

Reproducibility of two, three, four and five 24-hour recalls in peri-urban African adolescents in the North West province

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Keywords: adolescents, dietary assessment, reproducibility, 24-hour recalls, North West, peri-urban

Abstract

Background: The objective was to determine the reproducibility of two, three, four and five repeated 24-hour recalls among peri-urban African adolescents.

Method: A prospective study design was used within the multidisciplinary Physical Activity in the Young (PLAY) study. Eighty-seven Grade 9 learners (59 girls and 28 boys, aged 10-18 years) with a mean age of 14.7 ± 1.5 years, who had completed five 24-hour recalls, were investigated. The learners were from Seiphemelo Secondary School in Ikageng, a peri-urban area in the North West province of South Africa. Reproducibility coefficients (RCs) and 95% confidence intervals (CIs) were calculated, using the intraclass correlation coefficient formula for transformed values of selected nutrients and food groups, for two, three, four and five repeated 24-hour recalls. The RCs and 95% CIs were compared in order to identify the optimum number of 24-hour recalls to give the best reproducibility results.

Results: The RCs were nutrient- and food-group sensitive and ranged from 0.25 (riboflavin) to 0.6 (carbohydrate). Although differences were not statistically significant, RCs for four and five 24-hour recalls were higher than those obtained for two and three 24-hour recalls. For most nutrients and food groups, four 24-hour recalls gave the highest RCs, with non-significant differences overall between the four and five 24-hour recalls.

Conclusion: The results suggest that four 24-hour recalls would be sufficient to provide acceptable reproducibility of reported food group and nutrient intakes among peri-urban African adolescents.

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S Afr J Clin Nutr 2012;25(1):27-32

Introduction

Dietary intake is possibly the most challenging component of nutritional assessment to determine accurately.¹ The anthropometric, biochemical, and clinical components of nutritional assessment are measured by objective, verifiable and standardised techniques.² However, the assessment of dietary intake relies on the study of participants' ability to accurately record or recall food consumption, describe food characteristics and preparation methods, measure or estimate food portion sizes, and estimate time and frequency of consumption.² Furthermore, there are a number of dietary assessment (DA) methods, each of which varies in its implementation, depending on the aims, target population, and sample size of the study, and the investigators' preferences.¹

Lack of motivation, memory lapses, boredom, and preoccupation with body weight, build and image, may affect the ability of children to report dietary intake accurately.^{3,4} Similar factors could be expected to affect the ability of adolescents to report dietary

intakes. Additional systematic errors, which affect the quality of dietary data, may include underreporting intakes of foods such as alcohol and snacks, incorrectly estimating portion sizes, purposefully misreporting facts, and failing to mention the use of micronutrient, or other supplements.⁵ Furthermore, bias may be introduced by interviewers due to poor interviewing and recording techniques.⁵ Reported intakes may also be influenced by the desire to give socially acceptable responses.^{4,6} Therefore, it is essential that a DA method for use among adolescents takes these difficulties into account. In addition, there is little indication in the literature as to the most suitable DA method to use among adolescents.

Since the 24-hour recall method is quick to administer, does not require a high level of literacy, has a relatively low respondent burden and administration costs, and may provide more accurate estimates of absolute (actual) nutrient intake for recalled days, it has been suggested that it is the most suitable method for DA among adolescents.⁷⁻⁹ However, this method relies on memory, and the participants' subjective perception of, and ability to, report, their

food consumption. It is well recognised that a single 24-hour recall is inadequate if the aim of the study is to report on usual intakes of the study population. Multiple, or repeated, 24-hour recalls, are needed, to estimate usual nutrient intakes.^{2,8,10} However, there is little indication of the number of recalls needed to provide reproducible dietary intake information, especially among adolescents. The reported number of days of recall among adolescents varies from two, to a calculated possible number of 30.^{11,12}

While there is a considerable body of published work on DA methodology from developed countries, a recent literature review found only one published South African study that addressed the reproducibility of the multiple 24-hour recall method for collecting adolescent dietary intake data.^{6,8,11,13} While the literature suggests that multiple 24-hour recalls give the most accurate measure for adolescent dietary intake, there is little evidence as to whether or not this is true for an adolescent population in a peri-urban area in South Africa.¹⁰

The aim of this study was to determine the reproducibility of two, three, four and five, 24-hour recalls, among peri-urban African adolescents in the North West province.

Method

Study design, subjects, setting and ethics

This prospective study was nested in the multidisciplinary Physical Activity in the Young (PLAY) study, and investigated the dietary intakes of peri-urban African adolescents.¹⁴ A convenience sample of 87 (59 girls and 28 boys) Grade 9 learners (mean age 14.7 ± 1.5 years) attending a secondary school in an informal settlement in the North West province, who had completed all of five 24-hour recalls, was included in the study.

Measurements were taken over three seasons (seven months) on non-consecutive days in March (autumn), May, June (winter), August and September (spring) 2004.

Permission to conduct this study was obtained from the school principal. The parents or guardians and participants were informed of all aspects of the study. Parents and guardians were required to complete and sign an informed consent form, while participants agreed to take part in the study. The study was conducted under free-living conditions, and the participants were requested to maintain their normal daily routine (eating pattern and physical activity level) for the study duration. The PLAY study was approved by the North-West University ethics committee (ethics number 04M01), and funded by the National Research Foundation of South Africa.

Dietary assessment

Dietary intakes were assessed by 24-hour recall interviews (multiple pass method) on each data collection occasion (March, May, June, August and September 2004).⁵ Interviews were conducted by two trained and experienced interviewers, and supervised by a registered dietician. Participants recalled their food and beverage intake over the previous 24 hours (midnight to midnight, starting with the first food or beverage consumed on waking). Prompting was used to identify foods not mentioned, and to obtain detailed

information on preparation methods, brand names, and portion sizes. In the final pass of the recall, the information was checked with the interviewee, and any missing or incorrectly recorded information, corrected. Portion sizes were estimated using a food portion photograph book validated among Africans in the North West province (age range 15-60 years, mean 36 ± 16.5 years).¹⁵ Due to the multidisciplinary nature of the study, it was impossible to match a specific interviewer to a specific participant on each DA occasion. To ensure standardisation of interview and recording techniques, interview procedures were reviewed before each DA occasion. All 24-hour recalls were scrutinised on completion for visible errors, such as omissions of preparation methods and portion sizes, after which errors were discussed with both interviewers and participants, and corrections were made immediately.

Dietary data analysis

The 24-hour recall data were computerised and analysed using the FoodFinder3[®] programme.¹⁶ In cases of composite dishes, the most similar food items listed in the FoodFinder3[®] programme were used.¹⁶ The accuracy of food item and portion size data captured for all assessments was verified by comparison to the original recall data, and inconsistencies were corrected immediately. Analysed data were exported to Excel spreadsheets, where energy, macronutrients (carbohydrate, fat and protein), minerals [calcium (Ca), iron (Fe) and zinc (Zn)], and vitamins (A, C, B₁₂, B₆, folate, thiamin, riboflavin and niacin), were extracted prior to statistical analysis.¹⁷ These minerals and vitamins were selected based on the fact that they play an important role, and because there is an increased demand for them during adolescence.¹⁸

Food items were classified into food groups (maize meal, bread, cereal, milk and milk products, meat, fruit and vegetables, and sweets) using the classification of the FoodFinder3[®] programme, but modified for the present study (see Table 1). Existing data within the study area have shown maize meal porridge and bread to be the staple foods.¹⁹

The mean percentage contribution of energy, total carbohydrate, protein, fat and micronutrient (Ca, Fe, Zn, vitamin A, C, B₁₂ and B₆, thiamin, riboflavin, niacin and folate) intakes provided by each food group at each DA measurement was calculated.

Statistical analyses

The reproducibility of four sets of multiple 24-hour recalls was investigated (two, three, four, and five DAs per set). The Box-Cox transformation was used to obtain normality of both the nutrient and food group data, using Statistica.^{20,21} A two-way analysis of variance with participants and dietary assessment occasions as factors, was used to obtain the between-subjects mean square, the between-assessments mean square and the residual mean square.

The intraclass correlation coefficients (ICC) for a single measurement for each selected nutrient and food group were then estimated using the formula of Shrout and Fleiss (case 2).²²

$$ICC(1) = \frac{BMS - RMS}{BMS + (k - 1)RMS + k(AMS - RMS) / n}$$

where *k* is the number of assessments, and *n* is the number of participants.

Both participant and assessment effects were regarded as random, i.e. the participants were viewed as a random sample, while the five assessments were assumed to be randomly obtained from many possible assessments.

When dealing with the mean of *k* assessments, the reliability coefficient [presented in this study as reproducibility coefficient (RC)] can be obtained by means of the Spearman-Brown formula:²²

$$ICC(k) = \frac{k ICC(1)}{1 + (k - 1) ICC(1)}$$

Assuming normality of the data of participants' assessment and residuals, Shrout and Fleiss (equation 7) $(1 - \alpha)$ indicate 100 % confidence interval (CI) for ICC.²²

The single measurement ICC [ICC (1)] was then used to calculate the ICC (k) for each of the selected nutrients, and food groups obtained from the following data sets:

- Five 24-hour recall measurements per participant (435 recalls)
- Four 24-hour recalls per participant obtained by randomly discarding one of the five Das (348 recalls)
- Three 24-hour recalls per participant obtained by randomly discarding two of the five Das (261 recalls)

Table I: Classification of food items into the food groups used for food intake analyses

Food group	Food items representing the food group
Maize meal	Maize meal porridge
Bread	Bread, dumplings ^a and vetkoek ^b
Cereal	Rice, sorghum porridge, oats porridge, any type of breakfast cereal, maize, rice and pasta
Milk and milk products	Fresh, powdered, ultra-high temperature-treated and sour milk, yoghurt and cheese
Meat	Red meat, pork, entrails, chicken, fish, processed meat and eggs
Fruit and vegetables	Any type of fruit and fruit juice, sweet potatoes, potatoes and vegetables
Sugar, sweets and crisps	Added sugar, cold drinks, sweets, chocolate, cookies, cakes and crisps
Miscellaneous ^c	Legumes, nuts, margarine, butter, salad dressing, sauces, condiments and non-nutritive beverages

a = steamed bread, b = similar to doughnuts without the sugar or other coatings, c = food groups that contributed less than a mean of 5% of total energy intake over the five recall periods were combined into the miscellaneous group

- Two 24-hour recalls per participant obtained by randomly discarding three Das (174 recalls).

The SAS statistical computer package was used for the analyses.²³

Results

Food groups intake

Table 1 shows the classification of food items into the food groups used for the analysis of food intake data.

Table II: Mean (± 95% CI) percentage contribution of the food groups to selected nutrients of the 24-hour recall

Description	Maize meal ¹			Bread ¹			Cereal			Milk & milk product			Meat			Fruit & vegetables			Sugar and sweets			Miscellaneous		
	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI	Mean	- 95% CI	+ 95% CI
Energy	19.7	18	21.4	23.4	21.7	25	20	18.7	22.5	2.4	1.95	2.9	2	1.5	2.5	0.4	0.2	0.7	8.4 [*]	7.4	8.1	1.6	1.0	2.1
Carbohydrate	27.2	25	29.4	29	27	31	21.9	20	23.8	1.9	1.7	2.2	0.6	0.5	0.7	4.7	3.8	5.8	13.1 [*]	11.8	14.5	2	1.3	2.6
Protein	14.2	12.8	15.4	25.6	23.7	27.5	13.3	11.9	14.7	5.7	4.9	6.4	37.9	36	39.8	2.0	1.6	2.5	-	-	-	1.1	0.5	1.9
Fat	-	-	-	7.4	6.6	8.2	23.3	20.9	25.7	7.3	6.3	8.3	30.5	28.4	32.6	3.5	2.8	4.4	-	-	-	20	18	22
Calcium	-	-	-	36.6	33.5	39.6	14.3	12.7	15.9	28.7	25.5	31.9	9.4	8.2	10.6	5.4	4.6	8.0	-	-	-	1.7	0.9	1.3
Iron	11.9	10.5	13.3	31	28.7	33.3	21.2	19.1	23.3	1	0.8	1.2	23.9	22.2	25.7	5.1	4.1	6.8	-	-	-	1	0.4	1.6
Zinc	13	11.5	14.5	28.4	26.3	30.6	11.8	10.3	13	5.5	4.7	6.4	35.6	33.4	37.7	22.8	1.2	2.6	-	-	-	1.2	0.9	2.0
Vitamin B ₁₂	-	-	-	-	-	-	-	-	-	23	19	27	65	60	68				-	-	-			
Vitamin B ₆	8	5	9	-	-	-	26	24	28	4.5	3.7	5	30	27	32	10	8	12	-	-	-	0.4	0.2	0.7
Vitamin C	-	-	-	-	-	-	12.3	9.8	14.9	13.6	10.8	16.4	12.6	10	15.1	42.9	35.3	30.3	-	-	-	0.3	-0.2	0.7
Vitamin A	-	-	-	0.05	0	0.1	11.9	9.8	14.1	22.2	19.5	24.9	13.4	11.2	15.7	15.4	12.2	18.6	-	-	-	27.8	24.6	31
Folate	11	9	12	54	48	60	12	10.5	14.2	3.5	2.9	4.1	9	8	10	7	5.2	9	-	-	-	0.7	0.2	1.2
Riboflavin	7	6	8	13	11.7	14.4	30	27	33	16.3	14	18	26	24	28	3.6	2.6	4.5	-	-	-	0.2	0.04	0.3
Thiamine	28	26	30	30	26.6	31	18	16	20	2.2	2	2.5	17	15.3	18.1	5.2	4.1	6.5	-	-	-	0.5	0.2	0.9
Niacin	8	6.7	9	26.2	24	28	13	11.7	14.6	0.5	0.4	0.8	44.5	42	47	3.4	2.5	5.5	-	-	-	0.6	0.2	1

¹Nutrient composition of non-fortified maize meal and bread; - Negligible/no contribution by food group to nutrient intake; RC = Reproducibility coefficient; -95% CI = Lower 95% Confidence Limits; + 95%CI = Upper 95% Confidence Limits; ^{*}Difference between mean percentage intake of assessment 1 and assessment 5 significant (p<0.05)

Table III: The mean reproducibility coefficients and 95% confidence intervals of different nutrients and food groups for different numbers of 24-hour recalls (n = 87)

Descriptions	Two 24-h recalls			Three 24-h recalls			Four 24-h recalls			Five 24-h recalls		
	RC	- 95% CI	+ 95% CI	RC	- 95% CI	+ 95% CI	RC	- 95% CI	+ 95% CI	RC	- 95% CI	+ 95% CI
Energy	0.17	-0.21	0.46	0.28	-0.03	0.49	0.54	0.33	0.67	0.54	0.35	0.67
Nutrients												
Carbohydrate	0.15	-0.24	0.45	0.26	-0.05	0.48	0.60	0.40	0.71	0.56	0.37	0.68
Protein	0.04	-0.37	0.37	0.35	0.06	0.55	0.55	0.34	0.68	0.59	0.40	0.70
Fat	0.08	-0.33	0.40	0.13	-0.22	0.39	0.43	0.19	0.59	0.49	0.28	0.63
Calcium	0.38	0.04	0.60	0.28	-0.03	0.49	0.56	0.36	0.69	0.53	0.34	0.66
Iron	-0.03	-0.46	0.33	0.36	0.08	0.56	0.53	0.31	0.66	0.53	0.33	0.66
Zinc	0.18	-0.20	0.46	0.33	0.04	0.53	0.47	0.24	0.62	0.55	0.36	0.68
Vitamin B ₁₂	-0.22	-0.70	0.20	0.22	-0.11	0.45	0.40	0.15	0.57	0.35	0.10	0.53
Vitamin B ₆	0.17	-0.20	0.45	0.44	0.17	0.61	0.59	0.39	0.71	0.58	0.39	0.69
Vitamin C	0.22	-0.15	0.49	0.35	0.07	0.55	0.43	0.19	0.59	0.44	0.21	0.59
Vitamin A	0.42	0.09	0.62	0.32	0.02	0.52	0.52	0.30	0.66	0.52	0.32	0.65
Folate	0.04	-0.37	0.37	0.32	0.02	0.52	0.58	0.37	0.70	0.54	0.34	0.66
Riboflavin	-0.01	-0.44	0.34	0.30	0.00	0.51	0.25	-0.05	0.46	0.31	0.04	0.50
Thiamine	0.27	-0.09	0.52	0.24	-0.08	0.47	0.45	0.22	0.60	0.46	0.24	0.61
Niacin	0.43	0.11	0.62	0.49	0.23	0.64	0.55	0.35	0.68	0.60	0.41	0.71
Food groups												
Maize meal	0.49	0.17	0.67	0.47	0.21	0.63	0.59	0.39	0.71	0.65	0.48	0.75
Bread group	0.26	-0.10	0.52	0.31	0.01	0.52	0.57	0.36	0.69	0.61	0.44	0.72
Cereal group	0.01	-0.40	0.35	0.30	0.00	0.51	0.51	0.29	0.65	0.55	0.35	0.67
Milk group	0.55	0.24	0.70	0.50	0.25	0.65	0.51	0.29	0.65	0.56	0.37	0.68
Meat group	0.13	-0.27	0.43	0.14	-0.21	0.40	0.38	0.12	0.55	0.45	0.23	0.60
Fruit and vegetables	0.06	-0.35	0.39	0.26	-0.05	0.48	0.49	0.27	0.63	0.44	0.21	0.59
Sweets	0.06	-0.36	0.39	0.23	-0.09	0.46	0.50	0.27	0.64	0.40	0.16	0.56

a = reproducibility coefficient; -b = lower 95% confidence limits; c = upper 95% confidence limit

The mean percentage contribution, for the five DA measurements of different food groups to the total intakes of energy and the selected nutrients, is shown in Table II. The only differences in percentage contribution occurred for energy and carbohydrate intakes between DA 1-5 (p-value < 0.05).

Reproducibility of nutrients and food groups

The RCs and 95% CIs of the selected nutrients and food groups are given in Table III. Although there were no significant differences between the RCs of nutrients and food groups derived from two and three 24-hour recalls, as evidenced by the overlapping 95% CI, the

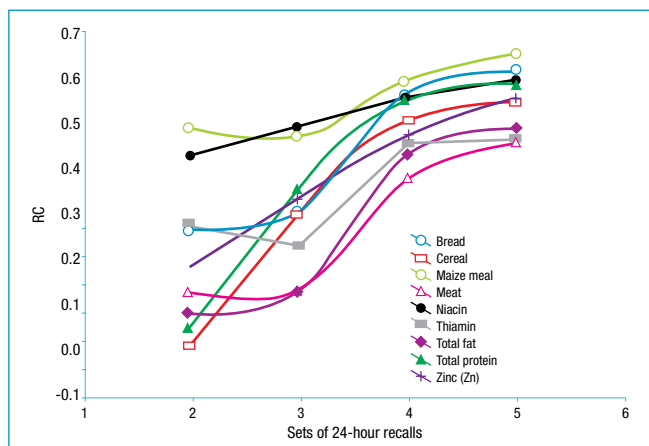


Figure 1: Reproducibility coefficients of food groups (bread, cereal, maize meal and meat), and nutrients (niacin, thiamin, total fat, total protein and zinc), with four different sets of 24-hour recalls

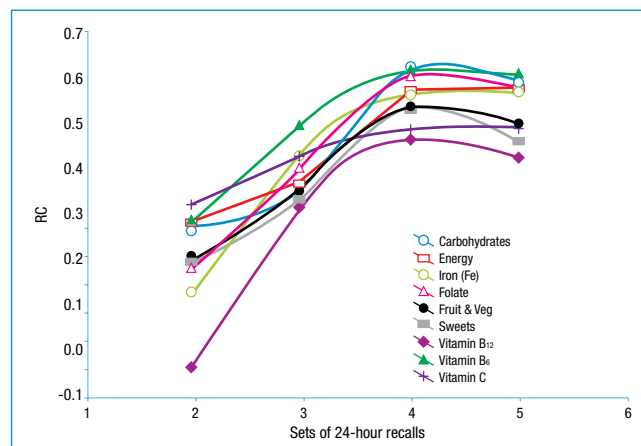


Figure 2: Reproducibility coefficients of specific food groups (fruit and vegetables, and sweets), and nutrients (carbohydrates, iron, folate and vitamins B12, B6 and C), and energy, at four different sets of 24-hour recalls

RCs from four and five 24-hour recalls were higher, and the 95% CIs narrower than those obtained for two and three 24-hour recalls. In addition, little difference was seen between the RCs and 95% CIs of the nutrients and food groups with four, compared to five, 24-hour recalls.

Five of the RCs for nutrients (protein, fat, zinc, thiamin and niacin), and four of the RCs for food groups (maize meal, bread, cereal and meat), showed a trend towards a higher RC from five 24-hour recalls, compared to two, three, and four, 24-hour recalls (see Figure 1).

The RCs for carbohydrates, folate, vitamins B₁₂ and B₆, as well as the sweets and fruit and vegetables groups, showed a tendency towards a higher RC from four 24-hour recalls, compared to two, three, or five, 24-hour recalls (see Figure 2).

Discussion

Although a number of reproducibility studies on 24-hour recalls have been published, relatively more reports have been published on the reproducibility of food frequency questionnaires, dietary histories, and food records. The present study is unique, because to our knowledge, there is a paucity of literature on the reproducibility of more than two 24-hour recalls among African adolescents in the 10-18-year-old age group. Our study indicated that the RCs for four, compared to five, 24-hour recalls of all measured nutrients, were at, or above, 0.43, with the exception of riboflavin and the meat food group. Eight nutrients, and five of the food groups, were similar, or higher, when five 24-hour recalls were used to study the dietary intakes of peri-urban South African adolescents, than when four 24-hour recalls were used. However, the differences between RCs for four and five recalls were small, and the highest mean RC of 0.65 was reported for the maize food group when five 24-hour recalls were taken.

In a previous study among peri-urban black 10-15-year-old South Africans, the reproducibility of 24-hour recalls was also determined.²⁴ The researchers concluded that two 24-hour recalls yielded a satisfactory reproducibility. However, only two nutrients had RCs of > 0.4, and the remaining nutrients had RCs of ≤ 0.3. In the present study, it was also found that most RCs for nutrients and food groups were below 0.4, when two, or three, 24-hour recalls, were used. Since the level of RC considered indicates that acceptable reproducibility is ≥ 0.4, it can be concluded that at least four to five 24-hour recalls are needed for acceptable reproducibility of nutrients and food groups in this specific group of adolescents.²⁵

Various factors that may influence the RC of a food group or nutrient are as follows:

- Whether the food ingested from a food group is a staple to the population studied
- Whether the ingestion of foods in a food group is subjected to seasonal variation
- Whether there is a large degree of variation in the intake of the foods within, and among, subjects.

Other factors that may also influence the RC of a food or nutrient, include the sample size of the study population, and interval between administration of the 24-hour recalls.

A study investigating the reproducibility of self-reported fruit and vegetable intake amongst sixth graders reported a high Spearman correlation coefficient of 0.75 (95% CI of 0.66, 0.82) between two 24-hour recalls for the fruit and vegetable group (excluding fruit juice and potatoes).²⁶ This is a much higher value than the RC of the current study for this food group at two, three, four, and five, 24-hour recalls. Possible explanations for the higher RC include a shorter interval between administrations (14 days vs. our one to two months), larger sample size, and Spearman correlation coefficient not taking into account within- and between-subject variations. Furthermore, fruit and vegetable availability and consumption among the present study's population group were subject to seasonal variation, lower during autumn and winter (May to August), and higher during spring and summer (March and September). Therefore, a lower degree of reproducibility was expected. The high RCs (> 0.6) of the maize meal and bread food groups could be anticipated, as these were the staple foods of the target population, and were consumed at relatively consistent frequencies and portion sizes at all DA occasions.

Reported intakes of vitamin B₆, folate, carbohydrates, and the maize meal group, had the highest RCs (RC ≥ 0.58), while intakes of riboflavin, vitamin B₁₂ and the meat group (RC ≤ 0.4), had the lowest RCs at four 24-hour recalls in this population. As these food groups (maize meal, bread and cereals) were the major contributors to energy and carbohydrate intakes (see Table II), it follows that the RCs for energy and carbohydrate intakes were high (> 0.5). Likewise, the RCs for calcium and the milk group, 0.53 and 0.56 with five 24-hour recalls, respectively, were also high. While the RC for riboflavin might have been expected to mimic that of the milk group, it was considerably lower. This could have been as a result of the large degree of variation in fortified breakfast cereal intake across data for 24-hour recalls (data not shown). The weakest food group RCs were for the fruit and vegetable, and sweets group.

Using a mixed model procedure, Palaniappan et al estimated that while three and five days of recall by adult men and women, respectively, would provide a reported energy intake within 30% of the true usual intake, 30 and 42 days for adult men and women respectively, would be needed to estimate energy intakes within 100% of true intakes.¹² Thus, the accuracy of reported energy intakes seems to increase with an escalating number of recalls. Our results show that the reproducibility of most of the tested nutrients and food groups increased, when four or five repeated 24-hour recalls were used, and that RCs of nutrients and related food groups were similar. In the light of the very similar RCs of four and five recalls for this study's food groups and nutrients, it seems unlikely that further increases to the number of recalls would improve the RCs significantly. Therefore, four 24-hour recalls are more practical and cost-effective, and carry a lower risk of non-compliance due to subject burden.

Conclusion

Four 24-hour recalls are more practical and cost-effective, and carry a lower risk of non-compliance due to subject burden, than five 24-hour recalls. This was also found in a preliminary study to decide the method for the United Kingdom Low Income Diet and Nutrition Survey, in which four repeat 24-hour recalls were recommended as the most appropriate method of dietary assessment in this group.²⁷

Our results indicated that when 24-hour recalls were taken on non-consecutive days spread over seven months, an increase in the number of days of recall improved the RC. However, there was no clear indication as to the number of days required to produce the most reproducible results. The best reproducibility was obtained from four repeated recalls of intakes of energy, carbohydrates, Ca, Fe, folate, vitamin A, C, B₁₂ and B₆, and the fruit and vegetable, and sweets groups. On the other hand, the RCs for five 24-hour recalls for intakes of protein, fat, vitamin C, riboflavin, thiamin and niacin, and five of the seven food groups, showed an improvement from four to five recalls. Furthermore, differences in RCs across all nutrients and food groups for four and five 24-hour recall were small, and none reached statistical significance. The mean portion size of a food, and a consistency in consumption of that food, over four repeated recalls, may also influence reproducibility. Four 24-hour recalls are more cost-effective to administer in a large study, when maintaining a larger sample size is important, and are more practical than five 24-hour recalls. Therefore, our results suggest that four 24-hour recalls would provide an acceptable level of reproducibility when assessing usual intake in peri-urban African adolescents.

Declaration

This study was funded by a grant from the National Research Foundation.

Conflict of interest

The authors declare no conflict of interest.

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