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A Belgian study on the reliability and relative validity of the Health Behaviour in School-Aged Children food-frequency questionnaire

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Abstract

Objective: In the Health Behaviour in School-Aged Children (HBSC) survey, the frequency of consumption of a limited number of food items – focusing on fibre, calcium and less healthy items – is queried using a 15-item food-frequency questionnaire (FFQ). The present study was conducted to assess the reliability and relative validity of the HBSC FFQ among school pupils in Belgium.

Design and subjects: To assess the reliability of the FFQ, 207 pupils aged 11–12 years and 560 pupils aged 13–14 years completed the questionnaire twice, with a test–retest interval of 6 to 15 days. To assess the relative validity of the FFQ, in a first study data were collected as part of the Flemish HBSC 2000 survey: 7072 pupils (11–18 years) completed the FFQ and a 24-hour food behaviour checklist (FBC). In a second study, 101 pupils (11–12 years) completed the FFQ and a 7-day food diary (FD).

Results: Reliability – weighted kappa values between test and retest ranged from 0.43 to 0.70, percentage agreement from 37 to 87%, and Spearman correlations from 0.52 to 0.82. Relative validity – comparison of the FBC with the percentage of respondents who should have consumed the food items on a random day, computed from the FFQ, showed good agreement between the FFQ and the FBC for most items. Only for cereals, diet soft drinks and other milk products were considerably higher food frequencies than expected found from the FBC. Comparison of the FFQ with the FD showed overestimation for all but three food items (cheese, soft drinks and chips). Spearman correlations ranged between 0.10 for crisps and 0.65 for semi-skimmed milk.

Conclusion: The HBSC FFQ is a reliable questionnaire that can be used for ranking subjects for most food items, although one must consider the overestimation when the FFQ is used for estimating prevalences.

Keywords
Food-frequency questionnaire
Reliability
Validity
Children
Adolescents

The dietary behaviour of young people is important because healthy eating patterns in childhood and adolescence promote optimal childhood health, growth and intellectual development[1]. Additionally, it has been recognised that diet in childhood and adolescence influences not only the immediate health of the child but also may impact positively or negatively on future adult health status[2]. Moreover, young persons having unhealthy habits tend to maintain these habits as they age[3,4].

In order to develop relevant comprehensive policies, programmes and practices to influence the eating patterns of young people, we need to know what their eating patterns are and which factors influence these eating patterns significantly.

Despite the difficulties in collecting accurate dietary intake data on children in large surveys[5], the benefits of incorporating dietary data into an international cross-sectional study on the health behaviours and lifestyles of young people must not be underestimated. An attempt was made to address this topic in the World Health Organization's collaborative cross-national study on Health Behaviour of School-Aged Children (HBSC). The HBSC study is an international survey carried out every four years in a growing number of European countries, Canada and the USA; in Belgium–Flanders, a survey is done every two years. The overall aim of the HBSC study is to monitor and increase understanding of the health behaviours and lifestyles of young people. A detailed description of the study has been given elsewhere[6].

Between the two last surveys (1997–1998 and 2001–2002), a number of separate studies have been undertaken in different countries to improve the reliability and validity of different parts of the questionnaire. The food items of the HBSC study have also been revised.

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Designing an appropriate dietary assessment protocol to meet a particular research objective requires careful evaluation of the strengths and limitations of existing methods with respect to the study design and population characteristics[7]. The HBSC study explores a wide range of health behaviours among a large number of school pupils using a questionnaire that can be administered quickly and easily. Thus, within the scope of this study, only assessment of the habitual consumption of a selected list of foods is possible and useful. Although the literature shows varying results of self-reported dietary assessment methods with subjects in this age group[8], the food-frequency questionnaire (FFQ) is increasingly being recognised as a suitable method for collecting data in epidemiological studies[5] from the age of 10 years upwards, when the cognitive processes of children become more similar to those of adults[9,10].

The purpose of the FFQ is to provide a reliable and accurate method for describing the eating patterns of young people with a limited number of questions. The questionnaire is not designed to retrieve unique details of an individual's diet and, consequently, its principal advantage is in ranking the diet of an individual, rather than in quantifying individual intake[8]. Because of the wide variation in food items that contribute to the daily supply of nutrients, the wide between-country variation in levels of consumption, and the limited space in the HBSC questionnaire for food items, a limited list of relevant food items had to be selected. Items were chosen as indicators of overall diet, specifically in relation to dietary fibre, calcium and products typical of youth culture. The detailed rationale for the selection of these food items has been described elsewhere[11].

The present paper documents the reliability and relative validity of the revised HBSC FFQ with a 24-hour food behaviour checklist (FBC) and a 7-day food diary (FD) among school pupils in Belgium–Flanders.

Methods

The FFQ

Respondents were asked about their consumption frequency of a total of 15 items as follows:

- important sources of fibre – fruits, vegetables, cereals (e.g. corn flakes, choco pops, muesli, etc.), white bread, brown bread;
- important sources of calcium – (semi-)skimmed milk, whole-fat milk, cheese, other milk products (e.g. yoghurt, quark, chocolate milk, fristi, puddings, etc.); and
- items relevant to youth food culture – crisps, chips, sweets or chocolates, soft drinks and diet soft drinks, alcoholic beverages.

The response categories for each food item were 'never', 'less than once a week', 'once a week', '2–4 days/week', '5–6 days/week', 'once a day, every day' and 'every day, more than once'.

Three separate studies were undertaken to assess the reliability and relative validity of the FFQ used in the HBSC study.

Study 1: Reliability

The test–retest reliability was tested in pupils aged 11–12 years and 13–14 years. Test–retest reliability is the extent to which the questionnaire measurements are consistent across administrations at different times[12].

Subjects and study design

Data for the reliability study among 11–12-year-olds were collected as part of a larger study on determinants of the consumption of fruits and vegetables. For this study, three primary schools in Flanders were approached. All of the principals agreed to participate. All pupils in Years 5 and 6 were invited to participate ($n = 235$). Written consent was collected from 216 parents/guardians. The questionnaires were completed anonymously in a class setting and in the presence of one researcher and one teacher. Participants were not told that they would complete identical questionnaires twice. Two hundred and seven pupils completed the questionnaire twice (88% response). The time interval between testing and retesting ranged from 7 to 15 days. Mean age of the participants was 11.22 (standard deviation (SD) 0.64) years. Of the sample, 43% were boys and 57% were girls.

Data for the reliability study among 13–14-year-old pupils were collected as part of a pilot study in which the traditional paper format of the HBSC questionnaire was compared with a computerised format. Five hundred and sixty pupils completed the questionnaire twice with a test–retest interval of 6–10 days. Of the sample, 60% were boys and 40% were girls. Mean age of the participants was 13.6 (SD 0.79) years. The study sample is described in detail elsewhere[13].

Analysis

The statistic of choice for measuring agreement with ordinal data is weighted kappa (κ_w), which is derived from kappa with assigned weights based on the magnitudes of observed disagreements[14]. Percentage agreement, percentage in the same or an adjacent category, and Spearman correlation coefficients are included for comparison with previous studies.

Study 2: Relative validity – comparison of the FFQ with the FBC

Validation, the demonstration that a method measures what it intends to measure, requires that the truth is known; however, dietary intake cannot be measured with absolute precision in free-living populations[15,16]. Thus, in the absence of an absolute gold standard for dietary assessment[12], a 'reference method' – one whose accuracy

is believed to be greater than the method under investigation – must be used as an alternative[5]. Therefore, a 24-hour FBC was included in the questionnaire: pupils were asked about food eaten the day prior to administration of the questionnaire ('yesterday') and for a selected list of food items only. An FBC is a simplification of the 24-hour recall[17] and, by focusing on a recent and defined time period, may reflect true food intake more accurately compared with recall of perceived 'usual' diet[17]. Additionally, the memory task is simplified by prompting only the relevant food items. In the study of Smith *et al.*[18], the FBC proved to be a reliable and valid tool. Although a single 24-hour recall is not representative of a person's usual diet, it can be used for estimating the mean intake of a group of people[19,20].

Subjects and study design

Data for the comparison of the FFQ with the FBC were collected as part of the Belgium–Flemish HBSC 2000 survey in representative samples of primary and secondary schools in Flanders, stratified by type of authority (Catholic, public, municipal and provincial). In each participating school two random classes or class groups were selected, taking in account gender, grade and education level (general, technical and vocational). In the primary schools only pupils of Years 5 and 6 were selected. In each school one teacher was appointed as co-ordinator. He or she received instructions on how to administer the survey. Pupils completed an anonymous questionnaire during one school lesson. Of the 7072 pupils (11–18 years) who completed the questionnaire, 47.4% were males and 52.6% were females.

Analysis

To allow comparisons between responses to the FFQ and the FBC, the percentage of respondents who should consume the food items on a random day was computed by making use of the responses of the FFQ. Namely, all pupils who answered 'once a day, every day' or 'more than once a day, every day' were expected to consume the inquired food item on any day. Of the pupils who answered '5–6 days/week', on average between 71% (5/7) and 86% (6/7) could be expected to consume it on a random day. Of the pupils who answered '2–4 days/week', at least 29% (2/7) and no more than 57% (4/7) could be expected to consume it on a random day. Of the pupils who answered 'once a week', 14% (1/7) should consume it on a random day. For the pupils who answered 'less than once a week', we agreed that they consumed it at least once every three months and no more than once in eight days. Therefore at least 1.1% (1/91) and no more than 12.5% (1/8) of these respondents should consume it on a random day. All pupils who answered 'never' should not have consumed it on the previous day.

Summing the lowest values of the different response categories (100% of the daily consumers + 71% of those who consume it 5–6 days/week + 29% of those who consume it 2–4 days/week + 14% of those who consume it once a week + 1.1% of those who consume it less than once week + 0% of those who consume it never) gives the minimum percentage of respondents who should consume the inquired item on a random day. Summing the highest values for each response category (100% of the daily consumers + 86% of those who consume it 5–6 days/week + 57% of those who consume it 2–4 days/week + 14% of those who consume it once a week + 12.5% of those who consume it less than once week + 0% of those who consume it never) gives the maximum percentage of respondents who should consume the item on a random day. As the FBC represents the average percentage of pupils who consume the food item on a random day, the FBC should lie between these limits.

In addition, internal consistency was checked by comparing: (1) agreement for the 'never' response on the FFQ with that on the FBC; and (2) agreement on the 'once a day, every day' and 'more than once a day, every day' responses on the FFQ with those on the FBC.

Study 3: Relative validity – comparison of the FFQ with the 7-day FD

As the purpose of the FFQ was to rank the diet of an individual, a third study was conducted in which the FFQ was compared with a food diary. A 7-day FD was chosen as the reference method because three to seven days are normally adequate to assess food group intakes[21]. The diary was structured according to meals (breakfast and mid-morning snack were grouped on one paper, midday meal and snack during the afternoon break on a second, and evening meal and snack in the evening on a third) and every meal contained food prompts (see Appendix). Instructions that focus attention on certain kinds of foods and are segmented in a day have been found to improve recall[9,22].

Subjects and study design

For this part of the study, two primary schools in Flanders were approached. All pupils in Years 5 and 6 were invited to participate ($n = 110$). Written consent was collected from parents/guardians. Mean age of the participants was 11.05 (SD 0.79) years. Of the sample, 52% were boys and 48% were girls.

The FFQ was completed anonymously in a class setting in the presence of two researchers.

After completing the FFQ, the researchers gave both oral and written instructions on how to fill in the blank diary forms. For the first day, pupils were asked to recall all the foods and beverages they had already consumed that day, while the researchers went round the classroom responding to requests for help in completing the diary.

The pupils' collaboration in completing the diaries for the following six days was encouraged by daily visits

(except on Saturday and Sunday) of the researchers to the classroom. For a task requiring a high degree of co-operation from children, it is essential that they are motivated regularly[20]. At the same time, the records were reviewed to ensure adequate documentation of the 15 food items of the FFQ (e.g. did they indicate 'brown' or 'white' bread, did they mention 'milk' if they had consumed 'cereals with milk'?). At the end 101 completed diaries were collected.

Analysis

The diaries were screened for all items of the FFQ except alcohol, because of the low consumption frequency in this age group. Frequency of consumption of the items per day was coded. Vegetables that were part of a composite dish were coded in a separate variable so that it would be possible to use both a broad and a narrower definition of vegetables, the latter excluding composite foods. Types of white bread were coded into separate variables for the same reason. Spearman correlations between the FFQ and the FD were computed. To enable comparison of the FFQ with the FD, FFQ categories were quantified using the midpoint of the interval. The Wilcoxon signed rank test was used to measure systematic differences between both measurement methods.

Finally, the FFQ and the diaries were translated into three comparable categories, 'once a week or less', '2–4 times/week' and '5 or more times/week', and percentage agreement and percentage of gross misclassification were computed.

Results

Study 1: Reliability

As shown in Table 1, weighted kappa values ranged from 0.43 (13–14-year-olds: other milk products) to 0.70 (11–12-year-olds: semi-skimmed milk). Percentage perfect agreement between test and retest ranged from 39 to 87% for the 11–12-year-olds with an overall perfect agreement of 55%, and from 37 to 68% for the 13–14-year-olds with an overall perfect agreement of 52%. Chips, alcoholic beverages and whole-fat milk had the highest agreement, whereas other milk products and sweets had the lowest. At least 74% of the 11–12-year-olds and 70% of the 13–14-year-olds gave an answer in the same or an adjacent category. Spearman correlations ranged from 0.52 to 0.82 for the 11–12-year-olds and from 0.57 to 0.78 for the 13–14-year-olds, with an overall mean correlation of 0.70 and 0.67, respectively.

Study 2: Relative validity – comparison of the FFQ with the FBC

Figure 1 shows the results of the comparison of the FFQ with the FBC. Bars represent the results of the FFQ, bullets indicate the percentage of respondents who consumed the item on the previous day and crosses indicate the percentage of respondents who should have consumed the food items according to our computations. Since no striking differences were found between boys and girls and between pupils aged 11–12, 13–14, 15–16 and 17–18 years, only results for the whole sample are presented.

The figure shows perfect agreement between the FFQ and the FBC for fruits, white bread, crisps, chips, sweets, soft drinks and cheese. For example, 63% of the pupils consumed fruit the previous day and, according to the FFQ, this should have been at least 53% and no more than 65%.

There was an insignificant difference between the FFQ and the FBC for vegetables (at least 77% should have consumed vegetables, while 76% did) and alcoholic beverages (at least 9.2% should have drunk an alcoholic

Table 1 Test–retest reliability: weighted kappa, κ_w (standard error, SE), percentage agreement, percentage in the same or an adjacent category and Spearman correlation coefficient (ρ)

	11–12-year-olds				13–14-year-olds			
	κ_w (SE)	% agreement	% same or adjacent	ρ	κ_w (SE)	% agreement	% same or adjacent	ρ
Fruits	0.53 (0.06)	47	85	0.68	0.57 (0.03)	52	89	0.70
Vegetables	0.50 (0.07)	51	85	0.59	0.50 (0.04)	52	86	0.59
Cereals	0.55 (0.05)	50	79	0.66	0.58 (0.03)	50	80	0.68
White bread	0.64 (0.05)	50	81	0.75	0.66 (0.03)	52	80	0.76
Brown bread	0.65 (0.05)	50	79	0.80	0.66 (0.03)	52	84	0.78
(Semi-)skimmed milk	0.70 (0.05)	54	83	0.82	0.61 (0.03)	51	76	0.71
Whole-fat milk	0.68 (0.08)	68	88	0.74	0.60 (0.04)	62	80	0.69
Cheese	0.57 (0.06)	50	85	0.72	–	–	–	–
Other milk products	0.44 (0.05)	39	74	0.59	0.43 (0.03)	37	70	0.57
Crisps	0.59 (0.06)	57	94	0.74	0.51 (0.04)	51	87	0.65
Chips	0.48 (0.08)	70	96	0.52	0.46 (0.05)	68	94	0.57
Sweets	0.45 (0.06)	47	79	0.58	0.46 (0.03)	42	97	0.61
Soft drinks	0.66 (0.05)	52	83	0.80	0.60 (0.03)	49	83	0.73
Diet soft drinks	0.66 (0.06)	54	87	0.78	0.56 (0.04)	53	80	0.67
Alcoholic beverage	0.68 (0.12)	87	100	0.74	0.54 (0.05)	67	94	0.63
Mean	0.58	55	85	0.70	0.55	52	84	0.67

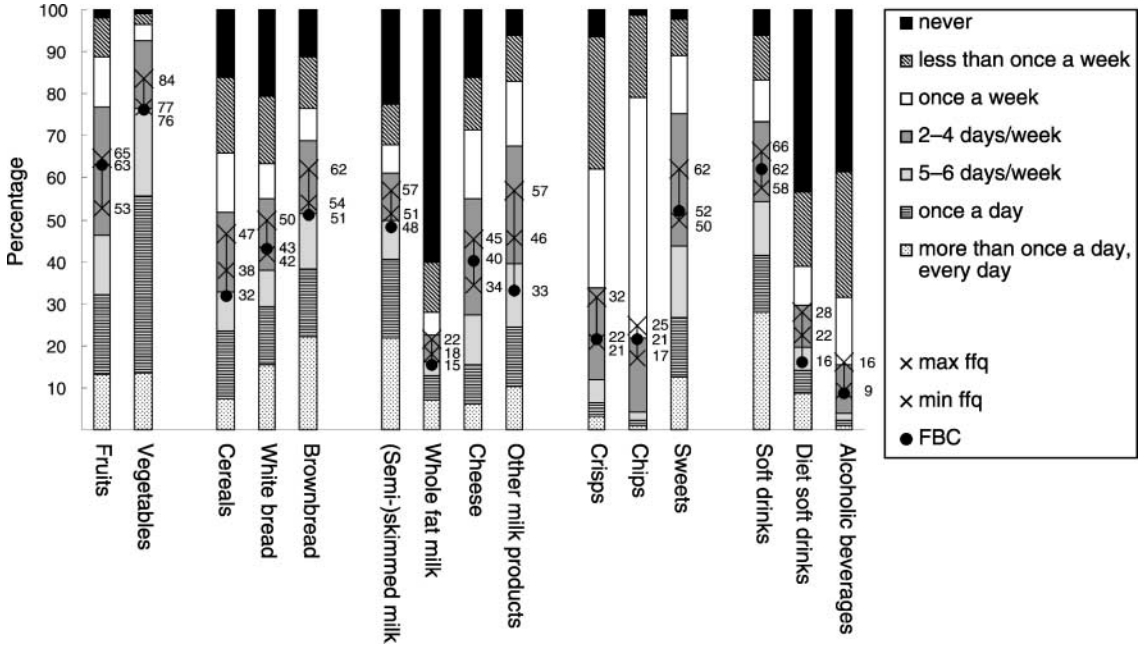

Fig. 1 Relative validity: comparison of the food-frequency questionnaire (FFQ) with the 24-hour food behaviour checklist (FBC). Max ffq−min ffq = according to the FFQ, the percentage of pupils who should have consumed the food item on a random day should lie between these limits

beverage, while 8.7% did), a small difference for (semi-)skimmed milk (at least 51% should have consumed (semi-)skimmed milk, while only 48% did), whole-fat milk (at least 18% should have consumed whole-fat milk, while only 15% did) and brown bread (at least 54% should have eaten brown bread, while only 51% did) and a considerable difference for cereals (at least 38% should have consumed cereals, while only 32% did), diet soft drinks (at least 22% should have drunk diet soft drinks, while only 16% did) and other milk products (at least 46% should have consumed them, while only 33% did according to the FBC).

Comparing the responses 'never' or 'once a day, every day' and 'every day, more than once' with the FBC showed a percentage agreement ranging from 89% (other milk products) to 99.3% (alcohol), with a mean agreement for all food items of 95.3% (data not shown).

Discrepancies between the FFQ and the FBC were mainly caused by discrepancies in reported consumption for those who claimed to eat a food item daily but did not indicate its consumption on the day prior to administration of the questionnaire (ranging from 0.6% for alcoholic beverages to 10.7% for other milk products).

Study 3: Relative validity – comparison of the FFQ with the 7-day FD

Table 2 presents the results of the comparison of the FFQ with the FD. Spearman correlations between the FFQ and the FD varied between 0.10 for crisps and 0.65 for semi-skimmed milk. Comparing mean consumption between the FFQ and FD shows overestimation for all but three items: the consumption of chips was underestimated, and no significance difference was found for cheese and soft drinks. Percentage agreement varied between 34% for the narrower definition of vegetables (excluding composite dishes) and 72% for whole-fat milk. Gross misclassification varied between 1% for chips and 21% for diet soft drinks.

Discussion

In the present study, the test–retest reliability of the HBSC FFQ was studied and the reported consumption frequencies were compared with a 24-hour FBC and a 7-day FD to test the relative validity of the instrument.

Reliability

All kappa values were higher than 0.40, indicating good agreement. Percentage perfect agreement between test and retest ranged from 37 to 87%, with an overall perfect agreement of 55% for the 11–12-year-olds and 52% for the 13–14-year-olds. For adolescent respondents 50% agreement appears to be reasonable, as possibly half of the foods they eat vary greatly[23]. The highest percentage agreements were found on alcoholic beverages, chips and whole-fat milk. Alcoholic beverages and whole-fat milk are foods consumed less commonly and, according to Speck *et al.*[24], individuals are likely to recall with more consistency the foods they never eat as opposed to the foods they sometimes eat. Chips, on the other hand, are eaten in a lot of families in Belgium–Flanders on a fixed day.

Table 2 Relative validity: Spearman correlation (ρ) between the 7-day food diary (FD) and the food-frequency questionnaire (FFQ), mean (standard error, SE) consumption frequency per week according to the FD and the FFQ, percentage agreement between categories comparable between the FD and FFQ, percentage gross misclassification and ratio FFQ/FD

		Mean (SE) consumption frequency (days/week)					
	ρ	FD	FFQ	*P*-value (Wilcoxon)	% agreement	% gross misclassification	Ratio FFQ/FD
Fruits	0.34	2.38 (0.21)	4.36 (0.22)	<0.001	38	11	1.837
Vegetables (excluding composite dishes)	0.45	3.18 (0.20)	5.16 (0.22)	<0.001	34	9	1.623
Vegetables	0.48	4.21 (0.18)	5.16 (0.22)	<0.001	58	2	1.226
Cereals	0.47	2.46 (0.20)	4.13 (0.27)	<0.001	54	12	1.683
White bread (excluding alternative types)	0.50	3.08 (0.23)	3.99 (0.27)	<0.001	48	11	1.295
White bread	0.47	4.80 (0.20)	3.99 (0.27)	0.024	50	11	0.83
Brown bread	0.51	1.96 (0.20)	3.26 (0.26)	<0.001	45	12	1.662
Semi-skimmed milk	0.65	2.90 (0.27)	4.00 (0.29)	<0.001	62	14	1.378
Whole-fat milk	0.64	1.42 (0.21)	2.00 (0.27)	0.006	72	7	1.411
Cheese	0.49	2.36 (0.19)	2.55 (0.24)	0.425	53	7	1.082
Other milk products	0.41	3.24 (0.18)	3.83 (0.25)	0.001	49	3	1.183
Crisps	0.10	0.43 (0.08)	1.80 (0.21)	<0.001	66	16	4.225
Chips	0.37	1.67 (0.12)	1.23 (0.14)	0.001	55	1	0.737
Sweets	0.25	1.59 (0.17)	3.06 (0.24)	<0.001	40	15	1.926
Soft drinks	0.46	4.23 (0.21)	4.07 (0.26)	0.462	50	10	0.963
Diet soft drinks	0.15	0.32 (0.09)	2.08 (0.25)	<0.001	65	21	6.578

Correlations (ranging from 0.52 to 0.82) were comparable with those of other studies among adolescents. In the study of Speck *et al.*[24], test–retest correlations ranged from 0.46 to 0.85 for their 48-hour retest and from 0.08 to 0.76 for their 2-week retest. Rockett *et al.*[25] reported correlations for the frequency of consuming foods and food groups in their 1-year test–retest ranging from 0.39 for meats to 0.57 for soda. In the study of Buzzard *et al.*[26], reliability was tested for 25 items after a 4-month period and correlations ranged from 0.24 to 0.59.

Comparison of the FFQ and FBC

Several studies have evaluated the validity of FFQs at the food level among older children and adolescents, yielding inconsistent results[23,24,27,28]. Our results showed good agreement between the FFQ and the FBC for most items. Only for cereals, diet soft drinks and other milk products did we find considerably higher food frequencies than expected from the FBC.

A limitation of the comparison with the FBC is that we were not able to collect 24-hour recalls of both Fridays and Saturdays, because the questionnaires are filled in at school and there is no school on Saturday and Sunday. If the consumption of certain food items is strongly connected with certain days of the week, the FBC may not give a true picture of the average percentage of respondents who consume that item on a random day. However, pilot results of a multi-centre study of eating behaviour, among 340 school pupils who completed a 7-day food diary, showed that the percentage of respondents who consumed whole-fat milk, low-fat milk, whole wheat bread, cereals, fried potatoes and sweets on average during a week (Monday to Sunday) did not differ from the percentage who consumed these items on average between Sunday and Thursday (unpublished data, 1997). Only small differences were found for soft drinks (Monday–Sunday: 58% vs. Sunday–Thursday: 56%), crisps (11% vs. 9%), fruits (53% vs. 55%) and vegetables (77% vs. 80%).

A second limitation is that our study gives only results of agreement at the group level, which is acceptable if the purpose of the study is to compare the responses of groups.

Comparison of the FFQ and FD

To use the data for correlation or multivariate analysis, the agreement on an individual level was examined by comparing the FFQ with a 7-day diary. For 11 of the 14 food items, higher consumption frequencies were found for the FFQ. This could be attributable to 'forward telescoping'[17], a term used in cognitive psychology to describe recall of a past event as more recent in time (e.g. consumption of an individual food item two weeks ago may be remembered as having been eaten last week).

However, exact agreement between the two methods is not critical to the ability of the FFQ to rank individuals[21]. For most of the food items we found correlations that could be accepted as fair, considering that in the literature the correlations for most foods and nutrients are in the range of 0.4 to 0.7[29]. The lowest correlations were found for crisps, diet soft drinks, sweets and fruits (0.10–0.34). The overestimation was also highest for these items. We suspect, however, that the validity of these items is underestimated in the present study. Pupils were asked to complete their diary immediately or shortly after eating a

meal or snack. However, the daily visit of the researchers to the classroom proved to be necessary. Many pupils did not follow the instructions and had to complete the diary at that moment, for all meals since the last visit. So, it is not inconceivable that pupils forgot one or more food items. If pupils had forgotten a primary food item that was part of a main meal, such as milk when they had eaten cereals or vegetables when they wrote down rice or potatoes, then the researchers could prompt their attention to this possible deficit. However, this was not the case for items that are mainly or often consumed as a snack, like sweets, crisps and fruit. Another explanation might be that main-course food items are recalled more accurately than secondary foods[10,30–32].

Conclusion

Our results indicate that the HBSC FFQ has sufficient reliability and validity to be useful for ranking subjects according to consumption of the individual food items included. Thus it can be used in multivariate or correlation analyses, although one must consider the overestimation of certain items when the FFQ is used for estimating prevalence of consumption.

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References

1 Centers for Disease Control and Prevention. Guidelines for school health programs to promote lifelong healthy eating. *Journal of School Health* 1997; **67**: 9–26.
2 Williams CL, Bollella M, Wynder EL. A new recommendation for dietary fiber in childhood. *Pediatrics* 1995; **96**: 985–8.
3 Kelder SH, Perry CL, Klepp KI, Lytle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *American Journal of Public Health* 1994; **84**: 1121–6.
4 Perks SM, Roemmich JN, Sandow-Pajewski M, Clark PA, Thomas E, Weltman A, *et al*. Alterations in growth and body composition during puberty. IV. Energy intake estimated by the youth–adolescent food-frequency questionnaire: validation by the doubly labeled water method. *American Journal of Clinical Nutrition* 2000; **72**: 1455–60.
5 Hammond J, Nelson M, Chinn S, Rona RJ. Validation of a food frequency questionnaire for assessing dietary intake in a study of coronary heart disease risk factors in children. *European Journal of Clinical Nutrition* 1993; **47**: 242–50.
6 Currie C. *Health Behaviour in School-Aged Children: Research Protocol for the 1997–1998 Survey* [online], 1998. Available at http://www.ruhbc.ed.ac.uk/hbsc/.
7 Buzzard IM, Faucett CL, Jeffery RW, McBane L, McGovern P, Baxter JS, *et al*. Monitoring dietary change in a low-fat diet intervention study: advantages of using 24-hour dietary recalls vs food records. *Journal of the American Dietetic Association* 1996; **96**: 574–9.
8 Rockett HR, Colditz GA. Assessing diets of children and adolescents. *American Journal of Clinical Nutrition* 1997; **65**: 1116S–22S.
9 Baranowski T, Domel SB. A cognitive model of children's reporting of food intake. *American Journal of Clinical Nutrition* 1994; **95**: S212–17.
10 Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proceedings of the Nutrition Society* 2000; **59**: 279–93.
11 *Health Behaviour in School-Aged Children: a WHO Cross-National Study. Research Protocol for the 2001–2002 survey*. Edinburgh: University of Edinburgh, 2002.
12 Willett W. *Nutritional Epidemiology*, 2nd ed. New York: Oxford University Press, 1998.
13 Vereecken C. Paper pencil versus pc administered querying of a study on health behaviour in school-aged children. *Archives of Public Health* 2001; **59**: 43–61.
14 Kramer MS, Feinstein AR. Clinical biostatistics. LIV. The biostatistics of concordance. *Clinical Pharmacology and Therapeutics* 1981; **29**: 111–23 [published erratum appears in *Clinical Pharmacology and Therapeutics* 1989; **46**(3): 309].
15 Block G. A review of validations of dietary assessment methods. *American Journal of Epidemiology* 1982; **115**: 492–505.
16 Serdula MK, Alexander MP, Scanlon KS, Bowman BA. What are preschool children eating? A review of dietary assessment. *Annual Review of Nutrition* 2001; **21**: 475–98.
17 Kristal AR, Abrams BF, Thornquist MD, Disogra L, Croyle RT, Shattuck AL, *et al*. Development and validation of a food use checklist for evaluation of community nutrition interventions. *American Journal of Public Health* 1990; **80**: 1318–22.
18 Smith KW, Hoelscher DM, Lytle LA, Dwyer JT, Nicklas TA, Zive MM, *et al*. Reliability and validity of the Child and Adolescent Trial for Cardiovascular Health (CATCH) Food Checklist: a self-report instrument to measure fat and sodium intake by middle school students. *Journal of the American Dietetic Association* 2001; **101**: 635–42, 647.
19 Koehler KM, Cunningham-Sabo L, Lambert LC, McCalman R, Skipper BJ, Davis SM. Assessing food selection in a health promotion program: validation of a brief instrument for American Indian children in the southwest United States. *Journal of the American Dietetic Association* 2000; **100**: 205–11.
20 Mcpherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: validity and reliability. *Preventive Medicine* 2000; **31**: S11–33.
21 Ling AM, Horwath C, Parnell W. Validation of a short food frequency questionnaire to assess consumption of cereal foods, fruit and vegetables in Chinese Singaporeans. *European Journal of Clinical Nutrition* 1998; **52**: 557–64.
22 Edmunds H, Hill AJ. Dieting and the family context of eating in young adolescent children. *International Journal of Eating Disorders* 1999; **25**: 435–40.
23 Frank GC, Nicklas TA, Webber LS, Major C, Miller JF, Berenson GS. A food frequency questionnaire for adolescents: defining eating patterns. *Journal of the American Dietetic Association* 1992; **92**: 313–8.
24 Speck BJ, Bradley CB, Harrell JS, Belyea MJ. A food frequency questionnaire for youth: psychometric analysis and summary of eating habits in adolescents. *Journal of Adolescent Health* 2001; **28**: 16–25.
25 Rockett HR, Wolf AM, Colditz GA. Development and

reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *Journal of the American Dietetic Association* 1995; **95**: 336–40.
26 Buzzard IM, Stanton CA, Figueiredo M, Fries EA, Nicholson R, Hogan CJ, *et al*. Development and reproducibility of a brief food frequency questionnaire for assessing the fat, fiber, and fruit and vegetable intakes of rural adolescents. *Journal of the American Dietetic Association* 2001; **101**: 1438–46.
27 Baranowski T, Smith M, Baranowski J, Wang DT, Doyle C, Lin LS, *et al*. Low validity of a seven-item fruit and vegetable food frequency questionnaire among third-grade students. *Journal of the American Dietetic Association* 1997; **97**: 66–8.
28 Domel SB, Baranowski T, Davis H, Leonard SB, Riley P, Baranowski J. Fruit and vegetable food frequencies by fourth and fifth grade students: validity and reliability. *Journal of the American College of Nutrition* 1994; **13**: 33–9.
29 Thompson FE, Byers T. Dietary assessment resource manual. *Journal of Nutrition* 1994; **124**: 2245S–317.
30 Basch CE, Shea S, Arliss R, Contento IR, Rips J, Gutin B, *et al*. Validation of mothers' reports of dietary intake by four to seven year-old children. *American Journal of Public Health* 1990; **80**: 1314–7.
31 Reynolds LA, Johnson SB, Silverstein J. Assessing daily diabetes management by 24-hour recall interview: the validity of children's reports. *Journal of Pediatric Psychology* 1990; **15**: 493–509.
32 Samuelson G. An epidemiological study of child health and nutrition in a northern Swedish county. II. Methodological study of the recall technique. *Nutrition and Metabolism* 1970; **12**: 321–40.

Appendix – Example items from the 7-day food diary

Evening meal		
Product group	Product	Amount
Beverages Water, whole-fat milk, semi-skimmed milk, fristi, chocolate milk, orange juice, soft drinks…		
Bread Brown, white, toast, rusks, cracker, sandwich…		
Sandwich filling Cheese, jam, chocolate spread, pâté, butter…		
Soup and/or starter…		
Potatoes Potatoes, chips, rice, pasta…		
Vegetables and/or compote…		
Meat/fish/egg…		
Dessert Apple, pear, porridge, ice…		
Remainder Jus, mayonnaise, vegetarian products…		
Evening and night		
Product group	Product	Amount
Beverages Water, whole-fat milk, semi-skimmed milk, fristi, chocolate milk, orange juice, soft drinks…		
Remainder Yoghurt, porridge, fruit, cookies, sweets, pastry, bread…		