RESEARCH
Original Research

Fourth-Grade Children's Reporting Accuracy for Amounts Eaten at School-Provided Meals: Insight from a Reporting-Error-Sensitive Analytic Approach Applied to Validation Study Data

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ABSTRACT

Background Validation studies that have directly assessed reporting accuracy for amounts eaten have provided results in various ways.

Objective To analyze amount categories of a reporting-error-sensitive approach for insight concerning reporting accuracy for amounts eaten.

Design For a cross-sectional validation study, children were observed eating school-provided breakfast and lunch, and randomized to one of eight 24-hour recall conditions (two retention intervals [short and long] crossed with four prompts [forward, meal name, open, and reverse]).

Participants/setting Data collected during 3 school years (2011-2012 to 2013-2014) on 455 children from 10 schools (four districts) in a southern US state.

Main outcome measures Items were classified as matches (observed and reported), omissions (observed but unreported), or intrusions (unobserved but reported). Within amount categories (matches [corresponding, overreported, and underreported], intrusions [overreported], and omissions [underreported]), item amounts were converted to kilocalories.

Statistical analyses performed A multilevel model was fit with food-level explanatory variables (amount category and meal) and child-level explanatory variables (retention interval, prompt, sex, and race/ethnicity). To investigate inaccuracy differences, *t* tests on three contrasts were performed.

Results Inaccuracy differed by amount category ($P<0.001$; in order from largest to smallest: omission, intrusion, underreported match, and overreported match), meal ($P=0.01$; larger for breakfast), retention interval ($P=0.003$; larger for long), sex ($P=0.004$; larger for boys), race/ethnicity ($P=0.045$; largest for non-Hispanic whites), and amount category×meal interaction ($P=0.046$). Overreported amounts were larger for intrusions than overreported matches ($P<0.0001$). Underreported amounts were larger for omissions than underreported matches ($P<0.0001$). Overall underreported amounts (from omissions and underreported matches) exceeded overall overreported amounts (from intrusions and overreported matches) ($P<0.003$).

Conclusions Amount categories provide a standard way to analyze validation study data on reporting accuracy for amounts eaten, and compare results across studies. Multilevel analytic models reflecting the data structure are recommended for inference. To enhance reporting accuracy for amounts eaten, focus on increasing reports of correct items, thereby yielding more matches with fewer intrusions and omissions.
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RESEARCH SHOWS THAT CHILDREN HAVE DIFFICULTY accurately reporting amounts eaten.[1-11] Nevertheless, studies of fourth-grade children's dietary-reporting accuracy have consistently shown that for matches (items observed eaten and reported eaten), qualitatively reported amounts eaten (eg, little bit or most) in reports of school-provided meals in 24-hour dietary recalls were reasonably accurate[12-15]; on average, when quantified, reported amounts for matches were within 0.25 serving of

what was observed. However, on average, after quantification of qualitative reports, children reported having eaten 0.76 serving of each intrusion (item reported eaten but not observed eaten) and were observed to have eaten an average of 0.80 serving of each omission (item observed eaten but not reported eaten).[12-15] Thus, children falsely claimed to have eaten most of the serving of intrusions, and omissions were not eaten in small amounts.

Many validation studies do not directly assess, at the food item level, reporting accuracy for amounts eaten, but instead use a so-called conventional approach in which all items and amounts in a reference set (eg, from meal observations) are transformed to kilocalories; likewise, all items and amounts in a reported set (eg, from 24-hour recalls) are transformed to kilocalories; then, kilocalories within each set are totaled for each respondent; finally, statistical tests are used to analyze report rate (ratio of total reported kilocalories to total reference kilocalories).[16] Thus, this conventional approach is insensitive to reporting errors of items and amounts, permitting, for example, overreport of some items to compensate for underreport of others.[16]

In contrast, in this article, a reporting-error-sensitive approach,[16] which quantifies reporting error in a way that depends on what items and amounts are misreported, was used to assess reporting accuracy for amounts eaten in a validation study. First, each item was defined as a match, omission, or intrusion. Next, for each match, omission, and intrusion, amounts were categorized. For matches, amounts were categorized as corresponding, underreported, or overreported. By definition, amounts of intrusions are overreported, and amounts of omissions are underreported.[16] Within each amount category, each item's amount was converted to kilocalories. The reporting-error-sensitive approach has been shown previously[16-20] to provide a different picture of dietary-reporting accuracy than the conventional approach.

In previous comparisons[16-20] of the reporting-error-sensitive and conventional approaches to analysis of validation-study data, the reporting-error-sensitive measures analyzed were the kilocalories measures correspondence rate (index of correct reporting) and inflation ratio (index of false reporting). For an analyzed meal, the sum of the correspondence rate and inflation ratio is the conventional approach's report rate, and each article's focus was on investigating the relationship of these measures to manipulated or respondent variables. The current article is the first to formally analyze only the amount categories (with amounts for items in each category converted to kilocalories) of the reporting-error-sensitive approach to provide insight concerning children's reporting accuracy for amounts eaten.

For the current article, data from a cross-sectional validation study[21] of children's reports of school-provided meals in 24-hour recalls were used to investigate hypotheses about reporting accuracy for amounts eaten (expressed in terms of kilocalorie inaccuracy or "inaccuracy") with the reporting-error-sensitive approach. The validation study[21] was designed to investigate the combined influence of retention interval and prompts on fourth-grade children's dietary recall accuracy. Retention interval is the time between the meals to be reported and the recall. Prompts are questions used to obtain reports of intake during the first pass of a multiple-pass recall procedure. Intake was validated with meal observations of school-provided breakfast and lunch. As in past studies,[12-15,22,23] observers and children used qualitative terms of amounts eaten (eg, half or most). There were three hypotheses.

Hypothesis 1 states that inaccuracy for amounts eaten will be greater for intrusions and omissions than for overreported matches and underreported matches (defined in Methods). Hypothesis 1a states that inaccuracy for overreported amounts will be smaller for matches than for intrusions (which would not be true in situations where only relatively small amounts are reported for intrusions). Hypothesis 1b states that inaccuracy for underreported amounts will be smaller for matches than for omissions (which would not be true in situations where omissions are of relatively small amounts). Hypothesis 1c states that all inaccuracy for underreporting (from omissions and underreported matches) will be larger than all inaccuracy for overreporting (from intrusions and overreported matches). Hypothesis 1 and 1a to 1c were based on results from research with fourth-grade children[12-15] summarized earlier.

Hypothesis 2 states that inaccuracy for amounts eaten will differ by meal (breakfast or lunch). Specifically, inaccuracy will be smaller for lunch than for breakfast. Hypothesis 2 was based on results from research[20,24] that showed that fourth-grade children's item accuracy in reports of school meals during 24-hour recalls was better for lunch than breakfast.

Hypothesis 3 states that inaccuracy for amounts eaten will vary for intrusions, omissions, overreported matches, and underreported matches as a function of retention interval, prompts, or sex, separately or combined. Specifically, inaccuracy for amounts eaten will be smaller for the short than for the long retention interval. The retention interval part of Hypothesis 3 was based on results from numerous studies[15,21-23,25,26] with third-, fourth-, or fifth-grade children that showed that their item accuracy in reports of school meals during 24-hour recalls was better with the short than long retention interval. No specific hypotheses were made for inaccuracy for amounts eaten as a function of prompts or sex.

METHODS

A previous publication[21] describes estimation for the validation study's sample sizes and results for food item and kilocalorie accuracy measures along with details about the design, sample, data collection, and quality control. This section summarizes the latter information. The University of South Carolina's Institutional Review Board approved the study. Written parental consent and child assent were obtained.

Data were collected during three school years (2011-2012, 2012-2013, and 2013-2014) with fourth-grade children from 10 schools in four districts in South Carolina. Across the three school years, of 1,780 children invited to participate in the study, 1,208 children agreed (67.9%). Each child selected to participate was observed eating two consecutive school-provided meals (breakfast and lunch) on the same day, and interviewed to obtain a 24-hour recall under one of eight conditions constructed by crossing two retention intervals (short or long) with four prompts (forward [distant to recent], meal name [breakfast, lunch, etc], open [no instructions], or reverse [recent to distant]). The rationale for the design is