 'sweet items' (i.e. sweets, chocolate, biscuits, cakes, desserts), 'crisps' (including packets of commercial savoury snacks), 'non-milk drinks' (i.e. any drink other than milk drinks, water or herbal teas), 'water' (including herbal teas) and 'other'.

For each of the three time points (at home, on the way to school, at school before the start of class), each type of food or drink recorded was scored as a '1' in the appropriate category, ignoring any frequencies or portion sizes (e.g., 'two slices of toast' was coded as a '1' in the 'bread' category). However, if two or more *different types* of food or drink were reported in one time point, each type was scored as one, even if they were from the same food or drink category. For example, if a child had written 'two apples', a score of one was given to the fruit category for the appropriate time point, whereas if the child had written 'apple and banana', a score of two was recorded in the fruit category. All the remaining food and drink categories were scored as '0'.

All data were entered by the same researcher to maintain consistency, and a second researcher independently entered 5% of the total baseline data collected in the initial phase of the evaluation in a separate file, giving a sub-sample of 118 questionnaires from which to calculate inter-observer reliability. For the dietary recall questionnaire, with the exception of the 'other' category (89%), agreement between coders was between 95 and 100% for all categories of breakfast items coded. Agreement for items consumed throughout the rest of the day was 89% for sweet items, 95% for crisps and vegetables and 97% for fruits. For the dietary recall interview, agreement between coders was between 83 and 100% for all categories.

Statistical analysis

Questionnaire validity (at individual level) and reliability (at group-level) were assessed in terms of (1) items consumed at breakfast (i.e. before classes started) on the day of reporting (same-day breakfast reporting), (2) items consumed at breakfast the previous day (previous-day breakfast reporting) and (3) fruits, vegetables, sweet items and crisps consumed throughout the rest of the previous day, that is excluding breakfast (rest of day reporting).

Same- and previous day breakfast reporting. For each breakfast occasion, three scores were computed as follows: (i) consumption versus non-consumption of each of the nine food and drink categories (see item coding), (ii) total number of 'healthy' items consumed (i.e. items from the categories, 'bread', 'cereal', 'milk' and 'fruits') and (iii) total number of 'unhealthy' items consumed (i.e. items from the categories 'sweets' and 'crisps').

For data set (i) (i.e. consumption versus non-consumption), comparisons between the questionnaire and interview measures were conducted by calculating Kappa coefficients, and by designating items as matches (reported on both measures or not reported on either), exclusions (reported in interview but not on questionnaire) or intrusions (reported on questionnaire but not in interview). Data sets (ii) and (iii) (i.e. 'healthy' and 'unhealthy' items) were skewed and therefore Spearman's rank correlation coefficients were used to compare the questionnaire and interview measures in terms of the numbers of 'healthy' and 'unhealthy' items reported. In interpreting these and all subsequent analyses, for both Kappa and Spearman's rank correlation coefficients, a statistic of 0 was interpreted as no agreement, 0.01–0.20 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial and 0.81–1 as almost perfect (Landis and Koch, 1977). All comparisons were conducted separately for same-day reporting and previous-day reporting.

Rest of day reporting. For items eaten throughout the previous day, excluding breakfast, validity and reliability were assessed in relation to intakes of (a) fruits, (b) vegetables, (c) sweet items and (d) crisps. For each of these four categories, the following scores were computed: (i) consumption versus non-consumption during each of the five time points (see Measures), (ii) the total number of items consumed for all five time points combined, (iii) the total number of items consumed at school (i.e. during morning break and lunchtime time points) and (iv) the total number of items consumed after school (i.e. before evening meal, evening meal or after evening meal). As with breakfast items, for data set (i) comparisons between measures were conducted by calculating Kappa coefficients and by designating items as matches, exclusions or intrusions, whereas for data sets (ii), (iii) and (iv) comparisons were conducted using Spearman's rank correlation.

Questionnaire reliability. Reliability at group-level was assessed using both cross-sectional and longitudinal approaches. Reliability analysis was conducted by calculating school level mean numbers of 'healthy' and 'unhealthy' breakfast items (for both same-day and previous-day reporting) and 'rest of day' fruits, vegetables, sweet snacks and crisps, for participants in each school assigned to the control condition of the evaluation. For cross-sectional analysis,

school level means for each of the food categories were calculated at baseline and 4-month follow-up, using the entire sample of children who filled in the questionnaire (baseline, $N=1176$; follow-up, $N=1154$), and the two time points were compared using Spearman's rank correlation. Longitudinal analysis took a similar format, but compared school level means calculated using only data for individuals who completed the measure on both occasions ($N=1024$).

Results

Questionnaire validity

Breakfast items. Statistics comparing breakfast data from the questionnaire with breakfast data from the interview for the whole group are displayed in Table 1. Separate statistics for men and women for same-day breakfast reporting are presented in Table 2, and for previous-day reporting in Table 3.

For same-day reporting, agreement for most food types was moderate to substantial, with all food types demonstrating at least a fair degree of agreement according to Kappa coefficients. With the exceptions of bread, water, cereals and drinks, gender differences in agreement statistics were marginal (i.e. difference $\leqslant 0.10$). Percentage matches were all between 84 and 94% for the whole group, with the exceptions of milk and drinks. An exclusion rate of 27% was observed for milk, whereas for the whole group all other exclusion rates were between 4 and 13%. Intrusion rates of between 2 and 7% were observed.

Owing to the low Kappa coefficient and high exclusion rate for milk, participants who had reported eating cereal were assumed to have consumed milk, even where this was not reported, and analysis was re-run. This resulted in an increased Kappa coefficient, an increased percentage of matches, a reduced exclusion rate, but an increase in percentage intrusions.

Agreement was lower for all previous day categories, with Kappa coefficients ranging from slight to moderate. Kappa coefficients indicated moderate levels of agreement for cereals and fair levels of agreement for bread and drinks. For the whole group, fair levels of agreement were also

Table 1 Comparisons between the dietary questionnaire and dietary interview in terms of consumers and non-consumers of the nine food and drink categories at breakfast on the day of reporting (same day) and the previous day (Kappa statistics, matches, exclusions and intrusions) ($n=374$)

Item	*Kappa*		*Percentage matches*		*Percentage exclusions*		*Percentage intrusions*		*Occurrences*	
	Same day	*Previous day*	*Same day*	*Previous day*	*Same day*	*Previous day*	*Same day*	*Previous day*	*Same day*	*Previous day*
Fruit	0.47	0.30	92	89	4	7	5	4	29	39
Bread	0.66	0.39	85	73	10	16	6	11	137	128
Cereal	0.71	0.46	86	73	10	20	4	8	201	214
Milk	0.36	0.23	70	63	27	31	3	5	163	172
Milk – adjusted[a]	0.57	0.42	78	71	5	5	17	24	163	172
Sweet	0.52	0.31	84	83	13	12	3	5	95	65
Crisps	0.31	0.03	94	92	4	5	2	2	22	21
Water	0.51	0.28	88	85	9	11	3	4	64	58
Drink	0.56	0.36	80	68	13	20	7	12	259	230
Other	0.39	0.20	87	82	9	12	4	12	54	60

[a]Children who report eating cereal, assumed to have consumed milk whether reported or not.

Table 2 Comparisons between the dietary questionnaire and dietary interview in terms of consumers and non-consumers of the nine food and drink categories at breakfast on the day of reporting for boys ($n=157$) and girls ($n=215$)

Item	*Kappa*		*Percentage matches*		*Percentage exclusions*		*Percentage intrusions*		*Occurrences*	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Fruit	0.44	0.47	95	89	3	6	2	5	6	23
Bread	0.55	0.73	76	89	16	7	8	5	58	78
Cereal	0.63	0.77	81	88	10	9	4	3	87	112
Milk	0.37	0.34	69	71	28	26	3	3	76	86
Milk – adjusted[a]	0.53	0.60	76	76	8	3	16	17	76	86
Sweet	0.59	0.49	87	83	11	14	2	3	38	56
Crisps	0.15	0.38	94	93	4	5	2	2	7	15
Water	0.61	0.44	90	87	8	10	1	4	28	36
Drink	0.46	0.62	74	84	17	11	9	5	102	155
Other	0.35	0.43	84	89	10	7	6	3	26	27

[a]Children who report eating cereal, assumed to have consumed milk whether reported or not.

Table 3 Comparisons between the dietary questionnaire and dietary interview in terms of consumers and non-consumers of the nine food and drink categories at breakfast on the previous day for boys ($n=157$) and girls ($n=215$)

Item	*Kappa*		*Percentage matches*		*Percentage exclusions*		*Percentage intrusions*		*Occurrences*	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Fruit	0.57	0.20	96	84	2	11	2	5	31	31
Bread	0.36	0.39	75	72	13	17	12	11	43	83
Cereal	0.40	0.49	70	74	20	18	8	7	101	111
Milk	0.14	0.29	59	66	33	31	8	3	70	101
Milk – adjusted[a]	0.32	0.51	65	75	5	6	30	19	70	101
Sweet	0.19	0.39	82	84	15	9	3	7	29	36
Crisps	0.16	−0.04	94	91	5	6	1	3	8	13
Water	0.20	0.35	80	88	13	10	6	2	28	30
Drink	0.33	0.38	66	70	24	17	10	13	93	134
Other	0.18	0.21	81	83	13	12	6	6	26	33

[a]Children who report eating cereal, assumed to have consumed milk whether reported or not.

demonstrated for sweets, fruits and milk, although these agreement levels varied between genders. Coefficients for all remaining categories indicated slight agreement. For seven out of nine categories, Kappa coefficients were higher for females than for males.

Percentage matches ranged from 63 to 92%, again with the lowest match rates observed for milk and drinks. The highest exclusion rates were again demonstrated for milk with all other percentage exclusions ranging from 5 to 20%. Percentage intrusions of between 2 and 12% were observed for all categories.

As with same-day reporting of breakfast items, owing to the low Kappa coefficient and high exclusion rate for milk, all participants who reported eating cereal were assumed to have consumed milk and analysis was re-run. This resulted in an increased Kappa coefficient, an increased percentage of matches, reduced percentage exclusions, but an increase in percentage intrusions. As the assumption that milk had been consumed with cereal appeared to increase the validity of measurement of milk intake, subsequent analyses involving milk products (i.e. 'healthy' breakfast items) used data based on this assumption.

Correlations between the two measures in terms of same-day reporting of 'healthy' breakfast items were moderate ($r=0.59$, $P<0.001$). Although still significant, correlations were markedly lower for previous-day reporting of 'healthy' items consumed at breakfast ($r=0.36$, $P<0.001$). Both correlations were more substantial for women (same day, $r=0.66$, $P<0.001$; previous day, $r=0.39$, $P<0.001$) than for men (same day, $r=.50$, $P<0.001$; previous day, $r=0.30$, $P<0.001$). Correlations between same-day reporting of 'unhealthy' items consumed at breakfast were moderate ($r=0.53$, $P<0.001$), whereas for previous-day reporting, this correlation was fair ($r=0.35$, $P<0.001$). Correlations for same-day reporting of unhealthy items were more substantial for men ($r=0.59$, $P<0.001$) than for women ($r=0.48$, $P<0.001$), whereas for the previous day, correlations were stronger for women ($r=0.42$, $P<0.001$) than for men ($r=0.24$, $P<0.01$).

Table 4 Comparisons between the dietary questionnaire and dietary interview in terms of consumers and non-consumers of fruits, vegetables, sweet items and crisps during five timeframes relating to the previous day (Kappa statistics, matches, exclusions and intrusions) ($n=374$)

	Kappa	*Percentage matches*	*Percentage exclusions*	*Percentage intrusions*	*Occurrences*
Morning break					
Fruit	0.36	85	7	8	49
Vegetables	—	99	0	1	3
Sweet items	0.41	87	9	4	58
Crisps	0.62	88	6	6	70
Lunch time					
Fruit	0.42	85	10	5	67
Vegetables	0.38	86	12	2	64
Sweet items	0.36	68	27	5	185
Crisps	0.57	84	10	6	83
Afternoon					
Fruit	0.07	91	5	4	21
Vegetables	0.18	98	2	0	9
Sweet items	0.13	74	17	9	83
Crisps	0.14	80	15	5	69
Evening meal					
Fruit	0.16	93	5	2	21
Vegetables	0.27	86	10	4	52
Sweet items	0.12	79	20	1	82
Crisps	0.13	94	4	2	16
After evening meal					
Fruit	0.23	89	9	2	43
Vegetables	0.24	98	1	1	5
Sweet items	0.15	69	24	7	117
Crisps	0.26	86	11	3	54

Rest of day items. Statistics comparing data from the questionnaire with data from the interview in terms of each of the four food categories: fruits, vegetables, sweet items and crisps, consumed during the five time points throughout the previous day, after breakfast, are displayed in Table 4. Gender-specific analyses are presented in Table 5.

Table 5 Gender-specific comparisons between the dietary questionnaire and dietary interview in terms of consumers and non-consumers of fruits, vegetables, sweet items and crisps during five time frames relating to the previous day (Kappa statistics, matches, exclusions and intrusions) (boys $n=157$; girls $n=215$)

Item	*Kappa*		*Percentage matches*		*Percentage exclusions*		*Percentage intrusions*		*Occurrences*	
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*
Morning break										
Fruit	0.28	0.39	88	83	5	8	7	9	13	36
Vegetables	—	—	99	99	1	1	0	0	1	2
Sweet items	0.27	0.51	85	88	11	8	4	5	23	34
Crisps	0.52	0.67	88	89	6	6	6	6	23	47
Lunch time										
Fruit	0.42	0.43	85	86	12	9	3	6	31	35
Vegetables	0.33	0.40	88	85	10	13	3	2	21	43
Sweet items	0.37	0.35	70	67	24	29	5	4	70	115
Crisps	0.37	0.72	81	91	14	6	5	3	36	46
Afternoon										
Fruit	−0.02	0.08	96	88	3	7	1	5	5	16
Vegetables	—	0.24	98	97	2	3	0	0	3	6
Sweet items	0.01	0.18	75	73	18	17	8	11	31	52
Crisps	0.15	0.14	79	80	18	13	3	6	33	36
Evening meal										
Fruit	0.18	0.15	95	92	4	6	1	2	7	14
Vegetables	0.18	0.32	85	86	10	10	5	4	20	32
Sweet items	0.05	0.07	77	80	21	19	2	1	35	47
Crisps	0.14	0.13	94	95	5	3	1	2	9	7
After evening meal										
Fruit	−0.03	0.25	88	87	10	10	2	3	15	28
Vegetables	0.66	−0.01	99	98	9	2	1	0	1	4
Sweet items	0.01	0.20	72	67	23	26	5	7	39	78
Crisps	0.16	0.29	87	85	10	12	4	3	18	34

Table 6 Correlations (Spearman's rank) between the dietary questionnaire and dietary interview in terms of types of foods eaten throughout the whole day (excluding breakfast), during school and after school ($n=374$)

	Whole day			*During school*			*After school*		
	Whole group	*Boys*	*Girls*	*Whole group*	*Boys*	*Girls*	*Whole group*	*Boys*	*Girls*
Fruit	0.39	0.36	0.40	0.45	0.45	0.45	0.21	0.24	0.20
Vegetables	0.41	0.31	0.46	0.41	0.34	0.45	0.36	0.27	0.41
Sweet	0.37	0.36	0.35	0.37	0.37	0.36	0.33	0.25	0.36
Crisps	0.41	0.28	0.51	0.62	0.54	0.68	0.31	0.28	0.33

For all four categories, higher levels of agreements were demonstrated for foods reported during school hours than for foods consumed after school, with agreements ranging from fair to moderate during school hours but from slight to fair for time points after school. For each of the five time points, sweet items were the most commonly omitted item, with exclusion rates ranging from 9% for morning break to 27% at lunchtime.

Correlation coefficients for items eaten throughout the previous day, excluding breakfast, for the four food categories are presented in Table 6. These are presented for the whole group and for boys and girls separately. Fair to moderate correlations were observed for all categories, with correlations between measures higher for all categories during time points when the child was at school.

Group-level reliability

Group-level reliability statistics comparing school level mean intakes at baseline and 4-month follow-up for all schools in the control condition of the evaluation are presented in Table 7. Where these were calculated from cross-sectional data (i.e. using all children who completed the measure at baseline and all children who completed the measure at

Table 7 Correlations between school level mean intakes of 'healthy' and 'unhealthy' breakfast items and fruits, vegetables, sweet snacks and crisps, comparing all children completing the measure at baseline with all children completing the measure at 4-month follow-up (cross-sectional) and groups limited to children who completed the measure on both occasions (longitudinal)

	Cross-sectional	*Longitudinal*
Same-day 'healthy' items	0.55	0.60
Same-day 'unhealthy' items	0.66	0.56
Previous-day 'healthy' items	0.40	0.48
Previous-day 'unhealthy' items	0.40	0.47
Fruit	0.31	0.33
Vegetables	0.53	0.39
Sweets	0.55	0.48
Crisps	0.86	0.75

4-month follow-up), correlations ranged from fair (fruits and previous-day 'healthy and 'unhealthy' breakfast items), to almost perfect (crisps), with all remaining categories demonstrating moderate to substantial agreement. Where longitudinal data were employed (i.e. school level means calculated using only children who completed measures on both occasions), correlations ranged from fair (fruits and vegetables), to substantial (crisps), with all remaining categories demonstrating moderate agreement.

Discussion

The questionnaire showed higher validity for breakfast items consumed on the day of reporting, compared with the previous day, indicating that the recency of reporting markedly influences its accuracy. In fact, Kappa statistics for every one of the nine food categories were higher on the day of reporting than for the previous day. Traditionally, 24-h recall measures have focused upon the whole previous day (Lytle *et al.*, 1993; Edmunds and Ziebland, 2002), whereas this study indicates that asking children to report the previous 24-h period, including part of the previous day and part of the present day, may elicit more accurate responses. This is consistent with research by Baxter *et al.* (2004), who found that measuring the previous 24 h rather than the previous day led to improved accuracy of 24-h recall interviews with fourth grade (i.e. 9–10 years old) US schoolchildren.

As well as differences in the accuracy of reporting related to recency, there were also differences between categories, with items such as bread and cereal reported most accurately on both occasions. Crisps demonstrated the lowest levels of agreement according to Kappa coefficients on both occasions, although this is in contrast with the high percentage of matches and low percentages of exclusions and intrusions for this category. The relatively low Kappa coefficient for crisps therefore appears largely to be owing to the low occurrence of this food category at breakfast, rather than to extensive reporting errors. This trend is also demonstrated for fruits consumed at breakfast, which was the next least commonly consumed breakfast item after crisps.

Relatively low agreements were demonstrated for milk according to Kappa coefficients. In contrast to crisps and fruits, however, this low level of agreement was borne out by examination of percentage matches, exclusions and intrusions, indicating systematic under-reporting of milk. This was probably due to children listing cereals, but omitting milk consumed with cereal on the questionnaire, whereas during the interview, milk may have been reported when the child was asked if they had added anything to their cereal. Indeed, assuming that children had consumed milk where cereal had been reported, even where milk was not listed, markedly improved the validity of recording of milk consumption. This assumption did however increase the intrusion rate. Although this is probably largely due to children omitting milk consumed with cereal on both measures, some intrusions may be due to the fact that cereal bars were coded as cereal on the self-completion measure, as the assumption that milk had been consumed with cereal arose from exploratory analyses carried out after coding was complete. Occurrences of cereal bar consumption at breakfast were however relatively low, with 15 occurrences at breakfast on the day of reporting and five the previous day, compared to 190 and 210 occurrences of breakfast cereal consumption for the same day and previous day, respectively. Hence, any bias occurring from the misassumption that milk had been consumed with cereal bars is likely to be negligible. However, coding cereal and cereal bars as separate categories in future studies would likely marginally increase the validity of the assumption that milk was consumed with cereal.

Milk may have been considered an accompaniment to the food, rather than an item in its own right and therefore not worth listing. This highlights one of the key limitations of the measure. Food accompaniments are likely to significantly alter the nutritional quality of an item. For example, if as part of an intervention a child is encouraged to add fruits to their cereal instead of sugar, yet on both of these occasions cereal is reported with no mention of sugar or fruits, a nutritionally important change will be overlooked. However, as discussed, issues such as motivation to comply and cognitive abilities of young children (Livingstone and Robson, 2000) inherently limit the likelihood of obtaining a full and detailed overview of diet by means of unassisted recall. Working within the clearly defined parameters of attempting to measure broad categories of foods eaten, the present measure appears to offer a useful indication of foods eaten for breakfast.

When food categories were collapsed to examine consumption of healthy and unhealthy breakfast items, correlations between measures were of reasonable strength, although again, same-day reporting appeared to offer the greatest degree of validity. This suggests that the measure is likely to detect changes in the frequency of these items after

an intervention, particularly in terms of average intakes at school level. Group-level test–retest reliability indicated moderate agreement between the two measurement occasions, in terms of the average number of 'healthy' and 'unhealthy' breakfast items consumed by children in each school, despite the fact that measurement occasions were 4 months apart.

Comparison between measures in terms of foods eaten throughout the day, after breakfast, demonstrated moderate agreement between measures for all categories of foods. Correlations were somewhat weaker than those demonstrated for breakfast items on the day of reporting, although stronger than for breakfast the previous day. However, the range for these items was limited, somewhat restricting the usefulness of correlations as a measure of agreement. Therefore further examination of agreement was carried out, in terms of consumption and non-consumption of each food category for each of the five time points after breakfast.

Kappa coefficients indicated fair to substantial agreement for items eaten during school, but slight to fair agreement for time points after school. This is consistent with the findings of Moore *et al*. (2005), who found that reporting of foods during school time on a computerized 24-h recall measure was more accurate than reporting for the whole day. Although this appears to be in contrast to the aforementioned trend for reporting to become less accurate as the time point reported becomes progressively less recent, children may remember structured occasions such as school breaks more accurately than evening eating occasions, where eating behaviour may be more sporadic (Davidson *et al*., 1986). Furthermore, the fact that the measures were conducted within the school environment may have provided cues for the recall of items eaten in school the previous day, and children may have prompted one another regarding food items consumed at morning break or lunchtime. For all categories except sweet items, however, percentage matches were consistently above 80% and the low Kappa coefficients appear to reflect low occurrences of each food category rather than substantial misreporting.

Sweet items, however, did appear to be substantially under-reported, with exclusion rates ranging from 13% at morning break to 32% at lunchtime. It is possible that this is partially due to the very high consumption of sweets relative to the other items, with occurrences of sweet items markedly higher than any other category in the interview. It is also however possible that a degree of social desirability bias may be responsible for this trend, as the recall questionnaire was conducted after a number of other measures, including a measure of attitudes towards eating breakfast, which may have imparted messages about the interests of the researchers. However, Kappa coefficients for sweet items were comparable to other categories, indicating fair to moderate agreement during time points at school, despite the level of under-reporting.

Gender-specific analyses indicated that the measure was acceptably accurate for both boys and girls, although validity tended to be slightly higher for girls. Kappa coefficients for six out of nine items on the day of reporting, and seven out of nine categories the previous day were higher for female than male participants. These differences in reporting accuracy may have implications for the exploration of trends relating to gender, as it is possible that a degree of systematic reporting bias related to gender may lead to false results. Future studies are needed to explore ways of encouraging both genders to engage with the reporting process equally, and to explore the underlying reasons for gender differences in reporting.

In summary, the questionnaire appears to offer an acceptably valid and reliable measure of foods eaten at breakfast and fruits, vegetables, sweet items and crisps eaten throughout the rest of the day. However, a number of limitations of this study merit discussion.

The first of these is the absence of a 'gold standard' measure of dietary intake against which to validate the questionnaire, in particular, the absence of an objective point of reference. Twenty-four-hour recall interviews were considered the most likely method to give a valid measure of dietary intake (Lytle *et al*., 1993) while covering the entire time period in question. This measure is itself however subject to a number of limitations and discrepancies may be due to errors on the questionnaire or the interview. Furthermore, the validation of a self-report recall measure against another self-report recall measure is problematic, as both likely share systematic variances relating to social desirability biases, motivations to comply and cognitive recall ability. Thus, occurrences of the same reporting errors on both measures may give an inflated account of the accuracy of the questionnaire. The questionnaire on which the measure was based was validated in comparison to objectively observed intakes recorded by researchers (Edmunds and Ziebland, 2002), and segments of the day were validated. However, such methods were not logistically viable in this instance due to the focus upon recording breakfast intakes in naturalistic settings. Furthermore, the assumption that if one section of the day is reported accurately that this can be generalized to the rest of the day is not upheld by previous research (Moore *et al*., 2005), or indeed by the findings of this study.

The second limitation was that the questionnaire was validated at the individual level rather than at the group (school) level for which it was primarily designed, owing to the low number of participants completing the interview from each school. As children's eating behaviour varies from day to day, a 1-day snapshot of eating behaviour is unlikely to provide a sufficient insight into a child's overall habitual dietary intake. This limitation means that recall measures are unlikely to be of use in detecting trends relating to individual level behaviour. As the study from which the data are derived was not designed specifically as a validation study, there was an absence of data on variables by which participants could be grouped in order to assess the ability of the measure to detect group-level trends associated with

theoretically justified *a priori* hypotheses. Further data collections are currently taking place as the evaluation continues, and details are being gathered, which will enable further analysis of the measure's group-level validity at a later date.

Random selection of pupils to undertake the recall interviews led, by chance, to a markedly higher number of female participants. Given the reported gender differences in reporting accuracy, it is possible that employing a predominantly female sample may give a slightly inflated account of the validity of the measure and future studies may benefit from stratifying by gender when selecting sub-samples to take part in a validation study. Furthermore, while little research has examined the influence of socio-economic status upon accuracy of reporting, the representativeness of the sample may be limited by the fact that the study was restricted to socio-economically disadvantaged areas. Given the current need to address social inequalities in health (Wanless, 2004), the testing of measures within more disadvantaged groups is important. However, it is also important to establish the usefulness of the measure beyond such populations, and its validity and reliability will be tested with more affluent groups when such data become available as part of the continuing evaluation.

In conclusion, the measure examined in this study appears to offer a reasonably valid and reliable estimate of children's dietary intake in relation to a number of clearly defined dietary markers. It offers significant potential as a method of assessment of the effects of dietary interventions, particularly those focusing upon breakfast eating behaviours.

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