Alterations in growth and body composition during puberty. IV. Energy intake estimated by the Youth-Adolescent Food-Frequency Questionnaire: validation by the doubly labeled water method[1–4]

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ABSTRACT

Background: Estimates of energy intake are required for an understanding of growth and disease; however, few methods of energy intake in children have been validated.

Objective: Our objective was to validate energy intake estimated by the Youth-Adolescent Food-Frequency Questionnaire (YAQ) against the criterion total energy expenditure (TEE) by doubly labeled water (DLW).

Design: Twenty-three boys and 27 girls (8.6–16.2 y of age) completed the YAQ and TEE measurements in 1 y.

Results: Energy intake by the YAQ (10.03 ± 3.12 MJ) and energy expenditure by DLW (9.84 ± 1.79 MJ) were similar ($P = 0.91$) with large lower (−6.30 MJ) and upper (6.67 MJ) ±2 SD limits of agreement. When within-subject CVs of repeated measures of the DLW and YAQ methods were used, 25 of the 50 subjects were deemed to have misreported their energy intake. The discrepancy in energy intake (YAQ – TEE) was related to body weight ($r = -0.25$, $P = 0.077$) and percentage body fat ($r = -0.24$, $P = 0.09$) but not to age ($r = -0.07$, $P = 0.63$) or the time between measures. From logistic regression, fatter boys were more likely to underreport energy intake than were fatter girls.

Conclusion: The YAQ provides an accurate estimation of mean energy intake for a group but not for an individual. *Am J Clin Nutr* 2000;72:1455–60.

KEY WORDS Children, adolescents, youth-adolescent questionnaire, Youth-Adolescent Food-Frequency Questionnaire, food-frequency questionnaire, energy expenditure, energy intake, doubly labeled water

INTRODUCTION

Dietary intake influences normal growth, the development and progression of obesity, and many other conditions. Therefore, the ability to accurately measure energy and nutrient intake in individuals and populations is of great importance. Focus on nutritional intake in the first decades of life is particularly important because many lifelong nutritional habits may be established during childhood and adolescence (1, 2). Measurement of energy and nutrient intake in youngsters is challenging because of their lower literacy levels, cognitive and memory differences, knowledge deficits about food and food preparation techniques, and a general lack of interest in the subject matter (3).

Baranowski and Domel (4) found that by age 10 y, most children are aware of the foods they have eaten and are able to give accurate information about their diet. Youth aged 9–18 y have shown the ability to complete a self-administered food-frequency questionnaire with reasonable consistency in responses over time (5). The accuracy of estimation of energy intake provided by food-frequency questionnaires may be assessed by comparison with doubly labeled water (DLW)–derived measurements of total energy expenditure (TEE). DLW-derived TEE is considered a criterion method for determining energy expenditure. Several studies showed that children and adolescents underreport their energy intake compared with their TEE (6–12). The subject's body composition, TEE, and age are significant factors in the magnitude of underreporting; fatter (6, 7, 10, 11) and older (6, 8–10) children underestimate their energy intake the most.

The recently developed Youth-Adolescent Food-Frequency Questionnaire (YAQ) may provide more accurate reporting of energy intake (5). A 1-y test-retest model of the estimated energy intake by the YAQ produced a mean coefficient of reproducibility of 0.49. The accuracy of the YAQ was tested against multiple dietary recalls with a correlation coefficient of 0.54 (13). However, the accuracy of intake estimated by the YAQ was not validated

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against TEE by the criterion DLW method. Thus, any systematic discrepancy in the YAQ is unknown. The purpose of the present study was to compare energy intake reported by children and adolescents using the self-administered YAQ with TEE measured by DLW and to determine whether sex, age, body weight, or percentage body fat influence the discrepancy between YAQ and TEE.

SUBJECTS AND METHODS

Subjects and study design

The data are from a cross-sectional sample of subjects (27 girls and 23 boys) enrolled in a longitudinal study of the endocrine control of growth and maturation at puberty. The study was reviewed and approved by the University of Virginia Human Investigation Committee. Informed consent was obtained from a parent of each child and assent was obtained from each child.

At entrance into the study, all subjects had height, height velocity, and weight measurements within 2 SDs of the mean for their chronologic age. Height was measured with a Harpenden stadiometer (Holtain Ltd, Croswell, United Kingdom) by a trained anthropometrist (JNR). Each subject's nude weight was measured to the nearest 0.01 kg on a calibrated scale. The aim was to compare energy intake reported by the YAQ with TEE measured by DLW. To accomplish these aims, the boys and girls completed a YAQ within 1 y of their measurement of TEE. The YAQ measures energy and nutrient intake over the previous 1 y (5, 13). The mean time lag (date of TEE − date of YAQ) between the TEE and YAQ measurements was 32 ± 23 d, with a range of −323 to 322 d. Fifteen of the 50 subjects completed the YAQ and TEE measurements on the same day. The proportion of the YAQ data collected within 60, 120, 180, and 240 d of the measurement of TEE was 17/50, 18/50, 34/50, and 46/50, respectively.

Energy expenditure

Basal metabolic rate (BMR) of subjects was measured via indirect calorimetry (Deltatrac; Sensormedics, Yorba Linda, CA). BMR was measured for 30 min on waking after an overnight stay in the General Clinical Research Center. TEE was measured by DLW. The subjects consumed a mixed oral dose of 99.9% enriched ^2H_2O (0.05 g/kg) and 10% enriched $H_2{}^{18}O$ (1.5 g/kg) at 0800. Urine samples were collected immediately before dosing, 4 and 5 h after dosing, and 1, 6, and 12 d after dosing. All urine samples were collected between 0800 and 1200 and kept frozen at −20°C in cryovials until analyzed by isotope ratio mass spectroscopy (Europa Hydra 20/20 gas isotope ratio mass spectrometer; Metabolic Solutions, Inc, Merrimack, NH).

^2H analysis was completed after a 72-h equilibration with standard hydrogen gas over a platinum catalyst. The data are reported as delta versus Vienna standard mean ocean water (VSMOW). For quality control of ^2H analyses, each of 4 standard water samples was analyzed 5–10 times/d. Over 50 d, the maximum interday CV ranged from 0.09% to 2.6%. The intraday CV had to be <2% (average of 0.5%) for the greatest deuterium control and <5% for the lowest deuterium control or the analysis run was not accepted and the samples were either reassayed by Metabolic Solutions, Inc or prepared again.

^{18}O analyses were completed by gas isotope ratio mass spectrometry after a 24-h equilibration with carbon dioxide. Quality control was established by internal laboratory standards assigned values versus VSMOW. The data are reported as delta VSMOW. Four quality-control standards ranging from −9‰ (tap water) to 220‰ were measured 4–5 times/d. The intraday CV for the standards was 0.9–0.09% and the interday CV was 2.8–0.21% (Metabolic Solutions, Inc). In a comparison of 18 prominent laboratories assaying DLW, the Metabolic Solutions laboratory had an error of 5.9%. The median error of all laboratories was 6.6% (14).

Differences in ^2H and ^{18}O in the pre- and postdose urine samples were determined by using the unprocessed mass spectrometric data as described previously (15). The unprocessed mass spectrometric (enrichment) data were normalized by expressing them as a fraction of the initial dose, as suggested by the consensus report of the International Dietary Energy Consultancy Group (15). Linear regression was used to determine the slope and intercept of the linear relation between the time in days and the normalized ^2H and ^{18}O data. The pool sizes for ^2H_2O (N_D) and $H_2{}^{18}O$ (N_O) were the reciprocals of the intercepts. The intercept of the regression line was the N_D-N_O ratio. The data points were analyzed and outliers were reanalyzed. The fractional turnover rates of ^2H (k_D) and ^{18}O (k_O) were determined from the slope of the regression line. Any N_D-N_O ratios lying outside the range of 1.015 and 1.06 were reanalyzed. The mean daily rate of carbon dioxide production (rCO_2, mol/d) was calculated by using the revised equations of Speakman et al (16). The mean daily energy expenditure was calculated by multiplying the rCO_2 value by 533.5 kJ/mol CO_2 (127.5 kcal/mol CO_2), the energy equivalent of the typical Western diet that will produce a respiratory quotient of 0.85, with 15% of energy from protein oxidation (15).

Body composition

At the same time that TEE was measured, body composition was estimated by using the 4-compartment model of Lohman (17). We described the use of this method in children and adolescents (18). In this model, body density is measured by underwater weighing with residual lung volume corrections based on the nitrogen-washout technique. Body density is corrected for total body water as assessed by deuterium oxide dilution and bone mineral concentration by dual-energy X-ray absorptiometry (18). The 4-compartment data were available only at the time of the TEE measures. The age-adjusted 2-compartment model of Lohman (19) was used to compare differences in body composition at the time of the TEE and YAQ measurements because data for the 2-compartment model were available at each time point.

Energy and nutrient intakes

Subjects completed the YAQ within 1 y of the TEE measurement. Subjects were instructed by a registered dietitian (MSP) on how to complete the YAQ. The content of the YAQ was described previously (5, 13). This questionnaire is reproducible and was validated recently for use in a 1-y time frame against multiple 24-h dietary recalls (5, 13). The questionnaire was self-administered by each subject, with minimal assistance from parents and staff. Subjects were instructed to base responses on usual dietary intake over the previous year. Forms were completed and collected during an overnight stay at the General Clinical Research Center. Trained investigators at the Channing Laboratory at the Harvard School of Public Health (Boston) analyzed the YAQ.

Statistical analysis

Differences in physical characteristics, energy expenditure, and YAQ-estimated nutrient intake between boys and girls were

TABLE 1
Physical characteristics of children and adolescents at the time of the total energy expenditure measurements[1]

	Both (n = 50)	Boys (n = 23)	Girls (n = 27)
Chronologic age (y)	12.6 ± 2.0	12.5 ± 1.6	12.7 ± 2.3
Height (m)	1.5 ± 0.13	1.4 ± 0.14	1.54 ± 0.13
Weight (kg)	47.4 ± 13.7	45.1 ± 14.1	49.4 ± 13.2
BMI (kg/m^2)	19.5 ± 3.3	18.3 ± 3.0	20.5 ± 3.3[2]
Percentage body fat (%)	22.9 ± 7.9	18.8 ± 7.1	26.4 ± 6.9[3]
Fat mass (kg)	11.3 ± 6.2	8.6 ± 5.2	13.5 ± 6.3[3]
Fat-free mass (kg)	36.1 ± 6.2	36.3 ± 11.6	35.9 ± 8.4
Time lag between measurements (d)[4]	31.8 ± 160.4	68.7 ± 148.4	0.3 ± 166.2

[1] $\bar{x}$ ± SD. Body composition measured by the 4-compartment model of Lohman (17).
[2,3] Significantly different from boys: [2] $P \leq 0.05$, [3] $P \leq 0.001$.
[4] Date of total energy expenditure measurement − date of Youth-Adolescent Food-Frequency Questionnaire.

tested by using one-way analysis of variance (ANOVA). Data not randomly distributed were log transformed before analysis. The Bland-Altman method (20) was used to determine the discrepancy in energy intake estimated by the YAQ and the measured TEE. The discrepancy in energy intake and energy expenditure was correlated with age, body weight, percentage body fat, and the lag time between collection of the YAQ and TEE data. Partial correlation analyses were performed between the discrepancy in energy intake or expenditure and age, body weight, percentage body fat, and lag time between measurements. Logistic regression was used to determine the probability of underreporting energy intake by YAQ as a function of sex, percentage body fat, and the interaction between sex and percentage body fat. A likelihood ratio test for the addition of age to the logistic regression model was also completed. Nested two-way [(2) sex × (2) tool] ANOVA was used to compare subject's physical characteristics at the time of the energy expenditure analysis and YAQ. The SAS system (version 6.12; SAS Institute, Cary, NC) was used for the statistical analyses.

RESULTS

Physical characteristics at the time of the TEE measurement are presented in **Table 1**. The ages of our subjects ranged from 9.8 to 16.2 y for the boys and from 8.6 to 15.96 y for the girls. The girls and boys were of similar age, height, weight, and fat-free mass. The girls had a greater body mass index (P = 0.02), percentage body fat ($P < 0.001$), and fat mass ($P < 0.001$) than did the boys at baseline. As shown in **Table 2**, the TEE, BMR, and physical activity level (TEE/BMR) were not significantly different between boys and girls. As shown in Table 1, the mean lag time (date of TEE − date of YAQ) was 68 d longer for the boys than for the girls, but this was not a significant sex difference. There were no significant differences in physical characteristics at the time of the TEE and YAQ measurements (no sex × time interactions) and no sex × dietary tool (TEE versus YAQ) interaction effects. The percentage body fat ($P < 0.001$) and fat mass (P = 0.003) were greater in the girls than the boys at both the YAQ and TEE measurements.

Equal numbers of subjects (n = 25) had a YAQ-estimated energy intake greater than and less than their TEE. TEE and estimated energy intake by YAQ were not related (r = 0.22, P = 0.13). The individual accuracy of estimated energy intake ranged from a 6.39-MJ/d underestimation to a 6.65-MJ/d overestimation compared with TEE. The proportion of YAQ data within 1%, 5%, 10%, 25%, and 50% of TEE was 2/50, 6/50, 13/50, 29/50, and 41/50, respectively. There was no sex difference for the discrepancy between YAQ-estimated energy intake and TEE (Table 2).

As shown in **Figure 1**, there was a slight mean discrepancy (0.19 MJ; P = 0.92) between the YAQ energy intake and the criterion TEE by DLW. However, there was a large range between the lower (−6.30 MJ; approximate confidence limits of lower point estimate: −7.89, −4.70 MJ) and the upper (6.67 MJ; approximate confidence limits of upper point estimate: 5.09, 8.28 MJ) ±2 SD limits of agreement.

With use of the published within-subject (w) CVs of repeated measures of the DLW and YAQ methods, the 95% confidence limits of agreement between these measures were established as follows to determine how many subjects could be deemed to have misreported their energy intake:

$$CV_{total} = \sqrt{[CV_{wDLW}{}^2 + (CV_{wYAQ}/\sqrt{d})^2]} \quad (1)$$

We assumed that CV_{wDLW} = 8.9% (21–23) and CV_{wYAQ} = 23% (24); d was days of dietary assessment and was assumed to be 28 d for the YAQ. Although the YAQ is assumed to measure habitual energy intake over the previous 1 y, this may not be true. There is only moderate test-retest precision in the measure (5, 13), the precision of the questionnaire decreases as the time between tests increases (5, 13), and the energy requirements of children change over time. On the basis of these assumptions, the 95% confidence limits are ±19.81% of the mean of the energy expenditure and energy intake (9.94 MJ/d) or ±1.97 MJ/d. This range encompasses 25 of the 50 subjects.

There was a direct relation (r = 0.51, $P < 0.001$) between the energy discrepancy (YAQ energy intake − TEE) and the mean of the YAQ estimated energy intake and TEE (Figure 1). There was an inverse relation between the energy discrepancy and both body weight (r = −0.25, P = 0.08) and percentage body fat (r = −0.24, P = 0.09). Chronologic age (r = −0.07, P = 0.63) and the time lag between measurements ($r < 0.00$, P = 0.98) were not correlated with the energy discrepancy. A partial correlation analysis was completed between the energy discrepancy and each of age, weight, percentage body fat, and the mean of the YAQ energy intake and TEE with each of the remaining variables as covariates in each model. This method is equivalent to multiple linear regression. After partial correlation analysis, weight (r = −0.52, $P < 0.001$)

TABLE 2
Total energy expenditure (TEE), physical activity level (PAL), and estimated energy intakes (EEI)[1]

	Both (n = 50)	Boys (n = 23)	Girls (n = 27)
TEE (MJ/d)	9.84 ± 1.79	10.09 ± 1.99	9.64 ± 1.62
BMR (MJ/d)	5.78 ± 1.03	5.86 ± 1.26	5.70 ± 0.80
PAL (TEE/BMR)	1.71 ± 0.21	1.74 ± 0.22	1.69 ± 0.19
YAQ EEI (MJ/d)	10.03 ± 3.12	10.34 ± 3.22	9.78 ± 3.07
YAQ EEI − DLW TEE (MJ/d)	0.185 ± 3.24	0.242 ± 2.97	0.136 ± 3.51

[1] $\bar{x}$ ± SD. There were no significant sex differences. BMR, basal metabolic rate; YAQ EEI, EEI by the Youth-Adolescent Food-Frequency Questionnaire; YAQ EEI − DLW TEE, discrepancy between the EEI YAQ and TEE by doubly labeled water.

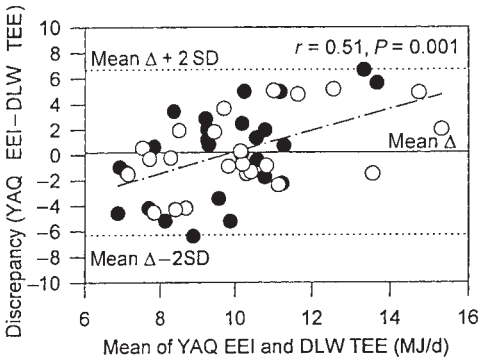

FIGURE 1. Discrepancy in estimated energy intake (EEI) between the youth-adolescent food-frequency questionnaire (YAQ) and total energy expenditure (TEE) measured by the doubly labeled water technique (DLW TEE) versus the mean of YAQ EEI and DLW TEE. ○, boys subjects; ●, girls.

and the mean of YAQ energy intake and TEE ($r = 0.61$, $P < 0.001$) were related to the energy discrepancy, but age ($r = 0.17$, $P = 0.29$) and percentage body fat ($r = 0.26$, $P = 0.19$) were not.

Logistic regression was used to further explore our a priori hypothesis that age, sex, and percentage body fat or their interaction may influence the validity of the YAQ. The variable age was ultimately excluded from the logistic regression model on the basis of the results of a likelihood ratio test, in which the log likelihood of a model that included terms for age and sex, percentage body fat, and the interactions of age × sex, age × percentage body fat, sex × percentage body fat, and age × sex × percentage body fat was compared with the log likelihood of a model that included only the terms for sex, percentage body fat, and the interaction of sex × percentage body fat. The P value for the likelihood ratio test was determined to be 0.306 and, therefore, the terms associated with age were removed from the model to create the most parsimonious model that accurately predicted the odds of a child underreporting his or her energy intake. As shown in **Figure 2**, for greater percentages of body fat, the odds of underreporting energy intake differed between boys and girls. Boys with a low percentage body fat had a low probability (≈0.10) of underreporting their energy intake and this probability was lower than that for lean girls (≈0.48). For boys with a greater percentage body fat, the probability (>0.90) of their underreporting their energy intake was greater. However, the probability of underreporting by girls with a greater percentage body fat was slightly lower (≈0.36) than that for girls with a lower percentage body fat.

The nutrient intake estimated by the YAQ is shown in **Table 3**. Calcium intake was greater ($P = 0.057$) in the boys than the girls, but otherwise there were no significant sex differences for nutrient intake.

DISCUSSION

We compared the energy intake estimated by the YAQ with the criterion TEE measured by DLW in children and adolescents. Although previous studies established the test-retest reliability of the YAQ (5, 13), this is the first investigation of the accuracy of the YAQ using TEE by DLW as a criterion measure. Our mean TEE is within the range documented for other children and adolescents (6, 8, 9). Our YAQ-derived mean energy and nutrient intake estimates are similar to the data reported in the development of the YAQ (5, 13). Misreporting of estimated energy intake on the YAQ ranged from a 6.65-MJ/d overestimation to a 6.39-MJ/d underestimation. The validity of a semiquantitative food-frequency questionnaire in children has not been reported except for data from a group of 4–7-y-old children (12) that was not highly comparable with the present study population because of differences in age, maturation, and other developmental aspects of the subjects groups, including cognitive ability.

The mean estimated intake of all of the nutrients we examined (Table 3), except fiber, differ by <10% from data reported by Rockett et al (13). This isolated difference in estimated fiber intake may be the result of regional food patterns because our subjects were from Virginia only and those in the study by Rockett et al were from several states across the nation.

TEE, when used to validate dietary assessment tools, assumes that subjects are in energy balance. We compared TEE and YAQ data taken up to 1 y apart. During that period, some subjects progressed into puberty, which increased their growth velocity and their typical daily energy requirements. However, the time lag between measurements did not appear to affect the conclusions about misreporting energy intake because it was not related ($r < 0.00$, $P = 0.98$) to the energy discrepancy (YAQ energy intake − TEE).

To maintain the normal growth we observed in our subjects, their energy intake would have to have been greater than their energy expenditure. Children who underreport their estimated energy intake by YAQ are suggesting that their energy intake has been less than their energy expenditure for the previous year. This could not happen without slowing their growth velocity. We followed these children for the past 5 y as part of a longitudinal growth study and know that their growth rates for weight and height are normal. At first thought, a positive energy balance would be expected for all subjects, albeit a smaller one in those who completed the YAQ well before the TEE measurement. However, this argument assumes that there is no test-retest error in the YAQ and TEE measures. With use of published within-subject CVs of repeated measures of the DLW and YAQ methods, the 95% confidence limits of agreement between these measures were found to be ±1.97 MJ/d. This encompassed the under- or overreporting energy discrepancy of 25 of the 50 subjects. Furthermore, after we accounted for the measured change in BMR between the time of the YAQ and that of the TEE measurement and assumed that growth accounts for 2% of TEE, the discrepancies of 24 subjects remained within these confidence limits. Thus, these growth-related differences in energy expenditure did not affect the conclusions about misreporting that corroborate our finding that the lag time between measurements was not related to the energy discrepancy.

Most validation studies of food-frequency questionnaires used observation or diet records as standards of accuracy. However, assuming energy balance, the DLW method is the most suitable method for identifying discrepancies in estimation of energy intake by dietary assessment tools. Only one study used the DLW method to validate food-frequency questionnaire estimates of energy intake (12) and the present study is the first study to validate the YAQ against TEE. Studies using diet records to validate the estimated energy intake and other findings of food-frequency questionnaires are more accurately described as calibration studies because they compare 2 tools that require self-report of dietary intake (3). Given the literature on underreporting

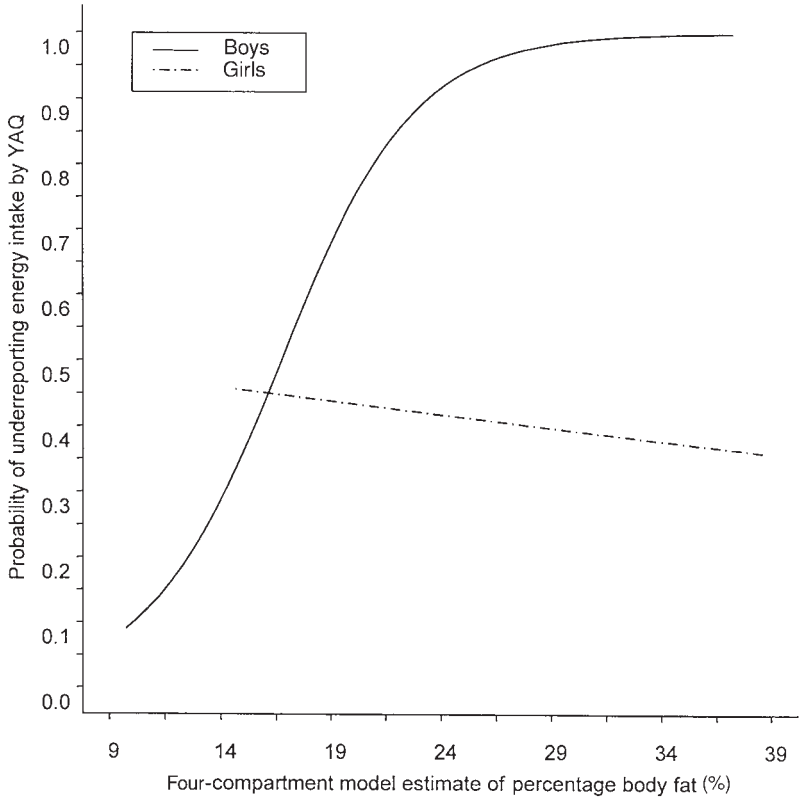

FIGURE 2. Logistic regression of the probability of underreporting the estimated energy intake by the Youth-Adolescent Food-Frequency Questionnaire (YAQ) and the percentage body fat estimated by the 4-compartment model of Lohman (17).

of energy intake on diet records (6–11), it is clear that this method is not appropriate for identification of the extent and nature of discrepancies in YAQ estimates.

Several factors may influence the reporting accuracy of dietary assessment tools. Age and the underreporting of energy intake by diet records are positively related (7–9). Surprisingly, no correlation between age and discrepancy in reporting of estimated energy intake was observed in our study. This may support the appropriateness of use of the YAQ throughout this age range. Several studies showed a greater underestimation of energy intake on diet records in obese than in nonobese children and adolescents (6, 7, 10, 11). We identified a similar correlation between percentage body fat and discrepancy in energy intake reported by the YAQ. The probability of underestimation was low (≈0.10) in boys with 10% body fat but was much higher for those with a greater percentage body fat and was very great (≈0.95) for boys with 25% body fat. The probability of underestimation by girls was not appreciably different for those with greater percentages body fat, remaining ≈0.40–0.50. This strong effect of adiposity on the reporting accuracy of boys but not of girls is an unanticipated finding for which we do not have an explanation. Notably, these sex-specific responses occurred within the normal ranges of percentage body fat and were not related to the age of the subjects. Perhaps girls, regardless of adiposity, are similarly aware of their dietary intake because of perceived societal pressure to maintain a lean body habitus. Conversely, boys may have less anxiety over body weight and adiposity and fatter boys may be less conscious of their dietary intake and not realize their underestimation of energy intake. The children were never counseled about their body weight or body composition during the study. The dietitian gave instructions only for completing the YAQ. Completion of the YAQ in a clinical environment and after being measured for body composition may have influenced the reporting of some children—perhaps in boys more than in girls. Kaskoun et al (12) compared estimated energy intakes by semiquantitative food-frequency questionnaire to TEE measured by DLW and found no correlation between body composition and discrepancy in estimated energy intake. The food-frequency questionnaires, however, were completed by the mothers of the subjects and therefore were not representative of reporting discrepancies of the children

TABLE 3
Nutrient data estimated by using the Youth-Adolescent Food-Frequency Questionnaire[1]

	Both (n = 50)	Boys (n = 23)	Girls (n = 27)
Carbohydrate (g)	337.9 ± 107.2	351.4 ± 108.9	326.5 ± 106.4
Protein (g)	88.9 ± 30.7	92.8 ± 30.1	85.5 ± 31.4
Fat (g)	78.8 ± 28.4	79.2 ± 31.0	78.5 ± 26.6
Saturated fat (g)	27.9 ± 10.7	27.9 ± 12.0	28.0 ± 9.7
Cholesterol (mg)	223.6 ± 93.6	227.3 ± 102	220.5 ± 87.7
Dietary fiber (g)	21.7 ± 8.1	21.8 ± 8.7	21.6 ± 7.6
Sodium (mg)	2998.9 ± 868.3	3083.8 ± 897.6	2926.6 ± 852.6
Calcium (mg)	1337.3 ± 527.8	1490.8 ± 528.0	1206.6 ± 500.6
Iron (mg)	19.4 ± 9.3	18.6 ± 7.6	20.1 ± 10.6
Zinc (mg)	14.7 ± 6.6	14.3 ± 5.6	15.0 ± 7.5
Folate (μg)	409.7 ± 19.7.9	405.0 ± 165.9	413.7 ± 224.7

[1] $\bar{x}$ ± SD. There was no significant main effect of sex for any variable.

and adolescents. Future research should confirm our results and should include psychological and behavioral measures to help answer why fatter boys underreport their energy intake.

In conclusion, the YAQ made a good estimation of the mean energy intake of prepubertal and pubertal boys and girls as a group but showed significant individual variability in reporting accuracy. The discrepancy between reported energy intake and TEE was directly correlated with the mean of the YAQ energy intake estimates and TEE, TEE itself, body composition, and weight. Given the range of variability in reporting accuracy with the YAQ observed in this study, the YAQ cannot be considered a criterion method by which to measure an individual child's or adolescent's daily intake. However, the YAQ holds promise as a method of estimating the mean energy and nutrient intakes of a group.

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