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# Girls' Dairy Intake, Energy Intake, and Weight Status

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**ABSTRACT**

We explored the relationships among girls' weight status, dairy servings, and total energy intake. The hypothesis that consuming dairy could reduce risk for overweight was evaluated by comparing energy intake and weight status of girls who met or consumed less than the recommended three servings of dairy per day. Participants included 172 11-year-old non-Hispanic white girls, assessed cross-sectionally. Intakes of dairy, calcium, and energy were measured using three 24-hour recalls. Body mass index and body fat measures from dual-energy x-ray absorptiometry were obtained. Because preliminary analyses suggested systematic underreporting of energy intake, the relationships among dairy servings and measures of weight status were examined for the total sample and for subsamples of under-, plausible, and overreporters. Data for the total sample provided support for the hypothesized relationship among weight status, dairy servings, and energy intake. Thirty-nine percent of girls reported consuming the recommended ≥3 servings of dairy per day; these girls also reported higher energy intake but had lower body mass index *z* scores and body fat than the girls who consumed fewer than three dairy servings each day. Among plausible reporters, no relationship between dairy intake and weight status was noted. This discrepancy may be attributable to a high percentage (45%) of overweight underreporters in the total sample. Our findings reveal that reporting bias, resulting from the presence of a substantial proportion of underreporters of higher weight status, can contribute to obtaining spurious associations between dairy intake and weight status. These findings underscore the need for randomly controlled trials to assess the role of dairy in weight management.

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The prevalence of pediatric obesity has been rising for more than 20 years (1). There is evidence that increased intake of dairy foods and calcium may play a significant role in maintaining a healthful weight and moderating body fat (2-15). However, results across studies have been inconsistent (16-28), and this may be attributable to major challenges in using self-reported dietary intake data. Self-reported intakes tend to be subject to underreporting bias and the underreporting of energy intake tends to be positively related to weight status. Underreporters also tend to weigh more (29,30). Doubly labeled water techniques assessing energy expenditure suggest underreporting results in a 10% to 50% underestimation of actual energy intake and is a significant problem in older children (31). Doubly labeled water techniques are expensive and not feasible for large samples; thus, several methods have been developed that use estimated energy requirements to assess reporting bias (29,32). Therefore, in this study the method suggested by Huang and colleagues (29) was used to classify children as under-, plausible, or overreporters. The objective of this study was to assess the relationship among girls' weight status, dairy servings, and total energy intake. The hypothesis that consuming dairy could reduce risk for overweight was evaluated by comparing energy intake and weight status of girls who met or consumed less than the recommended three servings of dairy per day. To explore the effect of reporting bias on this relationship, the hypothesis was evaluated using the total sample, and subgroups of girls identified as plausible, under-, or overreporters.

## SUBJECTS AND METHODS

### Subjects

Participants were 177 11-year-old girls (11.3±0.3 years) and their parents from central Pennsylvania and were part of a longitudinal study of the health and development of young girls. Five girls were excluded from analyses for the following reasons: one girl did not have dietary intake data, and four girls were outliers (one girl was extremely overweight and three girls had extremely high dairy intakes) that may have affected the statistical relationship between dairy intake and weight status.

Eligibility criteria for girls' participation at the time of recruitment included living with two biological parents, the absence of severe food allergies or chronic medical problems affecting food intake, and the absence of dietary restrictions involving animal products. Families were recruited for participation in the study using flyers and newspaper advertisements. In addition, families with age-eligible female children within a five-county radius received mailings and follow-up telephone calls. The Pennsylvania State University Institutional Review Board approved all study procedures, and parents provided consent for their family's participation before the study began.

### Measures

Twenty-four–hour recall interviews were conducted at the Dietary Assessment Center at the Pennsylvania State University by trained staff. Interviewers are required to complete 40 hours of intensive training and are subject to reliability tests. To assess reliability, a nutritionist administers three standard dietary recalls in a mock telephone interview to all newly trained interviewers. Reliability among interviewers is based on interclass correlation analysis of nutrient variables from the three tests for which a high degree of reliability for all nutrients is a correlation of 0.95 or higher (33). The Nutrition Data System for Research (NDS-R) software (food database version 12A, nutrient database version 28, 1996, University of Minnesota Nutrition Coordinating Center, Minneapolis) was used for data collection and analyses using a multiple pass technique to facilitate recall (34). The NDS-R software itself provides a structured, guided, controlled platform in which questions and probes are standard and the process of conducting the 24-hour recall is standard. Final calculations were completed using NDS-R version 4.03.31 (1999, University of Minnesota Nutrition Coordinating Center, Minneapolis). The NDS-R time-related database updates analytic data while maintaining nutrient profiles true to the bastion used for data collection. The NDS-R is updated annually.

Participants provided three 24-hour recalls within a 2- to 3-week period, including 2 weekdays and 1 weekend day. Mothers were present during daughters' interviews. Nutrient and food data were averaged across 3 days to obtain an estimate of dairy, energy, and calcium intakes for all foods consumed. Mixed dishes were disaggregated to include dairy food ingredients and then were summed to obtain dairy servings based on the US Department of Agriculture Food Pyramid Guidelines (35).

### Screening for Implausible Reporters

The methods used by Huang and colleagues (29) were used to classify participants as under-, plausible, or over-reporters. These procedures create sex- and age-group–specific $\pm 1$ standard deviation cutoffs for the plausibility of reported energy intake as a percent of predicted energy requirement. The first step taken to create the implausible reporting classification was to calculate predicted energy requirement for each individual girl using an equation obtained from the 2002 Dietary Reference Intakes (36). This equation derives predicted energy requirement from a constant for sex, coefficients for age, physical activity, weight, height, and a constant for growth (kilocalories for energy deposition). The physical activity coefficient is based on physical activity level ranges (36). As an objective measure of physical activity was not available for this sample, a conservative estimate of physical activity, the low active category (a physical activity level value $\geq 1.0 < 1.4$; physical activity coefficient of 1.5), was chosen. After calculating predicted energy requirement for each girl, reported energy intake was divided by predicted energy requirement and multiplied by 100 to provide evidence of plausibility for reported energy intake as a percentage of predicted energy requirement. Finally, $\pm 1$ standard deviation cutoff for reported energy intake as a percent of predicted energy requirement was calculated based on propagation of error variances. A more detailed explanation of these equations and calculations can be found in articles by Huang and colleagues (29,37).

### Weight Status

Height and weight were measured by a trained staff member following procedures described by Lohman and colleagues (38). Children were dressed in light clothing and measured without shoes. Height was measured in triplicate to the nearest 10th of a centimeter using a stadiometer (Shorr Productions stadiometer, Irwin Shorr, Olney, MD). Weight was measured in triplicate to the nearest 10th of a kilogram using an electronic scale (Seca Electronic scale, Seca Corp, Birmingham, UK). Age- and sex-specific body mass index (BMI) percentiles and *z* scores were calculated using the Centers for Disease Control and Prevention growth charts and girls were classified as overweight if their BMI percentile was $\geq 85$ and obese if it was $\geq 95$ (39). BMI *z* scores were calculated because this variable is normally distributed and minimizes the influence of extreme scores.

### Body Composition

Girls' percentage of body fat was assessed at age 11 years using a dual-energy x-ray absorptiometry scanner (Hologic QDR 4500W (S/N 47261), Hologic, Bedford, MA). A trained technician obtained measurements with children in a supine position, in light clothing without shoes.

### Data Analysis

All analyses were performed using SAS software (version 8.02, 2001, SAS institute, Cary, NC). Preliminary Pearson correlations were conducted to assess the relation between energy intake and weight status. Girls were categorized as either meeting or not meeting current dairy recommendations at age 11 years. Analysis of variance was used to assess differences between girls who met or consumed less than the recommended three servings of dairy. $\chi^2$ analyses were used to examine the association between reporting plausibility and weight status. Significance for relationships was determined at a level of $P \leq 0.05$; trends were noted at a significance level of $P \leq 0.10$.

## RESULTS

### Identification of Under-, Plausible, and Overreporters

Half of the sample was classified as plausible reporters, while 34% and 16% were classified as under- and overreporters, respectively. In the total sample, the lowest percent reported energy intake/predicted energy requirement was 38%; the highest was 184%. The mean percent reported energy intake/predicted energy requirement for underreporters was 71%, indicating that underreporters' reported energy intakes were, on average, about 30% below their predicted energy requirements. Mean percent reported energy intake/predicted energy requirement for plausible and overreporters was 99% and 136%, respectively.

### Weight Status and Reporting Bias

Girls' mean BMI (calculated as $kg/m^2$) was 20.0±3.9. Thirty percent of girls were classified as overweight and 14% were classified as obese; these findings are similar to national data for the prevalence of overweight and obesity in children (1). A significant negative correlation between reported energy intake and weight status was noted for the total sample ($r$=–0.16, $P$<0.05), suggesting the possibility of substantial underreporting bias, especially by girls with higher weight status. Results show that reporting classification and weight status were significantly related ($\chi^2$=10.0, $P$<0.01). Underreporters were significantly heavier than plausible ($P$<0.001) and overreporters ($P$<0.001). In fact, 45% of underreporters were classified as overweight; only 22% of plausible and 14% of overreporters were classified as overweight.

### Girls' Energy Intake, Weight Status, and Body Composition by Dairy Recommendations for the Total Sample and Plausible, Under-, and Overreporters

Among the total sample, 104 (60.5%) girls reported consuming less than the recommended three servings of dairy per day, whereas only 68 (39.5%) girls met or exceeded the current recommendations. Data for the total sample are consistent with dairy having a protective effect for overweight (see the Table); girls who met the recommended three servings of dairy per day reported significantly higher energy intake and had significantly lower weight status and percentage of body fat. In contrast, among plausible reporters (n=86), girls who reported ≥3 servings of dairy reported similar mean energy intakes to girls who consumed <3 servings, and girls meeting the recommendation did not differ significantly from those who did not meet the recommendation in either BMI $z$ scores, BMI percentiles, or percentage of body fat. This pattern is not consistent with ≥3 servings of dairy having a protective effect on body weight. Among underreporters (n=58), girls who reported ≥3 servings of dairy had slightly but not significantly higher reported energy intakes, and slightly but not significantly higher percentage of body fat, a pattern that does not support dairy having a protective effect on body weight.

**Table.** Mean energy intake, body mass index (BMI), and body composition by dairy foods group recommendations for the total sample and plausible, under-, and overreporters for predominantly middle-class, exclusively non-Hispanic white 11-year-old girls in central Pennsylvania[a]

| | Dairy intake <3 (servings/d) (n=104) | Dairy intake ≥3 (servings/d) (n=68) |
|---|---|---|
| | ←— *mean±standard deviation* —→ | |
| **Energy intake (kcal)** | | |
| Total sample | 1,706±424 | 2,040±419*** |
| Plausible reporters[b] | 1,861±206 | 1,884±171 |
| Underreporters[b] | 1,418±262 | 1,528±194 |
| Overreporters[b] | 2,654±537 | 2,540±302 |
| **BMI percentile** | | |
| Total sample | 66.9±26.3 | 58.7±28.0* |
| Plausible reporters | 58.7±28.0 | 58.8±27.5 |
| Underreporters | 76.0±21.9 | 76.1±21.9 |
| Overreporters | 59.7±24.9 | 50.9±28.2 |
| **BMI *z* score** | | |
| Total sample | 0.6±0.9 | 0.3±0.9* |
| Plausible reporters | 0.3±0.9 | 0.3±0.9 |
| Underreporters | 0.9±0.9 | 1.0±0.7 |
| Overreporters | 0.3±0.9 | 0.1±0.9 |
| **Body fat (%)**[c] | | |
| Total sample | 28.3±6.9 | 25.9±6.8* |
| Plausible reporters | 26.6±6.7 | 25.5±6.5 |
| Underreporters | 30.4±6.9 | 31.0±6.5 |
| Overreporters | 26.2±5.8 | 24.8±7.2 |

[a]Total sample (n=172), plausible (n=86), under- (n=58), and overreporters (n=28).
[b]Sample restricted to 1±standard deviation.
[c]Measured by dual-energy x-ray absorptiometry.
**P*<0.05 for difference from girls consuming <3 servings of dairy per day.
****P*<0.0001 for difference from girls consuming <3 servings of dairy per day.

## DISCUSSION

This research examined the relationship of reported dairy and energy intake with weight status among 11-year-old girls. The findings for the total sample were consistent with findings reported in other observational studies suggesting that dairy has a protective effect on overweight (9-14): girls who met the recommended 3 servings of dairy per day reported higher energy intake, but had lower weight status and body fat. Among plausible reporters, no relationship between dairy intake and weight status was noted. Similarly, for the under- and overreporters of energy intake, there was no evidence for a protective effect of ≥3 servings of dairy per day on weight status. This discrepancy may be attributable to a high percentage (45%) of overweight underreporters in the total sample. The contrasting findings for the total sample and plausible subsample reveal that the differences are not due to reduced power within the smaller plausible sample.

Huang and colleagues (29) also found that screening for plausible dietary reports had a significant influence on observed diet–obesity relationships. In their study, a US national sample of children and adolescents, energy intake was not related to weight status before the exclusion of implausible reports (29). In this sample, by age 11 years the preponderance of implausible reporters were underreporters. In addition, Ventura and colleagues' (40) findings revealed that underreporters were selective in their underreporting, reporting fewer servings from food groups and subgroups with higher energy densities and lower nutrient densities (ie, grain, dairy, and sweets and fats groups).

There is considerable controversy about the role of dairy in weight maintenance in children. Studies showing an inverse relationship between dairy intake and weight status in children are observational, thus, estimates of food intake are dependent on participants' self-reports (3,9-14). Results from intervention studies with children (in which dietary calcium can be manipulated) tend to report no association between calcium, dairy intake, and weight status (41). Analyses from this study reveal that reporting bias may contribute to the inconsistent relationship of energy and dairy intake with weight status seen in epidemiologic studies.

Major strengths of our study include the use of multiple-pass 3-day recalls. In addition, this study suggests techniques to screen for under-, plausible, and overreporters can be used with smaller samples and do not have to involve exclusion of implausible reporters. Despite these strengths, this study also has several limitations. First, the sample is homogeneous (girls were non-Hispanic white) and the findings cannot be generalized to other racial or ethnic populations or to boys. Second, the cross-sectional nature of the study does not allow for the detection of any cause-and-effect relationship in the association observed. Finally, it is possible that some girls have been misclassified with respect to reporting status because we did not use doubly labeled water technique to assess reporting bias.

This cross-sectional study provided support for an antiobesity effect of dairy products among the total sample; however, analysis revealed that this relationship was primarily attributable to substantial underreporting (34%) among the total sample. Findings underscore the need for intervention studies in children and adolescents, where energy and dairy intake can be carefully monitored, before concluding that dairy intake may have an antiobesity effect. Even if dairy intake does not protect children from overweight, dairy products are widely recognized as good sources of calcium and other micronutrients necessary to promote bone health to help reduce the risk of chronic diseases like osteoporosis and to promote overall health (42,43).

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