Children's school-breakfast reports and school-lunch reports (in 24-h dietary recalls): conventional and reporting-error-sensitive measures show inconsistent accuracy results for retention interval and breakfast location

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Abstract

Validation-study data were analysed to investigate retention interval (RI) and prompt effects on the accuracy of fourth-grade children's reports of school-breakfast and school-lunch (in 24-h recalls), and the accuracy of school-breakfast reports by breakfast location (classroom; cafeteria). Randomly selected fourth-grade children at ten schools in four districts were observed eating school-provided breakfast and lunch, and were interviewed under one of eight conditions created by crossing two RIs ('short' – prior-24-hour recall obtained in the afternoon and 'long' – previous-day recall obtained in the morning) with four prompts ('forward' – distant to recent, 'meal name' – breakfast, etc., 'open' – no instructions, and 'reverse' – recent to distant). Each condition had sixty children (half were girls). Of 480 children, 355 and 409 reported meals satisfying criteria for reports of school-breakfast and school-lunch, respectively. For breakfast and lunch separately, a conventional measure – report rate – and reporting-error-sensitive measures – correspondence rate and inflation ratio – were calculated for energy per meal-reporting child. Correspondence rate and inflation ratio – but not report rate – showed better accuracy for school-breakfast and school-lunch reports with the short RI than with the long RI; this pattern was not found for some prompts for each sex. Correspondence rate and inflation ratio showed better school-breakfast report accuracy for the classroom than for cafeteria location for each prompt, but report rate showed the opposite. For each RI, correspondence rate and inflation ratio showed better accuracy for lunch than for breakfast, but report rate showed the opposite. When choosing RI and prompts for recalls, researchers and practitioners should select a short RI to maximise accuracy. Recommendations for prompt selections are less clear. As report rates distort validation-study accuracy conclusions, reporting-error-sensitive measures are recommended.

Key words: **Children: Schools: Breakfast: Lunch: Dietary recalls**

School-provided meals are a major source of food for children in the USA. The average daily participation during the fiscal year 2014 was 13·5 million children for school breakfast and 30·3 million children for school lunch[1]. On a given day, 18% of children attending public schools participated in school breakfast, and 62% participated in school lunch[2]. Child nutrition interventions often target schools[3–8], and dietary recalls have been used to assess intake of children in upper elementary grades[9–16]. Of the dietary recall, food diary and FFQ, the dietary recall may be more appropriate for obtaining dietary intake information from elementary-school children as it can be administered without advance notice, and is thus unlikely to alter intake[17], is less burdensome than the food diary[17] and does not require certain cognitive skills (i.e. averaging consumption) required by a FFQ[18–20]. Nevertheless, validation studies show that children's dietary recalls can be substantially inaccurate[21–25]. Thus, it is important to investigate methods to improve children's recall accuracy, and to identify conditions in which children's recall accuracy is maximised.

For a 24-h dietary recall (24hDR), a respondent is to report all foods and drinks consumed during a 24-h period; the recall may be obtained in person, by telephone or by automated self-administration[26]. Prominent 24hDRs are multiple-pass procedures, with several passes to elicit reports of different aspects of intake for the target 24 h. The United States Department of Agriculture originally developed the multiple-pass 24hDR

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method[27]. In passes one through five, respectively, a respondent lists all foods consumed in a 24-h period; an interviewer elicits additional recall by asking about nine categories of foods that are often forgotten; the interviewer collects the time at which each food was eaten and the name of the eating occasion; in chronological order by eating occasion, the interviewer collects details of, and additions to, each food, amount eaten, source (e.g. restaurant or store), and whether it was eaten at home, and then reviews each eating occasion and interval between occasions to elicit additional recall; and the interviewer provides a final opportunity to recall foods[27].

There are various ways to specify the target 24 h for a 24hDR (e.g. prior 24 h (immediately before the interview), or previous day (midnight to midnight of the day before the interview)). For any such specification, a 24hDR may occur at any time of the day (e.g. morning, afternoon or evening). Choices of target period and interview time determine the elapsed time between the to-be-reported meals and interview, referred to as retention interval (RI). Studies with children in the USA (Georgia and South Carolina) and Wales have shown that dietary recall accuracy decreases as the RI increases[28–34].

In addition to RI, any 24hDR has prompts – questions asked in the first pass of a multiple-pass 24hDR to elicit a respondent's report. As examples, a respondent may be prompted to report intake for the target period in forward order (beginning to end), in reverse order (end to beginning), by meal name (e.g. breakfast, lunch, etc.) or with open prompts (no specific instructions). Prompts may influence recall accuracy, but few validation studies have examined this relationship[25,35]. For a recent validation study[36], we examined the effects of prompts on children's dietary recall accuracy for school meals, and assessed whether and how the effects of prompts depended on RI.

Dietary recall procedures ask where reported meals were eaten, and recall accuracy is plausibly related to eating location, or variability of eating locations. Our validation study conducted in schools permits investigation of the role of meal location in recall accuracy. In some schools, breakfast is provided and consumed in classrooms; in other schools, breakfast is provided and consumed in the school cafeteria. Children's breakfast accuracy may be better for classroom than for cafeteria breakfast because location cues could help discriminate classroom breakfast from lunch, located in the cafeteria.

Dietary recall accuracy in validation studies has usually been assessed by transforming reference (e.g. observed) and reported sets of foods to energy and/or nutrients and comparing these[37]. Using this 'conventional' approach, reported items are transformed into energy and/or nutrients without regard to whether those items were actually eaten, or determining the amount of each reported item that was actually eaten. Conventional 'accuracy' is measured by report rate – the ratio of reported kilocalories to reference kilocalories – with report rates about 100 % interpreted as accurate. However, reported kilocalories include not only kilocalories from items reported eaten that were eaten, but also kilocalories from over-reported amounts of items eaten, and kilocalories from items not eaten. We used these three categories of reported kilocalories, along with reference kilocalories, to calculate two 'reporting-error-sensitive'

measures – correspondence rate and inflation ratio[37]. Correspondence rate quantifies the match between kilocalories from items reported and kilocalories observed eaten; inflation ratio quantifies over-reporting relative to what was observed eaten. (For any analysed meal, the sum of the correspondence rate and the inflation ratio is the report rate.)

Most publications about validation studies that have used direct observations of school breakfast and school lunch to examine children's dietary recall accuracy have provided results for the two meals combined, as we did for our recently completed study of the effects of prompts on children's dietary recall accuracy, and whether and how prompts' effects depended on RI[36]. However, examining accuracy for individual meals can be informative, revealing, for example, particular ways in which reports of different meals differ systematically. In this article, we used data from that study to investigate factors that influence reports of school breakfast and of school lunch, and also compared the pictures of recall accuracy provided by conventional and error-sensitive measures. Our first goal for this article was to examine separately the relationship of accuracy of children's school-breakfast reports and school-lunch reports in 24hDRs to the variables manipulated in the study. Our second goal was to compare the accuracy of reports for school breakfast located in the classroom and in the cafeteria.

Methods

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the University of South Carolina human subjects review board. Written informed parental consent and child assent were obtained from all subjects. The sample size estimation, sample and data collection methods have been described in detail elsewhere[36], and thus only a summary is provided here.

Sample size

Power calculations were based on the methodologies of Neter *et al.*[38] and Winer[39]. The required sample sizes were estimated by using rates for omissions (items observed eaten but not reported eaten) and intrusions (items reported eaten but not observed eaten) from school-meal reports in fourth-grade children's 24hDRs in past studies[25,28,32]. Assuming $\alpha = 0.025$, we determined that a total of 480 children, with thirty children in each of sixteen cells (two RIs × four prompts × two sexes), were required to detect main effects, two-way interactions and the three-way interaction with power of at least 0·77 for even the smallest effect size of interest.

Sample

Data were collected on fourth-grade children during three school years (2011–2012, 2012–2013 and 2013–2014). Children were from all regular fourth-grade classes from a total of ten public schools from four school districts. At these schools, for

the three respective school years, the percentage of children eligible for free or reduced-price school meals ranged from 69 to 85, 58 to 90 and 59 to 90 %. Of 569, 782 and 429 children invited to participate for the three respective school years, 407 (71·5 %), 521 (66·6 %) and 280 (65·3 %) agreed. Each school year, distributions of race/ethnicity and sex of the children who agreed to participate were similar to those of children invited. For the three respective school years, data were collected in six, ten and five schools (twenty-six, thirty-eight and twenty-one classes).

Each district had implemented offer v. serve food service, and thus at each school, of the meal components available at each meal, children could refuse one at breakfast, and one or two at lunch, but had to select a fruit or vegetable at each meal[40]. A standard breakfast included fruit, grains and milk, whereas a standard lunch included meat or alternate, grains, fruit, vegetable and milk[40]; children had a choice of food items (e.g. fruit, juice, milk flavour, vegetable, entrée) at most meals. In the 3 consecutive years, breakfast was located in the classroom for all classes at two, two and two schools, respectively, and in the cafeteria for all classes at four, seven and three schools, respectively. For one school during the 2012–2013 school year, breakfast was in the cafeteria for all classes but one; some children in that class ate breakfast in the cafeteria, whereas others ate in the classroom. Breakfast locations were designated by school principals and were constant throughout a school year. For the three respective school years of data collection, at the schools in the study where breakfast was located in the cafeteria, the percentage of children eligible for free or reduced-price school meals ranged from 69 to 85, 58 to 90 and 71 to 90 %; at the schools in the study where breakfast was located in the classroom, the respective values ranged from 74 to 81, 60 to 82 and 59 to 82 %. Lunch was located in the cafeteria for all classes at all schools for all school years. Participation in breakfast, regardless of location, and participation in lunch, were optional for each child at each school. Research has shown that participation in school breakfast is related to location, with higher participation rates for classroom than for cafeteria breakfast[41,42].

Data were collected until 480 children, randomly selected from the pool of consented children each school year with the constraint that half were girls, were observed eating school-provided breakfast and lunch (with both meals observed on the same day for any child), with sixty (half were girls) interviewed to obtain a 24hDR in each of the eight protocol conditions formed by crossing two RIs ('short' – prior-24-h recall obtained in the afternoon and 'long' – previous-day recall obtained in the morning) with four prompts (forward, meal name, open and reverse). Within school year and school, assignment to condition (by sex) was balanced across classes as much as possible.

Direct meal observations

Research staff observed children eating school breakfast and school lunch according to a standard protocol. One of three observers watched one to three children simultaneously, and, on a paper form, noted items and amounts eaten in servings of standard school meal portions. Observers were present during the entire meal period so that any food trades could be noted[23,43]. For breakfast located in the classroom, children ate at their desks. For breakfast and lunch in the cafeteria, children sat according to the school's typical arrangement. Interobserver reliability was assessed before and throughout data collection each school year; mean agreement between observers to within one-fourth of a serving on amounts eaten was ≥97 %, which is considered excellent[44,45].

Dietary recall interviews

To obtain 24hDRs, one of four research staff interviewed children (without parental assistance) in person in private at school during the school day, using the protocol for the condition to which the child had been assigned. All interviews were conducted on Tuesdays through Fridays. Interviews concerning the previous day (long RI) were conducted after breakfast, and interviews concerning the prior 24 h (short RI) were conducted after lunch. (Thus, each long RI interview occurred approximately 25 h after the target breakfast and 21 h after the target lunch, with a non-target breakfast intervening between the end of the target period and the interview. Each short RI interview occurred approximately 5 h after the target breakfast and 1 h after the target lunch, with no intervening, non-target meals before the interview.) For prior-24-h-afternoon interviews, children were asked to report intake first for the interview day, and then for the previous day beginning 24 h before the interview start time. This approach, proposed by Buzzard[46], has been used previously with children[28–32]. For each child, different researchers observed meals and conducted the interview.

Training for interviewers included modelling, practice and assessment of pre-data-collection quality control for interviews. Children reported amounts eaten in qualitative terms (e.g. little bit, half, most), and interviewers wrote information reported by children on paper forms. Interviews were audio-recorded and transcribed. Each interviewed child was mailed a $10 cheque. For each interview, quality control was assessed using established procedures[25,28–30,32,47,48] to ascertain that the interviewer adhered to the protocol; only interviews that passed quality control were analysed.

Analyses

Analyses were limited to school meals in 24hDRs because only those meals were validated using direct meal observation by research staff. As in past studies[22,25,28–30,32,47], for a meal reported in a 24hDR to be counted as a school meal, the child had to refer to breakfast as 'breakfast' or 'school breakfast' and to lunch as 'lunch' or 'school lunch', the reported location had to be 'school', and the reported mealtime had to be within 1 h of the observed mealtime.

To quantify recall accuracy, for each child, for each school meal reported, an established system[22,25,28–30,32,47] was used to compare the set of food items and amounts reported eaten with the set of food items and amounts observed eaten. Each food item was classified as a match (item observed eaten and reported eaten), an omission (item observed eaten but not

reported eaten) or an intrusion (item reported eaten but not observed eaten)[49,50].

Amounts eaten were observed, reported and scored in servings of standard school meal portions as none = 0·00, taste = 0·10, little bit = 0·25, half = 0·50, most = 0·75, all = 1·00 or the actual number of servings if >1·00 serving was observed and/or reported eaten. Information on energy (in kilocalories) for each observed and/or reported item was obtained from the University of Minnesota's Nutrition Coordinating Center Food and Nutrient Database[51]. For observed and reported items for each meal for each child, quantified servings were multiplied by per-serving kilocalories.

For breakfast and lunch separately, a conventional energy measure – report rate – was calculated. Report rate is the reported percentage of the observed energy; it was calculated for each child as (total reported kilocalories/total observed kilocalories) × 100. A report rate of 0 % indicates that nothing was reported eaten at a school meal. Report rate has no maximum value, because there is no limit on what a person can report. Traditional interpretation of report rate is that values close to 100 % indicate high accuracy, values >100 % indicate over-reporting and values <100 % indicate under-reporting[24,52,53].

Also, for breakfast and lunch separately, two reporting-error-sensitive energy measures – correspondence rate and inflation ratio – were calculated[37,54–56]. Correspondence rate is the percentage of the observed kilocalories that are reported correctly; it was calculated for each child as (sum of corresponding kilocalories from matches/sum of observed kilocalories) × 100. Corresponding kilocalories from a match are the smaller of the reported kilocalories and the observed kilocalories. A correspondence rate is between 0 %, which indicates that no items observed eaten were reported eaten, and 100 %, which indicates that all items observed eaten were reported eaten, and that all amounts reported eaten were at least as large as amounts observed eaten. Higher correspondence rates indicate better accuracy.

Inflation ratio, a measure of reporting error, indicates the extent to which over-reported kilocalories augment correctly reported kilocalories; it was calculated for each child as (((over-reported kilocalories from matches) + (kilocalories from intrusions))/(total observed kilocalories))) × 100. An inflation ratio of 0 % indicates that there were no intrusions and that no amounts of matches were over-reported. Inflation ratio has no maximum value because there is no limit on what a person can report. Smaller inflation ratios indicate better accuracy. For any child for any meal, correspondence rate and inflation ratio sum to report rate.

Data were pooled over three school years for analyses. For each meal, we used χ^2 tests of homogeneity to investigate whether the proportions of children reporting meals that satisfied criteria (to be reports of school meals) varied over levels of RI, prompt, sex and breakfast location.

For breakfast, for report rate as well as for correspondence rate and for square-root-transformed inflation ratio, we used a linear model to ascertain main effects of RI, prompt, sex and breakfast location, their two-way interactions, and the three-way interaction of RI, prompt and sex. For lunch, except for

breakfast location, linear models were identical. Control variables were race/ethnicity, school year and district. The transformation of inflation ratio was to help satisfy the normality assumption.

For these linear models, we used generalised estimating equation methodology to account for possible correlation in response values within the same interviewer; an exchangeable correlation structure was assumed. For all models, analysis of residuals was used to check assumptions of constant error variance and normality of errors. We used simultaneous Wald's tests to jointly test for factor effects in each model, and the Benjamini–Hochberg procedure[57] to adjust for simultaneous tests on multiple factors and in multiple models, controlling the false discovery rate at 0·05. All *P* values reported are adjusted. Statistical analyses used SAS/STAT® (9.4© 2002–2012; SAS Institute Inc.).

Results

The 480 children interviewed were 54 % African American, 31 % white, 10 % Hispanic and 5 % other; their mean age was 10 years and 1 month. Of these children, 245 ate school breakfast in cafeterias and 235 ate school breakfast in their classrooms.

Reporting meals that satisfied criteria to be reports of school meals

A total of 125 children reported no meal that met the criteria to be a report of school breakfast; seventy-one children reported no meal that met the criteria to be a report of school lunch. (In all, twenty-five children are common to these two sets.) We call these children 'non-reporters' (for these meals); we call children whose reports satisfied criteria to be reports of school meals 'reporters'.

Table 1 shows, for each meal, the distribution of meal non-reporters by RI, prompt, sex and breakfast location. A larger proportion of non-reporters than reporters were in the long RI than in the short RI; this was marginally significant for breakfast ($\chi^2 = 3\cdot13$, $P = 0\cdot08$) and significant for lunch ($\chi^2 = 8\cdot75$, $P = 0\cdot003$). For breakfast, a higher proportion of reporters than non-reporters had forward and meal prompts than open and reverse prompts ($\chi^2 = 7\cdot99$, $P = 0\cdot046$). For lunch, meal-reporting status was not associated with prompt ($\chi^2 = 2\cdot96$, $P = 0\cdot40$). Meal-reporting status was not associated with sex (breakfast $\chi^2 = 0\cdot27$, $P = 0\cdot60$; lunch $\chi^2 = 1\cdot34$, $P = 0\cdot25$). For breakfast, meal-reporting status was not associated with breakfast location ($\chi^2 = 0\cdot06$, $P = 0\cdot80$).

Of the 125 school-breakfast non-reporters, (a) forty-two children (34 %) failed to report any breakfast, (b) twenty-four children (19 %) failed to report 'school' as the breakfast location (with twenty-two of twenty-four reporting 'home' as the breakfast location), (c) twenty-six children (21 %) failed to report the school-breakfast mealtime within 1 h of the observed mealtime and (d) thirty-three children (26 %) failed to report 'school' as the breakfast location *and* failed to report the school-breakfast mealtime within 1 h of the observed mealtime (with six of thirty-three reporting >1 breakfast). Of the seventy-one

Table 1. Number of children who did not report any meal to satisfy criterion to be considered school breakfast (n 125) or school lunch (n 71) for eight conditions created by crossing two retention intervals (RI) with four prompts from a validation study with 480 fourth-grade children

	Forward prompts	Meal name prompts	Open prompts	Reverse prompts	Total (n)
Breakfast					
Short RI					
Girls	8	7	7	7	29
Boys	4	5	9	7	25
Short RI total (n)	12	12	16	14	54
Long RI					
Girls	5	9	9	8	31
Boys	7	4	14	15	40
Long RI total (n)	12	13	23	23	71
Overall total (n)	24	25	39	37	125
Breakfast location – classroom					
Short RI					
Girls	5	3	2	2	12
Boys	2	2	6	4	14
Short RI total (n)	7	5	8	6	26
Long RI					
Girls	2	6	4	3	15
Boys	4	1	4	10	19
Long RI total (n)	6	7	8	13	34
Overall total (n)	13	12	16	19	60
Breakfast location – cafeteria					
Short RI					
Girls	3	4	5	5	17
Boys	2	3	3	3	11
Short RI total (n)	5	7	8	8	28
Long RI					
Girls	3	3	5	5	16
Boys	3	3	10	5	21
Long RI total (n)	6	6	15	10	37
Overall total (n)	11	13	23	18	65
Lunch					
Short RI					
Girls	3	3	3	5	14
Boys	2	4	1	3	10
Short RI total (n)	5	7	4	8	24
Long RI					
Girls	6	5	2	4	17
Boys	11	3	8	8	30
Long RI total (n)	17	8	10	12	47
Overall total (n)	22	15	14	20	71

Forward prompts, distant to recent; meal name prompts, breakfast, lunch, etc.; open prompts, no specific instructions; reverse prompts, recent to distant; short RI, recall in the afternoon about the prior 24 h intake; long RI, recall in the morning about the previous day's intake.

school-lunch non-reporters, (a) twenty-three children (32 %) failed to report any lunch, (b) one child failed to report 'school' as the lunch location, (c) forty-one children (58 %) failed to report the school-lunch mealtime within 1 h of the observed mealtime (with eight of forty-one reporting >1 lunch), and (d) seven children (10 %) failed to report 'school' as the lunch location *and* failed to report the school-lunch mealtime within 1 h of the observed mealtime.

In analyses of report rate, correspondence rate and inflation ratio described in subsequent sections, we did not include the 125 breakfast non-reporters, nor the seventy-one lunch non-reporters. Our rationale to not include them in analyses is as follows: for these children for these meals, the value of each of report rate, correspondence rate and inflation ratio was 0 %.

These values satisfy the intuition that, for these children, the value of report rate should indicate (maximal) under-reporting and the value of correspondence rate should indicate maximum error. However, a 0 % inflation ratio indicates maximum accuracy for the aspect of performance that it quantifies (i.e. it indicates that nothing that should not have been reported was reported), which conflicts with intuition. Although one might argue that meal non-reporters should be included in the analyses of report rate and correspondence rate, including them in analyses of inflation ratio would overestimate reporting accuracy by children in the sample.

Report rate

As explained earlier, report rate is total reported kilocalories divided by total observed kilocalories. We use customary interpretation to describe results, with values closest to 100 % as indicating accurate reporting, values >100 % as indicating over-reporting and values <100 % as indicating under-reporting.

Breakfast. Table 2 shows least squares means for breakfast report rate by RI, prompt, sex and location. The main effects of prompt ($P < 0.0003$) and location ($P < 0.0019$) were significant; these effects must be understood within the context of significant RI × prompt ($P < 0.0003$), prompt × sex ($P < 0.0003$), RI × prompt × sex ($P = 0.0011$) and prompt × location ($P = 0.0141$) interactions. Not significant were the main effects of RI ($P = 0.92$) and sex ($P = 0.92$), and the RI × sex ($P = 0.89$), RI × location ($P = 0.89$) and sex × location ($P = 0.46$) interactions.

The three-way interaction was due to different patterns of report rates by the two sexes over the four prompts at the two RIs. With the short RI, girls' breakfast report rate was most accurate with forward (98.9 %), over-reported with open (113.1 %) and under-reported with meal name (89.9 %) and reverse (91.5 %) prompts, whereas boys' report rate was most accurate with meal name (101.8 %), over-reported with reverse (113.4 %) and under-reported with forward (94.5 %) and open (85.7 %) prompts. With the long RI, girls' breakfast report rate was most accurate with open (108.1 %), over-reported with reverse (126.7 %) and under-reported with meal name (77.8 %) and forward (84.6 %) prompts, whereas boys' breakfast report rate was most accurate with forward (97.1 %) and meal name (99.0 %), over-reported with reverse (129.5 %) and under-reported with open (55.2 %) prompts.

Analyses of these data indicated over-reporting for breakfast located in the cafeteria (118.3 %) and under-reporting for breakfast located in the classroom (77.6 %). The prompt × location interaction indicated variation in the size of the difference over the four prompts. Breakfast report rates (cafeteria, classroom) by prompt were as follows: forward (108.6, 79.0 %), meal name (105.3, 79.0 %), open (116.8, 64.3 %) and reverse (142.6, 88.0 %).

It is noteworthy that, overall, breakfast report rate was unrelated to RI. Averaging across all other variables, breakfast report rate for the short RI was 98.6 % and for the long RI was 97.3 % – these values are conventionally interpreted as accurate.

Lunch. Table 2 also shows least squares means for lunch report rate by RI, prompt and sex. The main effects of prompt and sex

Table 2. Report rate – a conventional energy measure – for breakfast by retention interval (RI), prompt, sex and location, and for lunch by RI, prompt and sex, from a validation study of eight 24-h recall interview conditions with fourth-grade children
(Mean values with their standard errors)

	Forward prompts		Meal name prompts		Open prompts		Reverse prompts		Overall		P for significant effects and interactions (Wald's tests)						
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Prompt	Sex	Location	RI×prompt	Prompt×sex	RI×prompt×sex	Prompt×location
Report rate for breakfast (n 355 children)*																	
Short RI											<0.0003		<0.0019	<0.0003	<0.0003	0.0011	0.0141
Girls	98.9	2.0	89.9	8.7	113.1	6.3	91.5	13.0	98.4	4.0							
Boys	94.5	3.8	101.8	8.8	85.7	6.0	113.4	19.9	98.9	4.8							
Short RI (mean)	96.7	2.2	95.8	4.5	99.4	4.2	102.5	4.8	98.6	1.9							
Long RI																	
Girls	84.6	22.2	77.8	11.6	108.1	13.3	126.7	3.7	99.3	11.1							
Boys	97.1	14.5	99.0	3.5	55.2	4.8	129.5	17.3	95.2	5.0							
Long RI (mean)	90.9	7.4	88.4	4.6	81.6	9.0	128.1	8.1	97.3	5.1							
Overall mean	93.8	4.7	92.1	3.4	90.5	3.0	115.3	4.4									
Breakfast location (classroom, n 175 children; cafeteria, n 180 children)																	
Classroom	79.0	6.3	79.0	1.8	64.3	4.7	88.0	9.6	77.6	5.0							
Cafeteria	108.6	5.5	105.3	8.1	116.8	10.4	142.6	16.4	118.3	7.6							
Report rate for lunch (n 409 children)†											<0.0002	<0.0002	<0.0002	<0.0002		<0.0002	
Short RI																	
Girls	89.6	8.6	83.2	4.4	92.8	9.6	77.2	5.9	85.7	2.6							
Boys	81.0	4.9	78.1	8.6	109.1	2.5	96.5	9.8	91.2	2.3							
Short RI (mean)	85.3	3.0	80.6	4.9	100.9	3.9	86.8	6.6	88.4	2.3							
Long RI																	
Girls	82.2	8.6	66.0	7.0	69.5	4.4	99.6	14.8	79.3	7.8							
Boys	113.9	6.5	99.8	20.3	71.9	10.6	87.1	9.8	93.2	3.7							
Long RI (mean)	98.0	3.7	82.9	13.6	70.7	4.7	93.3	11.6	86.2	5.7							
Overall mean	91.7	3.4	81.8	8.7	85.8	3.7	90.1	5.1									

Report rate, the reported percentage of the observed amount calculated for energy for each child for breakfast and lunch separately as (total reported kilocalories/total observed kilocalories) × 100, and with a lower bound of 0 % which indicates nothing was reported, and with no upper bound because there is no limit on what a person can report, and with traditional interpretation that values close to 100 % indicate high accuracy and that values >100 % indicate over-reporting and that values <100 % indicate under-reporting, and with report rate = correspondence rate + inflation ratio; forward prompts, distant to recent; meal name prompts, breakfast, lunch, etc.; open prompts, no specific instructions; reverse prompts, recent to distant; short RI, recall in the afternoon about the prior 24 h intake; long RI, recall in the morning about the previous day's intake.
* Breakfast report rate – not significant were main effects of RI ($P = 0.92$) and sex ($P = 0.92$), and interactions of RI × sex ($P = 0.89$), RI × location ($P = 0.89$) and sex × location ($P = 0.46$) (Wald's tests).
† Lunch report rate – not significant were the main effect of RI ($P = 0.83$) and interactions of prompt × sex ($P = 0.62$) and RI × sex ($P = 0.16$) (Wald's tests).

were significant, as were the RI × prompt and RI × prompt × sex interactions (four P-values < 0·0002). Not significant were the main effect of RI ($P = 0.83$) and the prompt × sex ($P = 0.62$) and RI × sex ($P = 0.16$) interactions. For the three-way interaction, with the short RI, girls' lunch report rate was most accurate with open (92·8 %) and forward (89·6 %) prompts, not over-reported for any of the four prompts, and under-reported with meal name (83·2 %) and reverse (77·2 %) prompts, whereas boys' lunch report rate was most accurate with reverse (96·5 %), over-reported with open (109·1 %) and under-reported with forward (81·0 %) and meal name (78·1 %) prompts. With the long RI, girls' lunch report rate was most accurate with reverse (99·6 %), not over-reported for any of the four prompts, and under-reported with forward (82·2 %), meal name (66·0 %) and open (69·5 %) prompts, whereas boys' lunch report rate was most accurate with meal name (99·8 %), over-reported with forward (113·9 %) and under-reported with open (71·9 %) and reverse (87·1 %) prompts.

It is noteworthy that, as for breakfast report rate, the effect of RI on lunch report rate was not significant. Averaging across all other variables, lunch report rate for the short RI was 88·4 % and for the long RI was 86·2 %.

Correspondence rate

Correspondence rate indicates the extent to which kilocalories from items reported eaten match kilocalories observed eaten; it is the ratio of matching kilocalories to observed kilocalories. As explained earlier, a correspondence rate is between 0 and 100 %. Higher values indicate better accuracy.

Breakfast. Table 3 shows least squares means for breakfast correspondence rate by RI, prompt, sex and location. The main effects of RI, prompt and location were significant, as were interactions of RI × prompt, prompt × sex and RI × prompt × sex (six P-values < 0·0003). Not significant was the main effect of sex ($P = 0.89$) and the RI × sex ($P = 0.98$), RI × location ($P = 0.71$) and sex × location ($P = 0.98$) interactions. The prompt × location ($P = 0.0556$) interaction was not quite significant, using a significance level that controls the false discovery rate at 0·05.

On average, breakfast correspondence rate was higher with the short (67·2 %) than with the long (42·4 %) RI. For the three-way interaction, with the short RI, girls' breakfast correspondence rate was highest with forward (78·0 %) and reverse (72·4 %) prompts and lowest with meal name (60·2 %) and open (62·3 %) prompts, whereas boys' breakfast correspondence rate was highest with reverse (75·7 %) and lowest with forward (58·2 %) and meal name (60·9 %) prompts. With the long RI, girls' breakfast correspondence rate was highest with meal name (55·9 %) and lowest with open (32·5 %) prompts, whereas boys' breakfast correspondence rate was highest with reverse (53·4 %) and forward (49·9 %) prompts and lowest with meal name (31·7 %) and open (30·0 %) prompts.

Breakfast correspondence rates were higher for breakfast located in the classroom (61·9 %) than for breakfast in the cafeteria (47·7 %). Although the prompt × location interaction was not significant at the 0·05 level, there was some evidence of variation in the classroom advantage over the four prompts. Breakfast correspondence rates (classroom, cafeteria) by prompt were as follows: forward (60·9, 50·5 %), meal name (65·8, 38·6 %), open (53·8, 43·7 %) and reverse (67·0, 58·0 %).

Lunch. Table 4 shows least squares means for lunch correspondence rate by RI, prompt and sex. The main effects of RI and prompt were significant, as was the interaction of RI × prompt (three P-values < 0·0002). Not significant was the main effect of sex ($P = 0.94$) and the prompt × sex ($P = 0.20$), RI × sex ($P = 0.46$) and RI × prompt × sex ($P = 0.84$) interactions. On average, lunch correspondence rate was higher with the short (70·6 %) than with the long (53·2 %) RI. For the RI × prompt interaction, with the short RI, lunch correspondence rate was highest with open (76·1 %) and lowest with meal name (66·9 %) prompts, whereas with the long RI, lunch correspondence rate was highest with reverse (67·4 %) and lowest with meal name (45·8 %) and open (47·0 %) prompts.

Inflation ratio

Inflation ratio indicates the extent to which reported kilocalories do not match kilocalories observed eaten; it is the ratio of reported non-matching kilocalories to observed kilocalories. Higher values indicate more error.

Breakfast. Table 3 also shows least squares means for breakfast inflation ratio by RI, prompt, sex and location. The main effects of RI and location were significant, as were the RI × prompt, prompt × sex, RI × prompt × sex (five P-values < 0·0007) and prompt × location ($P = 0.0016$) interactions. Not significant were the main effects of prompt ($P = 0.49$) and sex ($P = 0.89$), and the RI × sex ($P = 0.89$), RI × location ($P = 0.92$) and sex × location ($P = 0.89$) interactions. On average, breakfast inflation ratio was lower with the short (31·3 %) than with the long (55·0 %) RI. For the three-way interaction, with the short RI, girls' breakfast inflation ratio was lowest with reverse (18·4 %) and forward (21·1 %) prompts and highest with open (51·1 %) prompts, whereas boys' breakfast inflation ratio was lowest with open (15·4 %) and highest with the other three (36·5–41·0 %) prompts. With the long RI, girls' breakfast inflation ratio was lowest with meal name (22·0 %) and highest with open (76·0 %) and reverse (78·5 %) prompts, whereas boys' breakfast inflation ratio was lowest with open (24·9 %) and highest with reverse (76·3 %) prompts.

Breakfast inflation ratio was substantially lower for breakfast located in the classroom (15·6 %) than for breakfast in the cafeteria (70·7 %). The prompt × location interaction was due to variation in the difference in inflation ratios between locations over the four prompts. The average inflation ratios (classroom, cafeteria) by prompt were as follows: forward (18·4, 57·8 %), meal name (13·2, 66·8 %), open (10·3, 73·4 %) and reverse (20·6, 84·9 %).

Lunch. Table 4 also shows least squares means for lunch inflation ratio by RI, prompt and sex. The main effects of RI ($P = 0.0005$), prompt ($P = 0.0045$) and sex ($P < 0.0002$) were significant, as were interactions of RI × prompt, prompt × sex

Table 3. Correspondence rate and inflation ratio – reporting-error-sensitive energy measures – for breakfast by retention interval (RI), prompt, sex and location, from a validation study of eight 24-h recall interview conditions with fourth-grade children
(Mean values with their standard errors)

	Forward prompts		Meal name prompts		Open prompts		Reverse prompts		Overall		P for significant effects and interactions (Wald's tests)						
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	RI	Prompt	Location	RI×prompt	Prompt×sex	RI×prompt×sex	Prompt×location
Correspondence rate for breakfast (n 355 children)*											<0·0003	<0·0003	<0·0003	<0·0003	<0·0003	<0·0003	<0·0003
Short RI																	
Girls	78·0	2·6	60·2	11·0	62·3	2·3	72·4	4·6	68·2	3·9							
Boys	58·2	2·5	60·9	4·2	70·3	7·2	75·7	0·6	66·2	3·2							
Short RI (mean)	68·1	1·3	60·5	5·5	66·3	2·6	74·0	2·4	67·2	1·3							
Long RI																	
Girls	36·6	7·2	55·9	5·2	32·5	1·5	48·6	4·0	43·4	1·9							
Boys	49·9	8·9	31·7	2·9	30·0	10·5	53·4	7·4	41·3	4·9							
Long RI (mean)	43·3	1·5	43·8	2·0	31·3	5·9	51·0	3·9	42·4	1·8							
Overall mean	55·7	0·9	52·2	2·1	48·8	3·5	62·5	0·9									
Breakfast location (classroom, n 175 children; cafeteria, n 180 children)																	
Classroom	60·9	3·1	65·8	7·6	53·8	4·9	67·0	1·9	61·9	1·9							
Cafeteria	50·5	1·4	38·6	4·9	43·7	5·0	58·0	1·3	47·7	1·8							
Inflation ratio for breakfast (n 355 children)†											<0·0007		<0·0007	<0·0007	<0·0007	<0·0007	0·0016
Short RI																	
Girls	21·1	2·3	29·2	8·3	51·1	7·4	18·4	15·7	29·9	7·7							
Boys	36·5	4·2	41·0	12·3	15·4	6·5	37·7	20·1	32·7	6·1							
Short RI (mean)	28·8	3·0	35·1	3·8	33·3	2·8	28·1	5·9	31·3	1·3							
Long RI																	
Girls	47·5	17·2	22·0	8·4	76·0	14·0	78·5	4·7	56·0	9·8							
Boys	47·3	15·3	67·8	3·0	24·9	14·4	76·3	24·5	54·1	5·5							
Long RI (mean)	47·4	8·1	44·9	2·8	50·4	13·8	77·4	11·0	55·0	6·4							
Overall mean	38·1	5·5	40·0	3·0	41·8	6·0	52·7	4·6									
Breakfast location (classroom, n 175 children; cafeteria, n 180 children)																	
Classroom	18·4	8·1	13·2	9·0	10·3	2·3	20·6	11·3	15·6	6·6							
Cafeteria	57·8	4·9	66·8	12·8	73·4	12·2	84·9	17·1	70·7	9·1							

Forward prompts, distant to recent; meal name prompts, breakfast, lunch, etc.; open prompts, no specific instructions; reverse prompts, recent to distant; short RI, recall in the afternoon about the prior 24 h intake; long RI, recall in the morning about the previous day's intake.

* Correspondence rate is the percentage of the observed amount that is reported correctly. It was calculated for energy for each child for breakfast as (corresponding kilocalories from matches/observed kilocalories) × 100. A match is observed eaten and reported eaten. Corresponding kilocalories from a match are the smaller of reported kilocalories and observed kilocalories. Correspondence rate may range from 0 to 100 %. Higher rates indicate better accuracy. Breakfast correspondence rate – not significant were main effect of sex ($P = 0.89$) and interactions of RI×sex ($P = 0.98$), RI×location ($P = 0.71$), sex×location ($P = 0.98$) and prompt×location ($P = 0.0556$) (Wald's tests).

† Inflation ratio reflects the extent to which reported kilocalories do not match kilocalories observed eaten; it is the ratio of reported non-matching kilocalories to observed kilocalories. It was calculated for energy for each child for breakfast as (((over-reported kilocalories from matches) + (kilocalories from intrusions))/(total observed kilocalories))) × 100. The over-reported kilocalories from a match are the amount by which reported kilocalories exceed observed kilocalories (or 0 if reported kilocalories are less than or equal to observed kilocalories). An intrusion is reported eaten, but not observed eaten. The kilocalories from an intrusion are the entire reported kilocalories for each intrusion. Inflation ratio has a lower bound of 0 % but no upper bound. Smaller values indicate better accuracy. For analyses, inflation ratio was square-root transformed to help satisfy the normality assumption. Breakfast inflation ratio – not significant were main effects of prompt ($P = 0.49$) and sex ($P = 0.89$), and interactions of RI×sex ($P = 0.89$), RI×location ($P = 0.92$) and sex×location ($P = 0.89$) (Wald's tests).

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Table 4. Correspondence rate and inflation ratio – reporting-error-sensitive energy measures – for lunch by retention interval (RI), prompt and sex from a validation study of eight 24-h recall interview conditions with fourth-grade children
(Mean values with their standard errors)

	Forward prompts		Meal name prompts		Open prompts		Reverse prompts		Overall		P for significant effects and interactions (Wald's tests)					
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	RI	Prompt	Sex	RI × prompt	Prompt × sex	RI × prompt × sex
Correspondence rate for lunch (n 409 children)*											<0.0002	<0.0002		<0.0002		
Short RI																
Girls	69.0	2.9	69.2	4.2	75.7	6.1	64.3	6.4	69.5	2.3						
Boys	69.9	5.9	64.6	5.1	76.6	4.1	75.9	2.2	71.8	0.6						
Short RI (mean)	69.5	3.1	66.9	2.3	76.1	1.8	70.1	3.8	70.6	1.2						
Long RI																
Girls	54.9	8.9	49.2	4.5	47.8	2.2	65.7	5.3	54.4	3.4						
Boys	49.9	5.9	42.4	6.5	46.3	5.7	69.0	5.1	51.9	3.0						
Long RI (mean)	52.4	5.3	45.8	5.4	47.0	3.8	67.4	3.7	53.2	2.6						
Overall mean	60.9	3.8	56.3	3.1	61.6	2.5	68.7	3.0								
Inflation ratio for lunch (n 409 children)†											0.0005	0.0045	<0.0002	<0.0002	<0.0002	<0.0002
Short RI																
Girls	20.7	5.9	13.9	2.4	16.3	3.8	12.5	1.5	15.8	1.0						
Boys	10.3	3.0	14.1	4.1	32.4	4.5	20.3	8.0	19.3	2.2						
Short RI (mean)	15.5	2.4	14.0	3.2	24.4	3.0	16.4	4.4	17.6	1.3						
Long RI																
Girls	26.8	3.7	16.3	2.5	21.6	5.8	33.4	11.2	24.5	5.0						
Boys	63.5	2.7	56.3	14.7	25.6	9.4	18.2	5.4	40.9	5.1						
Long RI (mean)	45.2	2.3	36.3	8.6	23.6	5.9	25.8	8.2	32.7	4.9						
Overall mean	30.3	1.4	25.1	5.8	24.0	2.9	21.1	2.4								

Forward prompts, distant to recent; meal name prompts, breakfast, lunch, etc.; open prompts, no specific instructions; reverse prompts, recent to distant; short RI, recall in the afternoon about the prior 24 h intake; long RI, recall in the morning about the previous day's intake.

* Correspondence rate is the percentage of the observed amount that is reported correctly. It was calculated for energy for each child for lunch as (corresponding kilocalories from matches/observed kilocalories) × 100. A match is observed eaten and reported eaten. Corresponding kilocalories from a match are the smaller of reported kilocalories and observed kilocalories. Correspondence rate may range from 0 to 100 %. Higher rates indicate better accuracy. Lunch correspondence rate – not significant were the main effect of sex ($P = 0.94$) and interactions of prompt × sex ($P = 0.20$), RI × sex ($P = 0.46$) and RI × prompt × sex ($P = 0.84$) (Wald's tests).

† Inflation ratio reflects the extent to which reported kilocalories do not match kilocalories observed eaten; it is the ratio of reported non-matching kilocalories to observed kilocalories. It was calculated for energy for each child for lunch as (((over-reported kilocalories from matches) + (kilocalories from intrusions))/(total observed kilocalories)) × 100. The kilocalories from a match are the amount by which reported kilocalories exceed observed kilocalories (or 0 if reported kilocalories are less than or equal to observed kilocalories). An intrusion is a food that is reported eaten, but not observed eaten. The kilocalories from an intrusion are the entire reported kilocalories for each intrusion. Inflation ratio is a measure of reporting error. It has a lower bound of 0 % but no upper bound. Smaller values indicate better accuracy. For analyses, inflation ratio was square-root transformed to help satisfy the normality assumption. Lunch inflation ratio – not significant was the RI × sex interaction ($P = 0.0628$) (Wald's test).

and RI×prompt×sex (three *P*-values < 0·0002). Not quite significant, using a significance level that controls the false discovery rate at 0·05, was the RI×sex interaction (*P* = 0·0628). On average, lunch inflation ratio was lower with the short (17·6 %) than with the long (32·7 %) RI. For the three-way interaction, with the short RI, girls' lunch inflation ratio was lowest with reverse (12·5 %) and meal name (13·9 %) prompts and highest with forward (20·7 %) prompts, whereas boys' lunch inflation ratio was lowest with forward (10·3 %) and highest with open (32·4 %) prompts. With the long RI, girls' lunch inflation ratio was lowest with meal name (16·3 %) and highest with reverse (33·4 %) prompts, whereas boys' lunch inflation ratio was lowest with reverse (18·2 %) and open (25·6 %) prompts and highest with meal name (56·3 %) and forward (63·5 %) prompts.

Discussion

In the current study, we analysed validation-study data[36] to investigate RI and prompt effects on accuracy of fourth-grade children's reports of school-breakfast and school-lunch (obtained in 24hDRs) and to compare accuracy of school-breakfast reports by breakfast location (classroom; cafeteria). We used two different approaches to assess accuracy.

According to correspondence rate and inflation ratio – the reporting-error-sensitive measures – accuracy for energy-transformed reports of intake was better with the short RI than with the long RI for breakfast reports and for lunch reports (in 24hDRs). This was not surprising as other validation studies have shown that recall accuracy is related to RI[28–34]. However, some of those validation studies obtained single-meal recalls, and some validation studies that obtained 24hDRs did not analyse accuracy for breakfast and lunch separately. This finding provides further evidence that recalls should be obtained as close in time to the eating events as possible.

In contrast, according to report rate – the conventional measure – accuracy did not depend on RI for breakfast or for lunch. Past comparisons of the reporting-error-sensitive and conventional approaches for analysing accuracy for reporting energy have found that report rate overestimates and provides a distorted picture of accuracy[37,54–56]. Thus, accuracy results for validation studies from the conventional measure (report rate) and from the reporting-error-sensitive measures (correspondence rate and inflation ratio) suggest different pictures of accuracy. This article's findings reinforce the importance of analysing recall accuracy in validation studies by examining which items or amounts were reported correctly rather than by simply dividing 'reported energy' by 'reference (e.g. observed) energy'. Aside from our publications[37,54–56], the reporting-error-sensitive approach has been cited in some publications[58–60], but used in few[61].

Analyses of correspondence rate, and especially of inflation ratio, indicate that reporting accuracy appeared better for lunch than for breakfast. This result is likely related to the result that accuracy was better with the short than with the long RI. With the short RI (prior-24-h-afternoon), the approximate number of hours between eating breakfast and the 24hDR was five, and between eating lunch and the 24hDR was one. However, for the long RI (previous-day-morning), the approximate number of hours between eating breakfast and the 24hDR was twenty-five, and between eating lunch and the 24hDR was twenty-one. Thus, on average in this study, the number of hours between eating and the 24hDR for lunch (11 h) was less than for breakfast (15 h).

However, average report rates suggest that accuracy for breakfast appeared better than that for lunch. Thus, report rate provided results that were opposite of those from correspondence rate and inflation ratio concerning accuracy for breakfast *v.* lunch. Simply dividing 'reported energy' by 'observed energy' without accounting for which items or amounts were reported correctly distorts the picture of reporting accuracy.

For two past validation studies, we provided accuracy results of fourth-grade children's school-breakfast reports and school-lunch reports (obtained in 24hDRs) separately. In our 2007 article[62], when children reported after breakfast about the previous day's intake, school-lunch reports were more accurate than school-breakfast reports, as indicated by higher correspondence rates for lunch than for breakfast and lower inflation ratios for lunch than for breakfast; report rate was not assessed in the 2007 article. In our 2009 article[63], accuracy for school-breakfast reports and school-lunch reports in 24hDRs was best when the RIs were shortest, and accuracy decreased as the RI increased. Specifically, as indicated by higher correspondence rates and lower inflation ratios, accuracy for school-breakfast reports was best for prior-24-h recalls conducted in the morning, and accuracy for school-lunch reports was best for prior-24-h recalls conducted in the afternoon, but report rates for school-breakfast reports and for school-lunch reports did not differ significantly by RI condition. However, in neither study did we manipulate prompts to examine their effects on recall accuracy.

For the current study, for each reporting-error-sensitive measure (correspondence rate, inflation ratio), for each of breakfast and lunch, the three-way RI×prompt×sex interaction was significant, except for lunch correspondence rate for which the two-way RI×prompt interaction was significant. Interpretations of the three-way interactions are aided by the bar graphs in Fig. 1 and 2, which show least squares means for each combination of levels of the three factors. In these graphs, the correspondence rate was subtracted from 100 so that in each graph a lower value indicates better accuracy. The most prominent feature of the graphs is that for each sex, for almost all prompts, accuracy was better with the short RI than with the long RI. Exceptions from this differed for boys and girls. Consider the breakfast data (Fig. 1): for girls, the accuracy advantage of the short RI (in correspondence rate and in inflation ratio) disappeared with meal name prompts. For boys, the accuracy advantage of the short RI was mitigated (in correspondence rate) with forward prompts and (in inflation ratio) with forward and open prompts. Consider the lunch data (Fig. 2): accuracy was generally better with the short RI than with the long RI; however, irrespective of sex, the accuracy advantage of the short RI (in correspondence rate) was most prominent with open prompts and decreased or disappeared with reverse prompts. For girls, the accuracy advantage (in inflation ratio) of the short RI was mitigated with forward and meal name prompts. For boys, the accuracy advantage
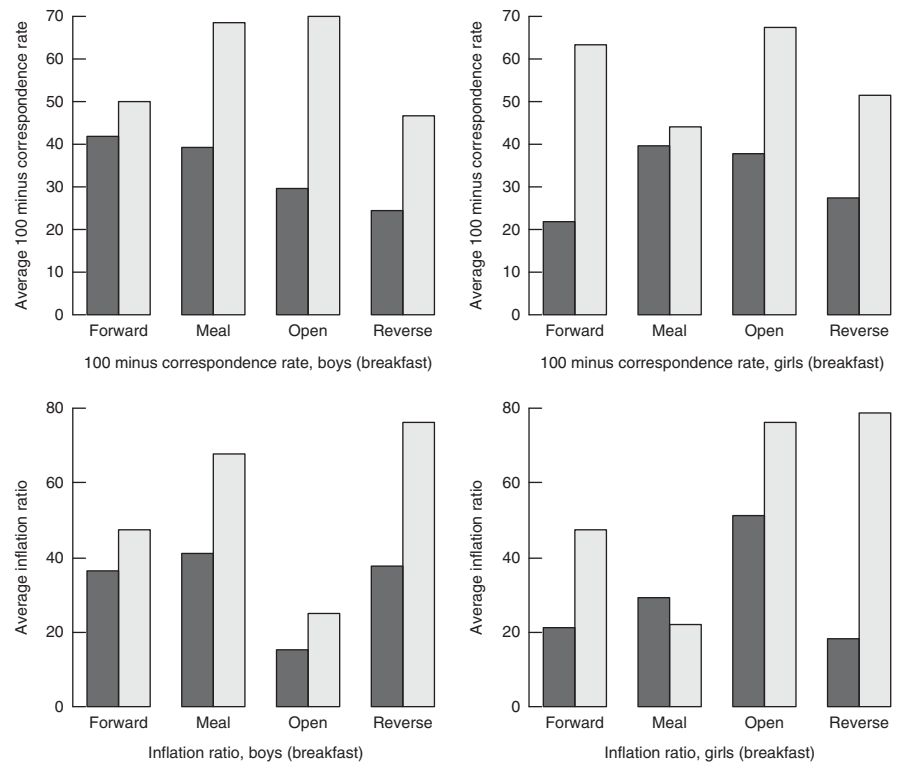
Fig. 1. Breakfast correspondence rate and breakfast inflation ratio, each for the two-way retention interval (RI) × prompt interaction. The heights of the bars represent averages (per RI-prompt-sex combination) of the correspondence rate subtracted from 100 (top row) and of inflation ratio (bottom row), so that in all cases lower heights represent better accuracy. ■, Short RI; □, long RI; the four categories along the horizontal axis are the four prompts.
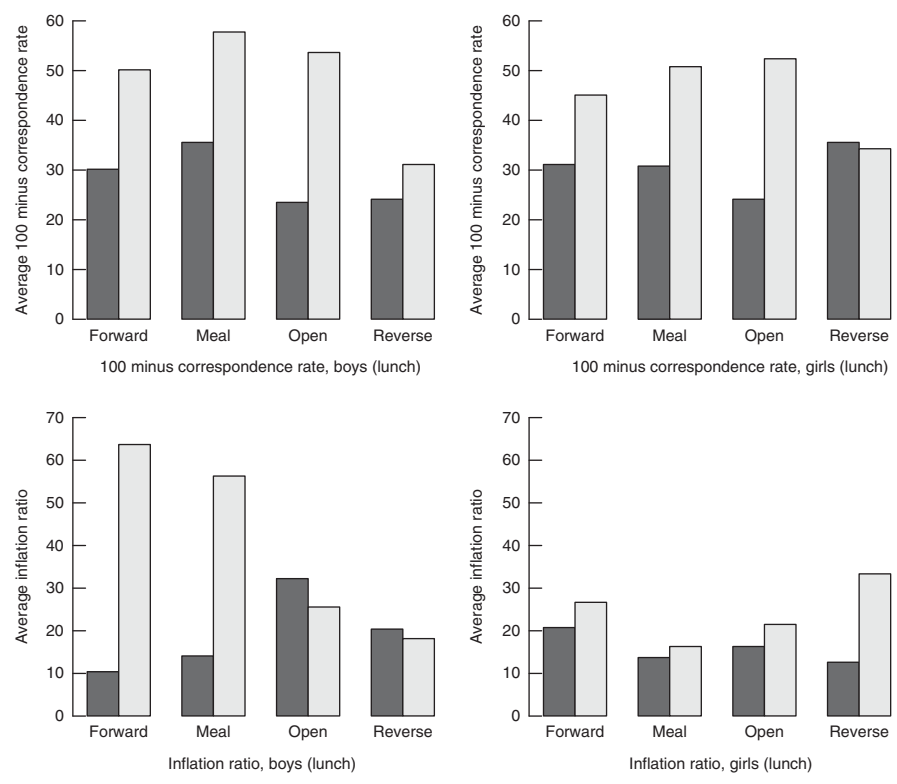

Fig. 2. Lunch correspondence rate and lunch inflation ratio, each for the two-way retention interval (RI) × prompt interaction. The heights of the bars represent averages (per RI-prompt-sex combination) of the correspondence rate subtracted from 100 (top row) and of inflation ratio (bottom row), so that in all cases lower heights represent better accuracy. ■, Short RI; □, long RI; the four categories along the horizontal axis are the four prompts.

(in inflation ratio) was only substantial for forward and meal name prompts. These results do not provide a clear basis for recommendations concerning prompts. Particular prompts may work differently for boys and for girls.

There was a relationship between children's breakfast accuracy and location of school breakfast. The reporting-error-sensitive measures – correspondence rate and inflation ratio – showed that, regardless of prompt, children's reporting accuracy was better for breakfast in the classroom than for breakfast in the cafeteria. Yet report rate communicated a very different picture: the average report rate was somewhat closer to 100 % (i.e. more accurate) for breakfast located in the cafeteria than for breakfast located in the classroom for three of the four prompts. With customary interpretation that report rates closer to 100 % are better, the accuracy results by breakfast location were opposite for the reporting-error-sensitive measures and the conventional measure.

Few studies have examined the relationship between children's dietary recall accuracy and school-breakfast location. In our 2009 study[63], none of correspondence rate, inflation ratio or report rate was related to accuracy of school-breakfast reports by school-breakfast location.

For the current study, there are several possible explanations for recall accuracy, indexed by the reporting-error-sensitive measures, to have been better for breakfast located in the classroom than in the cafeteria. The cafeteria environment was often noisier and more chaotic than the classroom environment; the calmer classroom environment may have helped those children be more mindful of their food intake. Children had more breakfast options when breakfast was located in the cafeteria than in the classroom. For example, in the cafeteria, children could often choose between a hot (e.g. sausage biscuit) and cold (e.g. ready-to-eat cereal) option, whereas in the classroom often only one option was available. Perhaps having more options in the cafeteria affected children's recall accuracy.

We conducted *post hoc* analyses on lunch data with breakfast location as a variable to determine whether recall accuracy for lunch was related to breakfast location. Results showed that for no response variable was lunch accuracy significantly related to breakfast location: report rate (unadjusted $P = 0.1779$), correspondence rate (unadjusted $P = 0.9385$), inflation ratio (unadjusted $P = 0.2089$). Thus, our supposition in the introduction that different school breakfast locations could help children discriminate breakfast and lunch, and thereby improve recall accuracy, appears to not be supported.

The distributions of the 125 school breakfast non-reporters and the seventy-one school lunch non-reporters over conditions deserve discussion. Concerning RI, for breakfast, there were 1·3 times as many meal non-reporters with the long RI than with the short RI (seventy-one *v.* fifty-four). For lunch, there were twice as many meal non-reporters with the long RI than with the short RI (forty-seven *v.* twenty-four). This is consistent with findings that recall accuracy for children whose reports satisfied the criteria was worse with the long RI than with the short RI. Concerning prompt, meal non-reporters were distributed across all four prompts for breakfast and for lunch (see Table 1). It is notable that some children did not report meals even when meal name prompts were used. (With meal name prompts, children were directly asked 'Did you eat breakfast?' and 'Did you eat lunch?'). With regard to sex, for breakfast the meal non-reporters were sixty girls and sixty-five boys, and for lunch the meal non-reporters were thirty-one girls and forty boys. Thus, although sex was unrelated to reporting status for breakfast, it was somewhat related for lunch, with 1·3 times as many boys as girls being meal non-reporters. With regard to location, sixty children with breakfast located in the classroom and sixty-five children with breakfast located in the cafeteria were meal non-reporters; thus, location was not a factor.

One limitation of the validation study that provided data analysed for this article was that only fourth-grade children were recruited to participate. Another limitation is that children were not assigned randomly to breakfast location. A third limitation is that because amounts eaten were observed and reported in a qualitative manner (i.e. servings of standard school meal portions), kilocalorie measures are not precise. However, the same procedure was used throughout data collection for all meal observations, and for reported information by all 480 children interviewed. Furthermore, the same method was used to convert qualitative terms from meal observations and 24hDRs into quantities of kilocalories. A fourth limitation is that data collection cells were not stratified by race/ethnicity; however, race/ethnicity was a control variable in analyses.

Strengths include those of the RI-and-prompt validation study. Specifically, reference information was obtained by direct meal observations. More children were recruited than needed for data collection, which made it difficult for children to determine who specifically was being observed, and to anticipate whether they would be interviewed. Rigorous and regular quality control was implemented for meal observations and interviews before and throughout data collection. Few past validation studies have examined the accuracy of children's school-breakfast reports and school-lunch reports (obtained during 24hDRs) separately.

In conclusion, in deciding to use dietary recalls, researchers and practitioners also decide which RI and prompts will be used for those recalls. To maximise recall accuracy, a short RI should be selected, whereas recommendations concerning the selection of specific prompts are less clear. Report rates provide a misleading picture of accuracy, and thus researchers should use reporting-error-sensitive measures to analyse validation-study data. In future validation studies, if meal location can be investigated as a potential source of systematic variability, it would be helpful to do so to accumulate information about this.

Acknowledgments

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