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Body Mass Index, Sex, Interview Protocol, and Children's Accuracy for Reporting Kilocalories Observed Eaten at School Meals

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Abstract

This pilot study investigated body mass index (BMI), sex, interview protocol, and children's accuracy for reporting kilocalories. Forty fourth-grade children (20 low BMI [LBMI; ≥5th and <50th percentiles; 10 boys; 15 black], 20 high BMI [HBMI;≥ 85th percentile; 10 boys; 15 black]) were observed eating school meals (breakfast, lunch) and interviewed either that evening about the prior 24 hours (24E) or the next morning about the previous day (PDM), with 10 LBMI (5 boys) and 10 HBMI (5 boys) per interview protocol. Five kilocalorie variables were analyzed using separate 4-factor (BMI group, sex, race, interview protocol) analyses of variance. No effects were found for *reported* or *matched* kilocalories. More kilocalories were *observed* ($p<0.02$) and *omitted* ($p<0.05$) by HBMI than LBMI children. For *intruded* kilocalories, means were smaller (better) for HBMI girls

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than HBMI boys, but larger for LBMI girls than LBMI boys (interaction $p<0.04$); LBMI girls intruded the most while HBMI girls intruded the least. For interview protocol, *omitted* and *intruded* kilocalories were higher (worse), although not significantly so ($ps<0.11$), for PDM than 24E. These results illuminate relations of BMI, sex, interview protocol, and children's reporting accuracy, and are consistent with results concerning BMI and sex from studies with adults.

Keywords

children; observation; dietary reporting accuracy; body mass index

Introduction

Dietary reporting studies with adults indicate that underreporting of kilocalories increases as body mass index (BMI) increases (1–3), especially for women (4–8). Studies with elementary school children (ages six to 11 years) have compared various dietary reporting methods against doubly-labeled water; a relationship between reporting accuracy and BMI was found in some studies (9–11) but not others (12–15). However, none of these studies strictly reflects *children's* reporting accuracy because dietary information was provided by parents (10), parents and children (9,14,15), parents, children, and observers (13), or children with "minimal assistance from parents and staff" (11); one publication stated "parents may be more likely to help younger children" (12). To our knowledge, only one study (16) of three families, two of which had two brothers (one obese, one non-obese) of elementary-school age, compared *children's* dietary reports to observations; it found no effect of obesity status on accuracy for reporting kilocalories. This article reports a pilot investigation of the relation of BMI, sex, and interview protocol to fourth-grade children's accuracy for reporting kilocalories observed eaten at school meals.

Methods

The Institutional Review Board at the Medical College of Georgia approved the study. Written child assent and parental consent were obtained.

Subjects

Children from all 24 fourth-grade classes at six public elementary schools in one district were invited to participate in August, 2002. During the school year of data collection, eligibility to receive free or reduced-price school meals averaged 70% (range: 58–82%) across all grades at these schools. Of the 443 children invited to participate, 312 (70%) agreed. The race/sex composition of the children invited to participate was similar to that of those who agreed. Schools provided children's race, sex, and date of birth.

Children's weight and height without shoes were measured in the morning in November, 2002, by research staff in a private location at school. Weights and heights were measured using digital scales (calibrated daily) and portable stadiometers, respectively, according to established procedures, and recorded to the nearest $1/10^{th}$ pound and $1/8^{th}$ inch, respectively (17,18). Daily assessments of inter-rater reliability across research staff on approximately 10% of randomly selected children yielded intraclass correlations ≥ 0.99 for weight and height. Date of birth was subtracted from date of measurement to calculate each child's age at the time of measurement. Each child's BMI-for-age percentile was determined from Centers for Disease Control and Prevention (CDC) sex-specific growth charts (19).

Children with percentiles $\geq 5^{th}$ and $<50^{th}$ were categorized as "low BMI" (LBMI) and children with percentiles $\geq 85^{th}$ as "high BMI" (HBMI). The HBMI lower limit was the 85^{th} percentile

because the CDC defines overweight for ages two to 20 years as ≥95th percentile, and at risk of overweight as ≥85th and <95th percentiles (20). The LBMI lower limit was the 5th percentile because the CDC defines underweight for ages two to 20 years as <5th percentile (20). The LBMI upper limit was the 50th percentile to have adequate separation between HBMI and LBMI groups. Using the 20th percentile as the upper limit of LBMI would have allowed equal percentile widths for the two BMI groups. However, of the 293 measured children (62% black, 33% white, 5% other), 2% were <5th percentile, 6% were ≥5th and <20th percentiles, 18% were ≥20th and <50th percentiles, 30% were ≥50th and <85th percentiles, 17% were ≥85th and <95th percentiles, and 27% were ≥95th percentile. Thus, it would have been difficult to identify enough LBMI children had the upper limit for LBMI been set at the 20th percentile.

From the subset of LBMI and HBMI children, and with the constraints that each BMI group have 10 boys and 15 black children, 20 LBMI and 20 HBMI children were randomly selected and observed eating school meals in December, 2002. Observed children were randomly assigned to be interviewed that evening about the prior 24 hours (24E) or the next morning about the previous day (PDM), with the constraints that each interview protocol have 10 LBMI (5 boys) and 10 HBMI (5 boys). A $15 check was mailed to each interviewed child.

The 40 children interviewed for this study were a subset of 120 children interviewed once each in August or September, 2002 for another study that sampled children irrespective of BMI (21).

Observations

One of two research dietitians observed each child eating breakfast and lunch at school on a school day. Observers followed established procedures to record items and amounts eaten in servings on paper forms (22–25). Due to difficulty identifying contents of meals brought from home, only children who obtained meals at school were observed (26). Entire meal periods were observed so that trading of food items could be noted (27–30). An observer stood by the table(s) where children regularly sat and observed one to three children while appearing to observe the entire class or group. Although children generally knew when observations occurred, they did not know specifically who was being observed, who would be interviewed, whether an interview would be 24E or PDM, and that only LBMI and HBMI children would be interviewed. Five days of practice observations per school were conducted prior to data collection to familiarize children with an observer's presence (23,25,30).

Interobserver reliability was assessed weekly throughout data collection using established procedures (23–25,31). Assessment on six children from three schools indicated 98% agreement across two observers for food items for which amounts observed eaten were within ¼ serving; this level of agreement is satisfactory (30,32).

Interviews

One of three research dietitians interviewed each child. Except for five children for whom breakfast had been observed by the interviewer, a child's interviewer had not observed that child's meals. Evening interviews were conducted by telephone between 6:30 p.m. and 9:00 p.m. on the day the child was observed. Morning interviews were conducted in person after breakfast at school on the day after the child was observed. (A validation study during the 2001–2002 school year (23) found no significant effect of interview modality [telephone vs. in-person] on fourth-graders' reporting accuracy.) Neither training nor interview tools were provided to children. During the interview, children were asked to report amounts eaten in servings, and told "a serving or helping is how much you were given or how much you got yourself."

Interviewers followed a multiple-pass protocol modeled on that of the Nutrition Data System for Research (NDS-R, version 4.05_33, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, 2000), which has frequently been used with children (33–41); however, interviewers wrote information reported by children onto paper forms instead of using NDS-R computerized entry. Interviews were also audio-recorded and transcribed.

The NDS-R protocol, which concerns the previous day (42), was adapted for interviews about the prior 24 hours, as was done previously (25). Children interviewed using the 24E protocol were asked to report intake for the interview day first, followed by intake for the previous evening (43). Table 1 describes the interview protocols.

Quality control for interviews was assessed throughout data collection using established procedures (23–25,44). Analysis of a randomly selected 27–33% of each interviewer's audio-recordings, along with their respective transcriptions and interview forms, indicated satisfactory adherence to interview protocols.

Analyses

Only school breakfast and school lunch were observed, so analyses were restricted to these parts of children's reports. As in previous studies (22–25), for reported items to be considered reports about school meals, children had to identify *school* as the location where items were eaten, refer to breakfast as *school breakfast* or *breakfast* and to lunch as *school lunch* or *lunch*, and report mealtimes to within an hour of observed mealtimes.

Each item was classified as a *match* if it was observed and reported eaten at the same meal, an *omission* if it was observed but not reported eaten at the same meal, or an *intrusion* (ie, false or phantom report) if it was reported but not observed eaten at the same meal (22–25,46–48). Because children can report foods many ways, reported items were scored as matches unless they clearly did not describe observed items; this may have overestimated reporting accuracy (22–25,46).

As in previous studies (22–25,45,46), values assigned to the qualitative labels used during observations and interviews were *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 was observed or reported. For each item observed and/or reported, standardized serving sizes provided for school meals were used to obtain per serving information about kilocalories from the NDS-R database; for items not in NDS-R, kilocalorie information from the school district's nutrition program was used. For each child, after classifying each item as a match, omission, or intrusion, serving size and kilocalories/serving information were used to estimate values of five kilocalorie variables – observed kilocalories, reported kilocalories, matched kilocalories, omitted kilocalories, and intruded kilocalories – as defined in the Table 2 legend. Although the estimates of kilocalories observed and kilocalories reported yielded by these approaches may be imprecise, the same approaches were used for observed items and reported items.

For each kilocalorie variable, a four-factor (BMI group, sex, race, interview protocol) analysis of variance was conducted using SAS (Version 8.2, SAS Institute, Inc., Cary, NC, 2001). The BMI group × sex and sex × race interactions were included in each model. A significance criterion of 0.05 was established.

Results and Discussion

As shown in Table 2, more kilocalories were *observed* eaten ($p<0.02$) by HBMI than LBMI children. However, for *reported* kilocalories, no tested effect was statistically significant.

For *matched* kilocalories, no tested effect was statistically significant. However, more kilocalories were *omitted* ($p<0.05$) by HBMI than LBMI children. (Higher omitted kilocalories represent lower reporting accuracy.) The BMI effect for omitted kilocalories is consistent with the BMI effect for observed kilocalories and the absence of a BMI effect for reported kilocalories.

High BMI girls *intruded* fewer kilocalories than LBMI girls, whereas HBMI boys intruded more kilocalories than LBMI boys (interaction $p<0.04$). High BMI girls intruded the fewest kilocalories, while LBMI girls intruded the most. (Higher intruded kilocalories represent lower reporting accuracy.)

For interview protocol, *omitted* and *intruded* kilocalories were higher, although not significantly so ($ps<0.11$), for PDM than 24E. This was anticipated because the time interval between eating and reporting was longer for PDM than 24E (24).

No other effects or interactions were statistically significant.

There are several limitations. The sample size was small. Observations included two school meals instead of an entire 24 hours. Five children were interviewed by the same dietitian who had observed their breakfast. Qualitative labels were used for amounts during observations and interviews, and converted to quantities for analyses.

Several strengths offset the limitations. Children provided reports *without* assistance from parents so *children's* reporting accuracy could be determined. Observations were used to validate two meals from children's dietary reports. Quality control occurred throughout the study for measurements, observations, and interviews. Analytic techniques were consistently applied to all observed items and to all reported items. Omitted and intruded kilocalories were analyzed separately because they characterize different aspects of reporting accuracy (47–50).

Conclusions

Results from this pilot study provide insight into BMI, sex, interview protocol, and *children's* dietary reporting accuracy. Specifically, children's reporting accuracy was affected significantly by BMI group and by BMI group × sex. High BMI children ate more kilocalories, and omitted more kilocalories, than LBMI children. High BMI girls intruded the fewest kilocalories and LBMI girls intruded the most kilocalories. These results are consistent with those concerning BMI and sex from studies with adults. Overall reporting accuracy was better the same evening than the next morning, although this difference was not significant.

To our knowledge, this is the first validation study to investigate BMI, sex, interview protocol, and *children's* dietary reporting accuracy. [The study mentioned in the introduction included only four elementary-school age boys (16).] To better understand the relationship between BMI, sex, interview protocol, and *children's* dietary reporting accuracy, validation studies with larger numbers of children by sex, race, and BMI group are needed. Validation studies should obtain dietary reports from children *without* assistance from parents to determine the extent to which children's dietary reporting accuracy is related to their own characteristics (eg, BMI, sex).

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Table 1

Description of two interview protocols

Previous day morning (PDM) protocol patterned after NDS-R (41)– for children interviewed in the morning after breakfast about the previous day's intake (eg, a child interviewed using the PDM protocol for an interview conducted at 9:00 a.m. on Tuesday morning was asked about intake on Monday from midnight to midnight):
1st pass: Quick list is obtained; *"After you got up yesterday morning, when was the first time you had something to eat or drink? What did you eat or drink at that time? When was the next time after ____ that you had something to eat or drink? What did you eat or drink…?"* (This process is repeated to cover yesterday's intake in chronological order.)
2nd pass: Quick list is reviewed; interviewer repeats back everything child reported at each time, and asks *"Can you think of anything else you ate at that time?"* and *"Can you think of anything else you drank at that time?"* (This process is repeated to review yesterday's intake in chronological order.)
3rd pass: Beginning with the first time yesterday morning and proceeding in chronological order, the child is asked to identify eating occasions, location of meals, details, additions, and amounts consumed.
4th pass: Each eating occasion is reviewed with the child for correctness, beginning with the first time yesterday morning and proceeding in chronological order, and the child is asked if s/he ate or drank anything else.
24 hour evening (24E) protocol adaptation (24,42)– for children interviewed in the evening between 6:30 p.m. and 9:00 p.m. about intake for the 24 hours prior to the time the interview started (eg, a child interviewed using the 24E protocol for an interview conducted at 8:00 p.m. on Tuesday night was asked about intake between 8:00 p.m. on Monday and 8:00 p.m. on Tuesday):
1st pass: Quick list is obtained; *"After you got up this morning, when was the first time you had something to eat or drink? What did you eat or drink at that time? Did you eat or drink anything else at that time? When was the next time after ____ that you had something to eat or drink? What did you eat or drink at that time? Did you eat or drink anything else at that time?"* (This process is repeated to cover today's intake in chronological order.) *"Now that we have talked about what you ate or drank today, let's talk about what you had yesterday. Let's start with this time last night. After (interview start time) last night, when was the first time you had something to eat or drink? What did you eat or drink at that time? Did you eat or drink anything else at that time? When was the next time after ____ that you had something to eat or drink? What did you eat or drink at that time? Did you eat or drink anything else at that time?"* (This process is repeated to cover the last night's intake in chronological order until the child indicates s/he went to bed and got up this morning.)
2nd pass: Quick list is reviewed; interviewer repeats back everything child reported at each time, and asks *"Can you think of anything else you ate at that time?"* and *"Can you think of anything else you drank at that time?"* (This process is repeated to review today's intake, beginning with the first time this morning and proceeding in chronological order, and then reviewing last night's intake.)
3rd pass: Beginning with the first time this morning and proceeding in chronological order until the time the interview started, and then reviewing last night's intake, the child is asked to identify eating occasions, location of meals, details, additions, and amounts consumed for each meal or snack.
4th pass: Each eating occasion is reviewed with the child for correctness, beginning with the first time this morning and proceeding in chronological order until the time the interview started before reviewing last night's intake, and the child is asked if s/he ate or drank anything else.

Table 2

Least squares means (and standard errors) for five kilocalorie[a] variables by body mass index (BMI) group, sex, race, interview protocol, and BMI group × sex

	n	Observed kilocalories[b]	Reported kilocalories[c]	Matched kilocalories[d]	Omitted kilocalories[e]	Intruded kilocalories[f]
BMI Group						
High[g]	20	909(58)[b]	653(65)	453(69)	456(53)[e]	200(42)
Low[h]	20	720(62)[b]	658(69)	412(73)	309(57)[e]	247(44)
Sex						
Girls	20	813(74)	617(83)	409(88)	403(68)	207(53)
Boys	20	816(56)	694(63)	455(67)	361(51)	239(40)
Race						
Black	30	765(46)	639(51)	406(54)	359(42)	233(33)
White	10	864(82)	672(92)	458(97)	406(75)	214(59)
Interview Protocol[i]						
24E	20	765(63)	623(70)	449(75)	316(58)[e]	174(45)[f]
PDM	20	864(62)	688(69)	415(73)	449(57)[e]	272(44)[f]
BMI Group×Sex						
High BMI Girls	10	963(87)	597(97)	474(103)	489(80)	123(62)[f]
Low BMI Girls	10	662(95)	636(106)	345(113)	317(88)	291(68)[f]
High BMI Boys	10	855(78)	708(87)	432(93)	423(72)	277(56)[f]
Low BMI Boys	10	778(78)	680(88)	478(93)	300(72)	202(56)[f]

[a] kilocalories: Amounts observed and/or reported eaten in servings were converted as follows: *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 was observed or reported. For each item observed and/or reported, the standardized serving sizes provided for school meals by the school district's nutrition program were used to estimate per serving kilocalories from the NDS-R database; for items not in NDS-R, kilocalorie information from the school district's nutrition program was used. For each child, after classifying each item as a match, omission, or intrusion, serving size and kilocalories/serving information were used to estimate values of five kilocalorie variables – observed kilocalories, reported kilocalories, matched kilocalories, omitted kilocalories, and intruded kilocalories. Although the estimates of kilocalories observed and kilocalories reported yielded by these approaches may be imprecise, the same approaches were used for observed items and reported items.

[b] Observed kilocalories: Total kilocalories from amounts of items observed eaten at school breakfast and school lunch. Significantly more kilocalories were observed eaten by HBMI children than by LBMI children ($p<0.02$).

[c] Reported kilocalories: Total kilocalories from amounts of items reported eaten at school breakfast and school lunch. Reported kilocalories did not differ significantly by BMI group, sex, race, interview protocol, BMI group × sex, or sex × race.

[d] Matched kilocalories: Total kilocalories from amounts of items reported eaten at school breakfast and school lunch that were observed eaten in the same amounts and at the respective school meals. Matched kilocalories did not differ significantly by BMI group, sex, race, interview protocol, BMI group × sex, or sex × race.

[e] Omitted kilocalories: Total kilocalories from amounts of items that were observed eaten at school breakfast and school lunch but were not reported eaten at all at the respective meals, and for items for which the amounts were reported in smaller quantities than were observed eaten at the respective meals. Higher omitted kilocalories represent lower reporting accuracy. Significantly more kilocalories were omitted by HBMI children than by LBMI children ($p<0.05$). More kilocalories were omitted by children who were interviewed in the morning about the previous day's intake than by children who were interviewed in the evening about the prior 24-hours' intake, although the difference was not significant ($p<0.10$).

[f] Intruded kilocalories: Total kilocalories from amounts of items that were reported eaten at school breakfast and school lunch but were not observed eaten at all at the respective meals, and for items for which the amounts were reported in greater quantities than were observed eaten at the respective meals. (Intruded kilocalories may be referred to as false or phantom kilocalories.) Higher intruded kilocalories represent lower reporting accuracy. More kilocalories were intruded by children who were interviewed in the morning about the previous day's intake than by children who were interviewed in the evening about the prior 24-hours' intake, although the difference was not significant ($p<0.11$). Among HBMI children, significantly fewer kilocalories were intruded by girls than by boys; however,

among LBMI children, significantly more kilocalories were intruded by girls than by boys (interaction $p<0.04$). High BMI girls intruded the fewest kilocalories and LBMI girls intruded the most kilocalories.

[g] High BMI Group: Children with sex-specific BMI-for-age percentiles $\geq 85^{th}$.

[h] Low BMI Group: Children with sex-specific BMI-for-age percentiles $\geq 5^{th}$ and $<50^{th}$.

[i] Interview protocol: 24E=24 hour evening. Children interviewed using the 24E protocol were asked about the prior 24-hours' intake by telephone in the evening between 6:30 p.m. and 9:00 p.m. on the day school breakfast and school lunch were observed eaten. PDM = previous day morning. Children interviewed using the PDM protocol were asked about the previous day's intake in person at school in the morning after breakfast on the day after school breakfast and school lunch were observed eaten.