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Quantifying Calcium Intake in School Age Children: Development and Validation of the Calcium Counts!® Food Frequency Questionnaire

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Abstract

Quantifying dietary behavior is difficult and can be intrusive. Calcium, an essential mineral for skeletal development during childhood, is difficult to assess. Few studies have examined the use of food frequency questionnaires (FFQs) for assessing calcium intake in school-age children. This study evaluated the validity and reliability of the Calcium Counts!® FFQ (CCFFQ) for estimating calcium intake in school children in the US. Healthy children, aged 7–10 years ($n = 139$) completed the CCFFQ and 7-day weighed food records. A subset of subjects completed a second CCFFQ within 3.6 months. Concurrent validity was determined using Pearson correlations between the CCFFQ and food record estimates of calcium intake, and the relationship between quintiles for the two measures. Predictive validity was determined using generalized linear regression models to explore the effects of age, race, and gender. Inter- and intra-individual variability in calcium intake was high (>300 mg/day). Calcium intake was ~ 300 mg/day higher by CCFFQ compared to food records. Concurrent validity was moderate ($r = 0.61$) for the entire cohort and higher for selected subgroups. Predictive validity estimates yielded significant relationships between CCFFQ and food record estimates of calcium intake alone and in the presence of such potential effect modifiers as age group, race, and gender. Test–retest reliability was high ($r = 0.74$). Although calcium intake estimated by the CCFFQ was greater than that measured by food records, the CCFFQ provides valid and reliable estimates of calcium intake in children. The CCFFQ is especially well-suited as a tool to identify children with low calcium intakes.

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Dietary behavior can have important implications for health and survival, but like many aspects of human behavior, it is difficult to quantify. Observational or self-recorded diary techniques for assessing dietary intake are burdensome and can alter patterns of food behavior. Other approaches, such as food recall interviews or food frequency questionnaires (FFQs), are subject to bias from memory or normative concepts of food consumption. Characterizing dietary behavior in children is further complicated by their level of independence and the degree to which caretakers are aware of the food that they consume throughout the day.

Adequate calcium intake during childhood may have long-lasting benefits, from optimizing peak bone mass in young adulthood (NIH, 1994) to preventing hip fractures in older adulthood (Kalkwarf et al., 2003). Short-term benefits during childhood include increased bone density (Johnston et al., 1992; Lee et al., 1994; Lloyd et al., 1992; Specker and Binkley, 2003) and lowered blood pressure (Gillman et al., 1995). In adults, a high calcium intake is associated with lower blood pressure (Gillman et al., 1995; Hajjar et al., 2003; McCarron et al., 1984; Townsend et al., 2005), and reduced risk of colon cancer (Baron et al., 1999; Wu et al., 2002) and metabolic syndrome (Liu et al., 2005). Because of calcium's important role in health during childhood, there is considerable need for a reliable and feasible tool to assess calcium intake.

Assessment of calcium intake is problematic. Calcium occurs in high concentrations in a limited number of foods, and day-to-day fluctuations in consumption impact the estimation of true calcium intake. Traditional tools for assessing calcium intake such as a 24-h dietary recall or 3- or 7-day food records can be inaccurate, burdensome, or both. A FFQ targeting high calcium foods, and foods lower in calcium but eaten frequently, provides an alternative for estimating calcium intake.

Calcium FFQs have been developed for preschool children (Huybrechts et al., 2006; Marshall et al., 2003; Taylor and Goulding, 1998), preteens (Bertoli et al., 2005), adolescents (Harnack et al., 2006; Jensen et al., 2004; Magkos et al., 2006; Moore et al., 2007; Wong et al., 2008), and adults (Brown and Griebler, 1993; Krall et al., 1989; Lee et al., 1994; Ritenbaugh et al., 1997). Preteen children are a particularly important age group since calcium requirements increase at 9 years of age, yet intake typically fails to keep pace with this increased need (Ervin et al., 2004). There are no calcium FFQs that have been validated for preteen children in the United States, where ethnic preferences and lifestyles may affect calcium intake and the reporting of calcium intake. This study describes the validation of the Calcium Counts!® FFQ (CCFFQ) in 7- to 10-year-old children relative to 7-day weighed food records (7D-records) using multiple validation criteria, with consideration of age, gender, and racial group that may influence the accuracy of the instrument.

METHODS

Subjects

Healthy children, aged 7–10 years, were recruited to participate in the *Building Better Bones in Childhood* study. Families were recruited from pediatric practices and from the surrounding community, using flyers and newspaper advertisements. Exclusion criteria included chronic medical conditions; use of medications known to affect growth, sexual development, nutritional status, or dietary intake; reported weight (prior to study enrollment) greater than 130% of ideal body weight; and height or weight for age less than the third percentile. Informed consent was obtained from the parent or guardian, and assent was obtained from subjects. This protocol was approved by the Committee for the Protection of Human Subjects at The Children's Hospital of Philadelphia (CHOP).

Calcium-intake assessment methods

7D-records—7D-records were used as the reference method to estimate calcium intake. Parents were provided with digital food scales (Sunbeam Products, Bridgeview, IL), and measuring cups and spoons. Verbal and written instructions for keeping a food record were provided. Returned 7D-records were reviewed by a registered dietitian (RD) for completeness, and families were contacted to resolve any questions regarding entries. A final rating (good, fair, poor) of the overall quality of the 7D-records was assigned based on completeness of information (e.g., were data for meals missing?) and level of detail provided (e.g., were portion sizes indicated?). Those rated as poor quality were dropped from consideration due to the gold-standard nature of the criterion needed for this study. Nutrient analysis was performed by an experienced research diet technician (Minnesota Nutrition Data System, Minneapolis, MN) (Nutrition Coordinating Center, 1998).

The Calcium Counts!® Food Frequency Questionnaire—A calcium FFQ developed for adults (Krall et al., 1989) was reviewed and modified for pediatric use by a panel of experienced pediatric research dietitians. Questionnaire items were adjusted to represent foods and beverages frequently consumed by children, based upon a review of the Data from the Continuing Survey of Food Intakes by Individuals (CSFII) for African-American and Caucasian children (Continuing Survey of Food Intakes by Individuals (CSFII), 1988). Since the CHOP patient population is mainly African-American and Caucasian, these two ethnic groups were targeted. Foods and beverages that contributed more than 50 mg/day of calcium were included.

The revised questionnaire, designed to be administered by interview with standardized instructions and script, food models, and serving containers, contained 41 food items. The items included beverages (milk, hot chocolate, calcium fortified juices, and milkshakes), other dairy products (ice cream and ice cream products, yogurt, and cheese), combination foods, and other calcium sources (e.g., pizza, Italian dishes with cheese, cheeseburgers, sandwiches with cheese, macaroni and cheese, kale, turnip and collard greens, candy bars containing milk chocolate, and commonly calcium-supplemented items such as waffles, granola/cereal snack bars). Calcium content of nutritional supplements was recorded.

Subjects were asked to report the frequency of consumption and portion size over the previous 4 weeks. Serving sizes were based on typical serving sizes of foods, e.g., one cup of milk, one slice of pizza. The number of servings consumed per day, week, month (or never) was recorded. For foods consumed frequently, the response might be recorded as two servings per day (i.e., two cups of milk per day). For less commonly consumed items, the response might be two servings per month (lasagna two cups per month). Following the interview, a quality rating (good, fair, poor) was determined subjectively by the interviewer. A computer program (FileMaker Pro) was utilized to allow for computerized calculation of calcium intake by the CCFFQ.

To capture the most complete account of the foods and beverages consumed by the child, the CCFFQ was administered to both the parent/guardian and child together by an RD. The 7D-records were completed during the week following the visit. Half the sample was randomly selected (stratified by race and gender) for a second administration of the CCFFQ to estimate the temporal stability (reliability) of the instrument. Subjects returned for a second visit within 3.6 months of the initial visit.

Data collection methods

Height, weight, and body mass index (BMI) were assessed by standard methods (Lohman et al., 1988) as previously described (Buisson et al., 2006), and Z-scores were calculated (Kuczmarski et al., 2000). Pubertal status was determined using a self-assessment questionnaire (Morris and Udry, 1980) to determine Tanner stage (Tanner, 1962), as previously validated in our laboratory (Schall et al., 2002). Children in breast or genital stage 1 were classified as prepubertal, and stages greater than 1 were classified as pubertal. Families also provided information on educational level attained for the primary caretaker, household income, and the self-identified race of the child by questionnaire. Children were categorized as African-American or non-African-American. This categorization was used because of racial differences in food preferences, and the small number of minority participants other than African-Americans.

Statistical analysis

Initial comparisons of calcium intake from the CCFFQ and 7D-Records were made for the whole group, and for specific subgroups based on age [7- to 8-year-olds (younger), 9- to 10-year-olds (older)], race (African-American, non-African-American), and gender, using traditional paired *t*-tests.

Using 7D-Records, the number of days necessary to estimate true calcium intake was calculated using the formula developed by Beaton et al. (1979) and described by Willett (1998b):

$$n = (Z_{\alpha} CV_{\omega} / D_0)^2$$

where *n* is the number of observation days needed per person; *Z_α* is the standard normal deviate associated with a given confidence interval (i.e., 1.96 for a 95% confidence interval); *CV_ω* is the within-person coefficient of variation; and *D₀* is the user-specified limit of

accuracy expressed as a percentage of long-term true intake. For the limit of accuracy, we used three clinically derived ranges within which mean calcium intake values could easily be interpreted: 100, 200, and 300 mg of calcium. These values were divided by the mean calcium intake for the sample to compute the percentage of long-term intake. In other words, this formula was used to compute the number of food record days needed to estimate a true calcium intake within three levels of accuracy, e.g., 800 ± 100 , 800 ± 200 , and 800 ± 300 mg/day.

To assess reliability, we estimated the temporal stability of the CCFFQ over time (median 32 days, 7–111 days) for the group and the aforementioned subgroups using traditional Pearson-*r* correlation coefficients, and deattenuated correlation coefficients as proposed by Willett (Willett, 1998a). To assess the criterion-related validity, concurrent criterion validity was evaluated by correlating calcium intake estimated from the CCFFQ with that estimated by the food record using a Pearson-*r* correlation coefficient, and then further evaluated it by testing the relationship between quintiles of the two measures using the Jonckheere–Terpstra test of significance (a doubly ordered $R \times C$ analog of Fisher's exact test using Monte Carlo simulation). Predictive criterion validity was then evaluated through the use of generalized linear models. Because of the multiplicity of tests conducted, the hypothesis-wise error rate for all analyses conducted here was set at the $\alpha = 0.01$ level using Tukey, Ciminera, and Heyse's adjustment for 20 highly correlated endpoints (Zhang et al., 1997). Data were analyzed using SAS 9.1 (SAS Institute, Cary, NC) and STATA 10.0 (Stata Corp, College Station, TX).

RESULTS

Sample characteristics

The study enrolled 139 children (62% female; 30% African-American). Subjects were, on average, within the normal range for height, weight, and BMI (Table 1). Seven percent were in the overweight range (BMI 95th percentile for age and sex) and 59% were prepubertal. Household income and education levels of the primary caregivers were distributed across a broad range of categories. Forty-nine percent had an annual household income level below \$60,000 (17% below \$30,000; 27% above \$80,000). The educational level of the primary caretaker was as follows: 19% never attended college, 32% had achieved some college education; and 23% achieved a graduate degree.

Comparison of mean calcium intake levels

All subjects completed a CCFFQ. Three interviews received a “Poor” quality rating because of poor recall or inability to estimate portion sizes. Because this study is a validation study, all cases were included in the analysis as a means of fully characterizing the validity and reliability of the CCFFQ. Mean (SD) calcium intake according to the CCFFQ was 1,192 (537) mg/day (Table 2).

Of the 139 enrolled subjects, 124 subjects returned 7D-Records. Of these, 104 subjects completed usable 7D-Records. The 7D-Record was used as the reference method, and so only those records receiving a good or fair rating by RD review were used in the analysis.

Subjects with unusable food records (poor rating) tended to be older ($P = 0.06$), were of African-American race ($P < 0.01$), had lower household income ($P = 0.04$), and had lower educational levels of the primary caretaker ($P < 0.01$), than those with usable 7D-Records.

Mean (SD) calcium intake according to the 7D-record was 885 (347) mg/day. The intraindividual standard deviation for calcium intake across the 7 days was 322 mg/day, and the coefficient of variation was 39%. Using these data with the Beaton formula (Beaton et al., 1979), we estimated that the number of food record observation days required to calculate mean calcium intake with an accuracy of 100 mg was 47 days; at the 200 mg level, the number of required days was 12 and at the 300 mg level, 6 days of observation were required.

On average, calcium intake estimated by the CCFFQ was 300 mg/day higher ($P < 0.01$) than the calcium intake estimated by the 7D-Records. The difference was larger for younger children (367 mg/day, $P < 0.01$) than older children (268 mg/day, $P < 0.01$), and larger for females (318 mg/day) than for males (275 mg/day). When comparing the CCFFQ with the 7D-records (Table 2), the calcium intake was 164 mg/day higher on the CCFFQ for African-American children ($P = 0.12$), and 337 mg/day higher for non-African-American children ($P < 0.01$).

Reliability and temporal stability

A second CCFFQ was administered to 61 children within 3.6 months of the initial study visit. The median time interval between the initial and second test was 32 days. Test-retest reliability (temporal stability) was high for the group ($r = 0.74$, deattenuated $r = 0.77$). The temporal stability of the measure was 0.69 (deattenuated $r = 0.73$) for 9- and 10-year-olds and 0.89 (deattenuated $r = 0.90$) for 7- and 8-year-olds. Test-retest reliability estimates for gender and racial subgroups were as follows: females ($r = 0.72$, deattenuated $r = 0.74$), males ($r = 0.81$, deattenuated $r = 0.86$), African-Americans ($r = 0.66$, deattenuated $r = 0.72$), non-African-Americans ($r = 0.79$, deattenuated $r = 0.82$). All coefficients were significantly different from zero ($P < 0.01$).

Criterion-related validity

Concurrent validity. Correlations between calcium intake estimated by the CCFFQ and the 7D-records were moderate for the sample as a whole ($r = 0.61$). Concurrent validity estimates for the specific subgroups were as follows: younger children ($r = 0.43$), older children ($r = 0.67$), females ($r = 0.59$), males ($r = 0.64$), African-Americans ($r = 0.35$), and non-African-Americans ($r = 0.66$). Quin-tiles from the two measures were then compared using cross-classification analysis (Table 3), yielding a statistically significant association between the two sets of quin-tiles and a 74% correct classification (same or adjacent quintile) rate ($P < 0.01$).

Predictive validity. Statistically significant relationships were observed when calcium intake from the CCFFQ was used to predict calcium intake by 7D-records within the context of both single and multiple linear regression prediction equations. In both the adjusted and unadjusted models, the beta coefficients for CCFFQ remained stable at 0.40 and 0.41,

irrespective of the number and type of covariates added. While addition of an age group term to the unadjusted model improved model fit (partial $R^2 = 0.04$), inclusion of a gender or race term did not (Table 4).

Further evaluation of these predictive models revealed that for the lowest 25% of calcium intake values (calcium intake < 650 mg/day), the CCFFQ prediction equation tended to underestimate average 7D-record values by 204 mg/day on average (range -493 to 21 mg/day). For those with higher calcium intakes, the CCFFQ prediction equation tended to more closely estimate calcium intake on average but with a broader range of variability (see Fig. 1). Thus, for children with lower calcium intake, the calcium intake estimated by the CCFFQ underestimated true intake, but the estimate was more reliable (i.e. less variable) than it was for children with higher calcium intakes.

DISCUSSION

Calcium intake of school-age children in the United States declines with age across racial groups in both genders (Alaimo et al., 1994), despite the increasing requirement for calcium to support the rapid growth that occurs in early adolescence (Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, The Institute of Medicine, 1997). In addition, the increasing dietary independence of children as they mature makes it difficult to measure nutrient intake and monitor dietary changes. Dietary assessment tools that are minimally intrusive are likely to be met with greater acceptance in older children, but are only useful if they provide valid and reliable results. FFQs, in general, are widely used, easy to administer, and may be more appropriate for estimating intake of nutrients, such as calcium, that tend to occur in a relatively small number of foods compared to more ubiquitous nutrients such as fat and protein (Kristal et al., 2005). Our findings support the reliability and validity of the CCFFQ in Caucasian and African-American children aged 7–10 years.

There are virtually no studies that have evaluated the use of a FFQ to estimate calcium intake in younger US school-age children. Table 5 summarizes the FFQ validation studies for preschool or older school-age groups of children. Most FFQs, like our CCFFQ, overestimated calcium intake compared to reference methods, but showed good correspondence. Different patterns of agreement in subgroups based on age, gender, and ethnicity have been observed (Jensen et al., 2004; Moore et al., 2007; Wong et al., 2008).

Only one small study of Italian children addressed the validity of assessing calcium intake by FFQ in 6- to 10-year-old children (Bertoli et al., 2005), using a 139-item FFQ for calcium and macronutrients compared to 7-day food records. The Pearson correlation coefficient for calcium intake was 0.77; 62% of subjects were correctly classified under the same or adjacent terciles of intake. Calcium intake was overestimated by 48% by their FFQ when compared to the food records.

Generally, we found similar or better validity (agreement between CCFFQ and food records: $r = 0.61$ and 72% correct classification) and reliability (test-retest $r = 0.74$) results compared to other studies in children (see Table 5). Age of the child, adult assistance, and ethnicity

may be important in the validity of the results obtained from a FFQ. Ours and other studies suggest that FFQs can give good estimates of the relative ranking of calcium intake (low vs. high intake). Most FFQs overestimate absolute intake. This may be due to a tendency for subjects to describe “ideal” intake by FFQ interview rather than “actual” intake as described by prospectively weighing food items for food records.

The intraindividual, or day-to-day, variation in calcium intake measured by 7D-records was 322 mg/day. This is approximately equivalent to a cup of milk. So, an accurate (within 100 mg) estimate of true calcium intake would require 47 days of food records. Clearly, this is prohibitive, yet underscores the need for measurement of calcium intake over longer periods of time to accurately estimate intake. Although we used 7D-records as a “gold standard” with which to validate the CCFFQ, it clearly had limitations in estimating calcium intake and was not completed by all subjects because of the high participant burden. The excellent agreement of results for the CCFFQ in the test–retest analysis demonstrated that respondents were able to consistently report their intake of calcium-containing foods based on a 4-week recall period.

We used regression models (Table 4) and the CCFFQ results to predict calcium intake by 7D-records. The use of this equation adjusts for the overestimation of calcium intake by the CCFFQ and could be used to calculate calcium intake for comparison with the adequate intake (AI) for calcium (Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, The Institute of Medicine, 1997). Our results showed that the variability between dietary assessment methods was better at lower calcium intakes than at higher calcium intakes, indicating that the CCFFQ worked well to identify children with low calcium intake. Generally, low calcium intake is of greatest interest because of its adverse health effects such as poor bone mineral accrual and higher blood pressure levels.

The CCFFQ has several advantages over food records. The primary advantage is the reduction in participant burden and greater likelihood of complete data when using the CCFFQ compared to weighed food records. The CCFFQ was also time- and cost-efficient; the interview takes ~ 15 min to complete, and the analysis requires only 15–30 min at minimal cost. Furthermore, 98% of CCFFQ interviews were rated as usable by an RD, whereas only 75% of the 7D-records were rated as usable.

The CCFFQ has some limitations, including difficulty in recall, interviewing a parent/guardian not fully knowledgeable about a child's intake, and high variability in household availability of high calcium foods making it difficult to estimate the frequency of consumption. These factors were taken into consideration in determining the quality rating of the CCFFQ. In addition, the CCFFQ was tested in African-American and Caucasian children 7–10 years of age in the United States and may not be applicable for children in different age or ethnic/race categories, or in a self-administered format. Nevertheless, the CCFFQ had clear advantages, including reduced participant burden, greater likelihood of complete data (98%), and time and cost efficiency.

CONCLUSION

Calcium intake is highly variable and can be difficult to assess in school-age children. Furthermore, calcium intake is often suboptimal in US children, which in turn may have both short- and long-term detrimental health consequences. The CCFFQ is a user-friendly and valid method for assessing calcium intake and can be used reliably among 7- to 10-year-old US children. It can be used in both research and clinical settings to estimate calcium intake and would serve exceptionally well as a tool for identifying children or groups of children with low calcium intake who might benefit from nutrition interventions aimed at increasing calcium intake.

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Fig. 1.

The final adjusted multiple covariate model from Table 4 was used to calculate the difference between predicted and observed calcium intake in the lowest quartile of calcium intake, the middle two quartiles, and the highest quartile of calcium intake. The figure demonstrates the increasing variability in predicted calcium intake as calcium intake (by weighed food records) increased.

TABLE 1

Sample characteristics

Variable	Girls (<i>n</i> = 86)	Boys (<i>n</i> = 53)	Total (<i>n</i> = 139)
Age (year)	8.9 (1.1)	9.0 (1.1)	8.9 (1.1)
Weight (kg)	31.1 (7.5)	30.7 (7.2)	30.9 (7.4)
Weight-Z	0.2 (1.0)	0.2 (0.9)	0.2 (0.9)
Height (cm)	133.6 (9.2)	134.0 (7.7)	133.8 (8.7)
Height-Z	0.2 (1.0)	0.1 (0.8)	0.2 (1.0)
BMI (kg/m ²)	17.2 (2.3)	16.9 (2.5)	17.1 (2.4)
BMI-Z	0.2 (0.9)	0.1 (0.9)	0.2 (0.9)

All values represent mean (SD).

TABLE 2

Calcium intake (mg/day) by age, gender, and race subgroups

Variable	CCFFQ			7D-Record			Difference		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Whole group	139	1,192	537	104	885	347	104	300	414
Age group									
Younger	40	1,099	464	34	776	270	34	367	430
Older	99	1,229	561	70	937	370	70	268	405
Gender									
Male	53	1,194	492	43	950	373	43	275	392
Female	86	1,190	565	61	838	323	61	318	431
Race									
African American	42	1,058	533	22	822	336	22	164	473
Non-African American	97	1,249	530	82	901	351	82	337	392

Younger age group is 7–8 years; older age group is 9–10 years of age.

TABLE 3

Cross-classification analysis of quintiles for CCFFQ scores and 7D-Record scores

CCFFQ quintile (range)	7D-Record quintiles (range)				
	Quintile 1 (616)	Quintile 2 (617, 739)	Quintile 3 (740, 894)	Quintile 4 (895, 1,132)	Quintile 5 (1,133)
Q1 (696)	11	4	3	2	0
Q2 (697, 957)	6	4	4	5	2
Q3 (958, 1,310)	2	4	8	5	2
Q4 (1,310, 1,554)	1	4	5	6	5
Q5 (1,554)	0	5	1	3	12

 $n = 104$; $P < 0.0001$.

TABLE 4

CCFFQ adjusted and unadjusted single and multiple covariate models ($n = 104$)

Covariate	β Coefficient	SE	t	P	Model P -value	R^2
Unadjusted single covariate model						
CCFFQ model					<0.01	0.37
CCFFQ score	0.41	0.05	7.77	<0.01		
Intercept	402.65	67.66	5.95			
Adjusted single covariate models						
Age group model					<0.01	0.41
Age group	136.11	56.60	2.40	0.02		
CCFFQ score	0.40	0.05	7.81	<0.01		
Intercept	319.15	74.69	4.27			
Racial group model					<0.01	0.37
Race	-23.71	68.07	-0.35	0.73		
CCFFQ score	0.41	0.05	7.66	<0.01		
Intercept	416.95	79.39	5.25			
Gender model					<0.01	0.39
Gender	84.32	54.84	1.54	0.13		
CCFFQ score	0.40	0.05	7.71	<0.01		
Intercept	374.02	69.75	5.36			
Adjusted multiple covariate model						
Final model					<0.01	0.42
Age group	129.49	56.83	2.28	0.02		
Race	-15.32	66.38	-0.23	0.82		
Gender	73.45	54.24	1.35	0.18		
CCFFQ score	0.40	0.05	7.59	<0.01		
Intercept	307.50	86.93	3.54			

Covariates were coded as follows: Age group (0 = younger; 1 = older), Race (0 = non-African Americans; 1 = African Americans), Gender (0 = male; 1 = female).

TABLE 5

Summary of other calcium FFQ validation studies in children

Reference	Country	Sample size	Age range (years)	Reference method	Validity	Reliability	Method difference, mean (SD)
Taylor and Goulding (1988)	New Zealand	67	3–6	4-day diet record	0.52		144 (355)
Huybrechts et al. (2006)	Belgium	509	2–6	3-day diet record	0.52	0.79	61 (294)
Jensen et al. (2004)	USA (Hawaii)	162	10–18	2-day diet record	0.54	0.68	
Harnack et al (2006)	USA (MN)	248	11–14	3-day 24-h recall	0.43	0.74	–137
Bertoli et al. (2005)	Italy	18	6–10	7-day diet record	0.77		48%
Magkos et al. (2006)	Greece	351	10–15	1-day 24-h recall	0.64		74 (340)
Wong et al. (2008)	USA (Utah)	161	11–18	2-day 24-h recall	0.56	0.72	
Moore et al. (2007)	Canada	162	9–16	1-day 24-h recall	0.43-0.46		