Published in final edited form as:

J Am Diet Assoc. 2006 April ; 106(4): 534–542. doi:10.1016/j.jada.2006.01.005.

Dairy and Dairy-Related Nutrient Intake During Middle Childhood

LAURA M. FIORITO, MS, RD, DIANE C. MITCHELL, MS, RD, HELEN SMICIKLAS-WRIGHT, PhD, and LEANN L. BIRCH, PhD

L. M. Fiorito is a research assistant, Department of Human Development and Family Studies, D. C. Mitchell is a coordinator, Diet Assessment Center, Department of Nutritional Sciences, H. Smiciklas-Wright is a professor of nutrition, Graduate Program in Nutrition, and L. L. Birch is a distinguished professor, Department of Human Development and Family Studies and the Graduate Program in Nutrition, The Pennsylvania State University, University Park.

Abstract

Objective—To characterize patterns of dairy intake among girls in middle childhood.

Design—Longitudinal data were used to characterize girls' patterns of dairy intake at age 5, 7, 9, and 11 years.

Subjects—Participants were 151 girls from predominately middle-class and exclusively non-Hispanic white families living in central Pennsylvania.

Statistical analyses—Intakes of dairy, energy, macronutrients, vitamin D, calcium, and phosphorus were assessed using three 24-hour dietary recalls in 151 non-Hispanic white girls at age 5, 7, 9, and 11 years. Analyses of changes over time were conducted using repeated measures analysis of variance. McNemar's χ^2 test was used to analyze change in percentage of dairy consumers over time.

Results—From age 5 to 11 years, girls' total dairy intake remained stable. Total milk consumption declined, due to a decline in intake of milk as a beverage, while intakes of cheese and dairy desserts increased. Much of the decline in milk intake from age 5 to 11 years, especially for milk as a beverage, was due to a reduction in the percentage of girls consuming milk as a beverage, not simply due to a decline in the servings of milk as a beverage consumed by consumers. On average, girls met vitamin D recommendations over time; however, by age 9 and 11 years girls failed to meet calcium and phosphorus recommendations.

Conclusions—Although girls' dairy intake was stable over time, at age 7, 9, and 11 years girls did not meet the recommended three servings per day, leading to suboptimal intakes of calcium and phosphorus at age 9 and 11 years. Increasing milk intake among all children should continue to be a major focus of interventions.

Milk and other milk products make important contributions to children's diet quality by providing abundant amounts of protein, vitamins, and minerals. Dairy products are therefore nutrient-dense foods necessary to promote bone health, to help reduce risk for chronic diseases like osteoporosis, and to promote overall health (1,2). Dairy products are major sources of calcium and vitamin D and also an abundant food source of phosphorus, potassium, magnesium, riboflavin, niacin, vitamins B-12 and A, and protein in children's diet (1,3,4).

Despite the recommendation that children consume two to three servings per day (5), dairy food intake by children, especially girls, falls well below this (6). The percentage of all school-

aged children who met the recommendations for dairy products has declined in recent years: from 40% to 30% between 1989-1991 and 1994-1996 (6,7). Although the decrease in milk consumption has occurred for both girls and boys, it may be more problematic for girls because they may be at greater risk for developing osteoporosis later in life (8). Nationally representative cross-sectional data indicate an increase in cheese intake from 1989-1991 to 1994-1996; however, this increase was not sufficient to compensate for the decrease in milk and total dairy consumption (6,9-11). Similar trends in national and regional data have been observed in other studies (12-16) and in an analysis of the US food supply (17). As result of decreased dairy product consumption, particularly by a decline in milk consumption, calcium intake in school-aged children is falling (6). Milk provides the main source of calcium in children's diets, representing nearly 50% of children's total calcium intake (3,18). Thus, it is unlikely that children in the United States will obtain adequate amounts of calcium and other dairy-related nutrients without dairy products in their diet (9,19,20).

Dairy products are essential throughout the life cycle, particularly during childhood and adolescence. However, much of the data on children's dairy intake is based on national food consumption survey data (6). There is growing evidence that milk consumption declines significantly as children move from middle childhood into adolescence, yet there is a lack of data on changes in intakes during middle childhood, and whether decreases in milk intake are compensated for by increases in intake of other dairy products. Specifically, it is not known how intake of other dairy (ie, cheese, yogurt, and dairy desserts) changes over time. The aim of this study was to describe longitudinal changes in girls' dairy, dairy-related nutrients, and energy across middle childhood.

SUBJECTS AND METHODS

Participants

Participants were part of a longitudinal study of the health and development of young girls from central Pennsylvania. At entry into the study, participants included 197 5-year-old girls (mean age 5.4 ± 0.4 years) and their parents, of whom 192 families were reassessed 2 years later when girls were 7 years old (mean age 7.3 ± 0.3 years). A third assessment with 183 families was conducted 2 years later when girls were 9 years old (mean age 9.34 ± 0.3 years), followed by a fourth assessment with 177 families when girls were 11 years old (mean age 11.34 ± 0.3 years). This research includes a sample of 151 families that have complete data on all measures pertaining to this study; families with incomplete data on relevant measures were excluded from analyses. The families who were excluded did not differ from those included in the analyses on family income ($F=0.03$, $P=0.85$), mothers' education level ($F=0.06$, $P=0.81$), fathers' education level ($F=1.00$, $P=0.32$), or mean body mass index (BMI) ($F=0.05$, $P=0.82$) at entry into the study.

Eligibility criteria for girls' participation at the time of recruitment included living with both 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 phone calls (Metromail Inc, Lombard, IL). On average, parents were in their mid-30s at the time of recruitment (mean age of mothers 35.4 ± 4.8 years; fathers 37.4 ± 5.4 years). Participating families were non-Hispanic white, predominately middle income, with a mean of 15 ± 2 years of education for fathers and mothers. Approximately equal numbers of families reported incomes in the following ranges \$20,000 to \$35,000, \$35,000 to \$50,000, and above \$50,000 when girls were 5 years old. Parents were on average slightly overweight at the first time of measurement with a mean BMI (calculated as kg/m^2) score of 26.4 ± 6.05 for mothers, and 28.0 ± 4.35 for fathers. The Pennsylvania State University Institutional Review Board

approved all study procedures, and parents provided consent for their family's participation before the study began.

Methods

Twenty-Four-Hour Dietary Recall—Girls' energy, macronutrient, micronutrient, and dairy intakes were assessed using multiple-pass 24-hour dietary recalls at age 5, 7, 9, and 11 years. Mothers were the primary reporters of girls' intake at each age; girls were asked to be present during all interviews to facilitate the recall process. Three recalls were obtained per respondent at each time of measurement; 2 weekdays and 1 weekend day during the summer and fall months were randomly selected over a 2-week period. Interviews were conducted by trained staff at The Pennsylvania State University Diet Assessment Center using a computer-assisted data system. When the girls were 5 years old, the Nutrition Data System (version 2.91, 1996, Nutrient database version 26, food database 11a, Nutrition Coordinating Center, University of Minnesota, Minneapolis) was used. Nutrient Data System for Research (Nutrition Coordinating Center, University of Minnesota, Minneapolis) was used when the girls were 7, 9, and 11 years old. Nutrient Data System for Research (versions 4.01_30, 2000; 4.02_31, 2001; and 4.06_34, 2003, Nutrition Coordinating Center, University of Minnesota, Minneapolis) were used at age 7, 9, and 11 years, respectively. Food portion posters (2D Food Portion Visual, Nutrition Consulting Enterprises, Framingham, MA) were used to assist in the estimation of food amounts.

Dairy products are essential throughout the life cycle, particularly during childhood and adolescence

Dietary supplement intake was assessed as additional questions during 24-hour recall. Nutrient data were averaged across 3 days to obtain an estimate of energy and nutrient intakes. The percent of energy consumed from fat, carbohydrate, and protein were compared with the Acceptable Macronutrient Distribution Ranges (21). For vitamin D and calcium, mean intakes were compared with Adequate Intake recommendations (22). Phosphorus mean intake was compared with the Recommended Daily Allowances (22). Girls' intakes at age 5 and 7 years were compared with the recommendations for 4- to 8-year old children and at age 9 and 11 years intakes were compared with the recommendations for 9- to 13-year old girls. Nutrient intake estimates were based on foods consumed. Total vitamin D and calcium intake at each age included intake from multivitamin-multimineral supplements.

Measures of Dairy Intake—The mean number of servings consumed from the dairy food group of the US Department of Agriculture Food Guide Pyramid was calculated from the 24-hour recall data using methodology previously described (23). To do this, the gram weights of all foods consumed were summed, including those contained in mixed dishes. Mixed dishes were disaggregated into the corresponding ingredient gram weights and the ingredient gram weights were summed into single whole food weights that were assigned to the dairy food group according to the Food Guide Pyramid. The number of servings was calculated from gram weights of whole foods consumed and were based on serving sizes as defined by the Food Guide Pyramid.

Dairy output files were used to calculate average 3-day dairy consumption into three categories: total dairy, total milk, and other dairy. Total dairy included total milk, cheese, yogurt, and dairy desserts. Total milk intake was that consumed as a beverage and milk consumed with other foods (eg, cereal) or as part of a recipe. Other dairy included cheese, yogurt, and dairy desserts. Consumption in each category was expressed in servings, and as a percent of total daily energy intake.

Weight Status—Height and weight were measured at age 5, 7, 9, and 11 years by a trained staff member following procedures described by Lohman and colleagues (24). Children were dressed in light clothing and measured without shoes. Height was measured in triplicate to the nearest 0.1 cm using a Shorr Productions stadiometer (Irwin Shorr, Olney, MD). Weight was measured in triplicate to the nearest 0.1 kg using a Seca Electronic Scale (Seca Corp, Birmingham, UK). Age- and sex-specific BMI percentiles were calculated using growth charts from the Centers for Disease Control and Prevention (25).

Statistical Analysis

The aim of the study was to describe girls' dairy and dairy related nutrient intake across ages 5 to 11 years. Girls' dietary intake data were analyzed using SAS (version 8.02, 2004, SAS Inc, Cary, NC) and $P < 0.05$ was used to indicate significant effects. Analyses of time effects were conducted using repeated measures analysis of variance. Pairwise comparisons of significant effects were computed using contrast statements. Because the contrast statements are equivalent to multiple t tests, a Bonferroni correction was used to control the overall error rate at $P < 0.05$ (ie, individual contrasts were considered significant at $P < 0.0127$). McNemar's χ^2 test was used to analyze change in percentage of consumers between age 5 and 11 years. McNemar's test is a variation of the χ^2 test that is appropriate for paired data.

RESULTS

Weight Status

Girls' height, weight, BMI, and BMI-for-age percentiles are presented in Table 1. BMI increased significantly at each time period. The percentage of girls classified as at risk for overweight and classified as overweight increased significantly from age 5 to 11 years.

Dairy Intake

As shown in Table 2, on average, at age 5 years girls met the recommended two servings of dairy per day; however, by age 7, 9, and 11 years girls consumed fewer than the three servings of dairy per day recommended by the US Department of Agriculture Dietary Guidelines (5). Although the number of servings of total dairy consumed remains stable over time, the intake for milk, cheese, and dairy desserts changed over time.

Percentage of Dairy Consumers at Age 5 and 11 Years

From Table 3 it can be seen that the decline in milk, especially for milk as a beverage, is due to a reduction in the percentage of girls consuming milk as a beverage from age 5 years to age 11 years, and not simply due to a decline in the servings of milk consumed by consumers. The pattern is different for cheese, where the proportion of consumers remained relatively unchanged; however, there was a significant increase in the amount consumed over the period studied. The proportion of girls consuming dairy desserts increased over time, as well as the amount consumed. Finally, the proportion of girls consuming yogurt remained stable.

Energy and Macronutrient Intake

Descriptive statistics on girls' energy and macronutrient intakes are provided in Table 4. Girls' mean daily energy intake fell within the estimated energy requirements range for girls aged 4 to 8 years and 9 to 18 years (21). Expressing each macronutrient as a percentage of energy showed that at all points, on average, girls were within the Acceptable Macronutrient Distribution Ranges for carbohydrate and protein. In addition, from age 5 years to age 9 years, girls' reported intake indicated that girls were consuming $< 32\%$ of energy from fat (21). Consistent with energy requirements (21), girls' mean daily energy intake decreased by 35.5 kcal/kg from age 5 years to age 11 years. For the macronutrients, protein intake remained stable

over time; however, from age 5 years to age 11 years girls consumed significantly less energy from carbohydrate and more from fat.

Energy from total dairy and other dairy remained constant over the 6-year period; however, energy from total milk significantly decreased (Table 4). Whereas energy from carbohydrate from total dairy and other dairy remained stable over time, there was a significant decrease in energy from carbohydrate from total milk over time. Energy from protein from total dairy significantly decreased, due to a significant decrease in energy from protein from total milk over time. Energy from protein from other dairy remained constant over the 6-year period. Energy from fat from total dairy remained stable over time; however, there was a significant decrease in energy from fat from total milk, and a significant increase in energy from fat from other dairy.

Nutrient Intake

Table 5 presents girls' age-appropriate dietary recommendations as well as the mean intakes for vitamin D, calcium, and phosphorus from our sample. At age 5 years and at age 7 years, on average, girls met recommendations for total vitamin D, calcium, and phosphorus. However, by age 9 years and age 11 years, mean intakes of total calcium and phosphorus fell below the recommended levels. Nutrient densities (intake per 1,000 kcal) of vitamin D, calcium, and phosphorus significantly decreased with age. Vitamin D from total dairy significantly increased over time. Vitamin D from total milk did not vary with age.

In addition, calcium and phosphorus intake from total dairy decreased significantly over the 6-year period. Calcium and phosphorus intake from total milk decreased significantly with age, whereas calcium and phosphorus from other dairy increased significantly.

The percentage of girls who were using supplements at age 5 years was 45.3%, and the percentage was reduced to 23.3% at age 11 years ($P<0.0001$). The proportion of vitamin D and calcium provided by supplements significantly decreased over time. Vitamin D intake from supplements decreased from 26.3% to 13.7% from age 5 years to age 11 years ($P<0.001$). Similarly, calcium intake from supplements decreased from 3% to 1.3% over the 6-year period ($P<0.01$).

DISCUSSION

We investigated patterns of dairy and dairy-related nutrient intake during middle childhood in a sample of non-Hispanic white girls. Findings revealed that, on average, girls' total dairy intake remained stable from age 5 years to age 11 years. However, by age 7, 9, and 11 years, girls were not consuming the three servings of dairy per day recommended by the US Department of Agriculture Dietary Guidelines (5). Total dairy intake remained stable from age 5 years to age 11 years, although milk consumption declined across the period of time studied, due to a decline in milk intake as a beverage, which was accompanied by an increase in cheese and dairy desserts intake. These findings do not agree with previous cross-sectional studies (26) that have shown that dairy intake declines across middle childhood and into adolescence. In agreement with the 1989-1991 and 1994-1996 Continuing Surveys of Food Intakes by Individuals (CSFII), and the Bogalusa data (11,12,26), our data show that milk intake as a beverage declined over time, whereas cheese intake increased; in our sample, the increase in cheese as well as the increase in dairy desserts were able to compensate the decline in milk intake.

In agreement with Nicklas (12) and Wilkinson and colleagues (10), findings from this study reveal that the decline in milk intake was due to a reduction in the percentage of girls consuming milk as a beverage from age 5 to 11 years, and not simply due to a decline in the servings of

milk as a beverage consumed by consumers. Several studies among children and adolescents suggest that milk consumption has decreased over the past few decades and from childhood into adolescence due to an increase in consumption of soft drinks and noncitrus juice drinks (13-15,27-30).

Findings from this study are consistent with other data indicating that cheese intake increases with age (3). Results from nationally representative surveys and the Bogalusa study (10,12, 17) show that cheese intake increased over the past years. However, these studies showed that both the percentage of individuals consuming cheese and servings of cheese consumed increased, yet in this study only girls' cheese servings intake increased significantly over time. According to Putnam and Gerrior (17) a change in lifestyle, such as eating away from home, could explain the increase in cheese intake over the past 2 decades. In fact, those authors explained that two thirds of cheese consumption in the United States comes in commercially manufactured and prepared foods (eg, pizza, tacos, nachos, and fast-food sandwiches, among others). It is important to note that there are few data on other dairy intake (ie, dairy desserts and yogurt), in part due to the fact that intakes for these dairy categories are extremely low (31). The data from this study showed that the proportion of girls consuming dairy desserts increased over time, and that mean amounts consumed also increased. In contrast, CSFII data show that dairy desserts intake remained stable over the past 20 years for girls age 6 to 11 years (10). Finally, in agreement with other data, the consumption of yogurt in this study was very low and remained relatively stable over time (10,32).

The fact that girls' dairy intake remained stable and did not increase to three servings per day by age 7, 9, and 11 years is of concern, and explains, in part, why girls failed to meet recommendations for calcium and phosphorus by age 9 years and age 11 years. Consistent with national data (CSFII and the Third National Health and Nutrition Examination Survey) (3,4), this study shows that dairy foods were the largest food source of vitamin D, calcium, and phosphorus, indicating that consumption of dairy foods is critical to meet recommendations for these nutrients. From our data it can be concluded that other food groups are still very important in meeting requirements. For example, despite the reduction in the percentage of calcium and phosphorus provided by dairy, mean intakes of these nutrients increased over the 6-year period. In this study, vitamin D and calcium from supplements was included, and data show that the percentage of girls who were using supplements (45.3% and 23.3% at age 5 years and at age 11 years, respectively) were similar to national data (4,33).

It is important to note that although girls' calcium and phosphorus intakes increased from age 5 years to age 11 years, these increases were not sufficient to meet recommendations at age 9 years and at age 11 years, in part due to an increase in recommendations at age 9 years. In contrast to our data, previous cross-sectional studies have shown that calcium intake decreases with age (6,26). In addition, results from our study revealed that vitamin D intake decreased over time, however, girls met recommendations from age 5 years to age 11 years. The results of the present study are consistent with the CSFII and Third National Health and Nutrition Examination surveys (4), which indicate that vitamin D intake in women declines with age.

In agreement with previous studies, this research also shows a decline in indicators of diet quality during middle childhood (34,35). In this study we saw that at age 5 years, 69% of the girls met the dairy recommendations; however, by age 11 years only 39% met recommendations. As mentioned previously, this is due in part to an increase in the recommendations by age 9 years. Although reported energy intake also increased across the period from age 5 years to age 11 years, and the percentage of energy from dairy was unchanged across time, girls' dairy intake at age 7, 9, and 11 years did not meet the increased dairy recommendation. Furthermore, results from this study showed that nutrient densities for vitamin D, calcium, and phosphorus declined from age 5 years to age 11 years. These lower

nutrient densities may be attributable, in part, to declines in percent of energy from milk, in combination with concomitant increases in percent of energy from cheese and dairy desserts, and from an increase in total energy from fat from age 5 years to age 11 years.

In addition to the importance of dairy nutrients on bone health and the prevention of osteoporosis (8), recent evidence lends further credence to the contribution of dairy nutrients to children's overall health (36). For example, there is increasing evidence indicating that vitamin D may play a role not only in reducing the risk of rickets and osteoporosis, but also in reducing cancer risk during adulthood (37). Furthermore, recent studies provide evidence that dairy foods and calcium may play a significant role in weight maintenance and moderating body fat in children (38-40). In an 8-year study of school-aged children, higher intakes of dairy foods and calcium were associated with lower body fat (38,39). Consistent with these findings, Fisher and colleagues (29) recently reported that girls age 5 to 9 years in our sample who met calcium recommendations had higher energy intakes, but did not have higher BMI *z* scores than girls who failed to meet recommendations.

Although our study provides the longitudinal data needed to address several important questions, the study also has several limitations. First, the sample is a homogeneous one; girls were non-lactose-intolerant, non-Hispanic white, and our findings cannot be generalized to other racial or ethnic populations or to boys. For example, African-American children tend to consume less milk (41). Finally, although our longitudinal data allowed us to follow the same cohort of girls over time and provided essential data on changes in dairy intake across middle childhood—from age 5 to 11 years—and to identify girls who become nonconsumers over time, we cannot assess the extent to which the observed decline in milk intake and changes in dairy intake are attributable to developmental changes or secular trends.

The longitudinal design of this investigation allowed us to evaluate developmental stability and change, not just age differences, in dairy intake over time. Furthermore, results from this study show evidence that indexes of diet quality related to dairy intake declined with development from age 5 to 11 years. Finally, longitudinal data revealed that the declines in milk intake over time were, in part, attributable to the fact that a subsample of girls became nonconsumers during middle childhood.

CONCLUSIONS

Our findings underscore the importance of developing simple intervention strategies for increasing and maintaining milk intake, especially milk as a beverage, among girls. Several studies indicate that parents through role modeling, expectations, or attitudes influence young children's milk intake (29,42-45). For example, Fisher and colleagues (29) concluded that maternal modeling and making milk available at meals and snacks was a significant predictor of milk intake, independent of maternal modeling.

The emergence of a group of nonconsumers by age 11 years suggests that one approach could focus on identifying those children who become nonconsumers during childhood. Developing tailored strategies for promoting adequate intake of dairy nutrients among those who are becoming nonconsumers should continue to be a major focus of interventions. The development of dietary habits that include frequent milk intake is likely to lead to higher vitamin D, calcium, and phosphorus intakes in later years, which could reduce the risk for chronic diseases, including osteoporosis, obesity, hypertension, and cancer.

Acknowledgements

This research was supported in part by National Institutes of Health grant no. RO1 HD32973, The National Dairy Council, services provided by the General Clinical Research Center National Institutes of Health grant M01 RR10732, and the Diet Assessment Center of The Pennsylvania State University.

References

1. Gerrior, S.; Bente, L. Nutrient Content of the US Food Supply, 1909-1997. US Department of Agriculture; Washington, DC: 2001. Home Economics Research Report No. 54
2. Ilich JZ, Kerstetter JE. Nutrition in bone health revisited: A story beyond calcium. *J Am Coll Nutr* 2000;19:715-737. [PubMed: 11194525]
3. Subar AF, Krebs-Smith SM, Cook A, Kahle LL. Dietary sources of nutrients among US children, 1989-1991. *Pediatrics* 1998;102:913-923. [PubMed: 9755265]
4. Moore C, Murphy MM, Keast DR, Holick MF. Vitamin D intake in the United States. *J Am Diet Assoc* 2004;104:980-983. [PubMed: 15175600]
5. Nutrition and Your Health: Dietary Guidelines for Americans. Backgrounder 2005 Dietary Guidelines Advisory Committee Report. [Accessed September 27, 2004]. Available at: <http://www.health.gov/dietaryguidelines/dga2005/Backgrounder.htm>.
6. Gleason, PM.; Suitor, CW. Changes in Children's Diets: 1989-1991 to 1994-1996. US Department of Agriculture; Washington, DC: 2001. Report No. CN-01-CD1
7. Munoz KA, Krebs-Smith SM, Ballard-Barbash R, Cleveland LE. Food intakes of US children and adolescents compared with recommendations. *Pediatrics* 1997;100:323-329. [PubMed: 9282700]
8. Miller, GD.; Jarvis, JK.; McBean, LD. Handbook of Dairy and Nutrition. 2nd ed.. CRC Press; Boca Raton, FL: 2000.
9. Morton JF, Guthrie JF. Changes in children's total fat intakes and their food group sources of fat, 1989-91 vs 1994-95: Implications for diet quality. *Family Econ Nutr Rev* 1998;11:44-57.
10. Wilkinson Enns C, Mickle SJ, Goldman JD. Trends in food and nutrient intakes by children in the United States. *Family Econ Nutr Rev* 2002;14:56-62.
11. Nielsen SJ, Popkin B. Changes in beverage intake between 1977 and 2001. *Am J Prev Med* 2004;27:205-210. [PubMed: 15450632]
12. Nicklas TA. Calcium intake trends and health consequences from childhood through adulthood. *J Am Coll Nutr* 2003;22:340-356. [PubMed: 14559926]
13. Cavadini C, Siega-Riz AM, Popkin B. US adolescent food intake trends from 1965 to 1996. *Arch Dis Child* 2000;83:18-24. [PubMed: 10868993]
14. Harnack L, Stang J, Story M. Soft drink consumption among US children and adolescents: Nutritional consequences. *J Am Diet Assoc* 1999;99:436-441. [PubMed: 10207395]
15. Rampersaud GC, Bailey LB, Kauwell GP. National survey beverage consumption data for children and adolescents indicate the need to encourage a shift toward more nutritive beverages. *J Am Diet Assoc* 2003;103:97-100. [PubMed: 12525800]
16. Alaimo, K.; McDowell, MA.; Briefel, RR.; Bischof, AM.; Caughman, CR.; Loria, CM.; Johnson, CL.; National Center for Health Statistics. Dietary Intake of Vitamins, Minerals, and Fiber of Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91. Hyattsville, MD: 1994. Advance Data From Vital and Health Statistics, No. 258
17. Putnam, J.; Gerrior, S. "America's Eating Habits: Changes and Consequences." Trends in the US food supply, 1970-97. US Department of Agriculture; Washington, DC: 1999.
18. Fleming KH, Heimbach JT. Consumption of calcium in the US: Food sources and intake levels. *J Nutr* 1994;124(suppl 8):S1426-S1430.
19. Kennedy E, Powell R. Changing eating patterns of American children: A view from 1996. *J Am Coll Nutr* 1997;16:524-529. [PubMed: 9430079]
20. Guthrie J, Morton JF. Food sources of added sweeteners in the diets of Americans. *J Am Diet Assoc* 2000;100:43-48. [PubMed: 10646004]

21. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. National Academies Press; Washington, DC: 2002.
22. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. National Academies Press; Washington, DC: 1997.
23. Mitchell DC. Database requirements to meet food grouping needs. *J Food Comp Anal* 2001;14:279–285.
24. Lohman, TG.; Roche, AF.; Martorell, R., editors. Anthropometric Standardization Reference Manual. Human Kinetics; Champaign, IL: 1988.
25. Kuczmarski, RJ.; Ogden, CL.; Grummer-Strawn, LM.; Flegal, KM.; Guo, SS.; Wei, R.; Mei, Z.; Curtin, LR.; Roche, AF.; Johnson, CL. CDC Growth Charts: United States. Advance Data from Vital and Health Statistics. National Center for Health Statistics; Hyattsville, MD: 2000. No. 314
26. Gleason, PM.; Sutor, CW. Children's Diets in the Mid-1990s: Dietary Intake and Its Relationship with School Meal Participation. US Department of Agriculture, Food and Nutrition Service; Washington, DC: 2001 [Accessed July 25, 2004]. Nutrition Assistance Program Report Series, Report No. CN-01-CD1. Available at: <http://www.fns.usda.gov/oane>
27. Bowman SA. Beverage choices of young females changes and impact on nutrient intakes. *J Am Diet Assoc* 2002;102:1234–1239. [PubMed: 12792618]
28. Guenther PM. Beverages in the diets of American teenagers. *J Am Diet Assoc* 1986;86:493–499. [PubMed: 3958400]
29. Fisher JO, Mitchell DC, Smiciklas-Wright H, Mannino ML, Birch LL. Meeting calcium recommendations during middle childhood reflects mother-daughter beverage choices and predicts bone mineral status. *Am J Clin Nutr* 2004;79:698–706. [PubMed: 15051617]
30. Fisher JO, Mitchell DC, Smiciklas-Wright H, Birch LL. Maternal milk consumption predicts the trade-off between milk and soft drinks in young girls' diets. *J Nutr* 2000;131:246–250. [PubMed: 11160541]
31. Gwynne Weinberg L, Berner LA, Groves JE. Nutrient contributions of dairy foods in the United States, Continuing Survey of Food Intakes by Individuals, 1994-1996, 1998. *J Am Diet Assoc* 2004;104:895–902. [PubMed: 15175587]
32. Brady LM, Lindquist C, Herd SL, Goran MI. Comparison of children's dietary intake patterns with US dietary guidelines. *Br J Nutr* 2000;84:361–367. [PubMed: 10967615]
33. Ervin RB, Wright JD, Kennedy-Stephenson J. Use of dietary supplements in the United States, 1988-94. *Vital and Health Statistics No. 11* 1999;244:1–14.
34. Sutor CW, Gleason PM. Using Dietary Reference Intake-based methods to estimate the prevalence of inadequate nutrient intake among school-aged children. *J Am Diet Assoc* 2002;102:530–536. [PubMed: 11985410]
35. Mannino ML, Lee Y, Mitchell DC, Smiciklas-Wright H, Birch LL. The quality of girls' diets declines and tracks across middle childhood. *Int J Behav Nutr Physical Activity* 2004;1:5.
36. Hoolihan L. Beyond calcium: The protective attributes of dairy products and their constituents. *Nutr Today* 2002;39:69–77. [PubMed: 15100496]
37. Grant WB. An ecologic study of dietary and solar ultraviolet-B links to breast carcinoma mortality rates. *Cancer* 2002;94:272–281. [PubMed: 11815987]
38. Carruth BR, Skinner JD. The role of dietary calcium and other nutrients in moderating body fat in pre-school children. *Intl J Obes* 2001;25:559–566.
39. Skinner JD, Bounds W, Carruth BR, Ziegler P. Longitudinal calcium intake is negatively related to children's body fat indexes. *J Am Diet Assoc* 2003;103:1626–1631. [PubMed: 14647089]
40. Novotny R, Daida YG, Acharya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. *J Nutr* 2004;134:1905–1909. [PubMed: 15284374]
41. Forshee RA, Storey M. Total beverage consumption and beverage choices among children and adolescents. *Intl J Food Sci Nutr* 2003;54:297–307.
42. Novotny R, Han H, Biernacke I. Motivators and barriers to consuming calcium-rich foods among Asian adolescents in Hawaii. *J Nutr Educ* 1999;31:99–104.

43. Auld G, Boushey CJ, Bock MA, Bruhn C, Gabel K, Gustafson D, Holmes B, Misner S, Novotny R, Peck L, Pelican S, Pond-Smith D, Read M. Perspectives on intake of calcium-rich foods among Asian, Hispanic, and white preadolescent and adolescent females. *J Nutr Educ Behav* 2002;34:242–251. [PubMed: 12559059]
44. Johnson RK, Panley CV, Wang MQ. Associations between the milk mothers drink and the milk consumed by their school-aged children. *Fam Econ Nutr Rev* 2001;13:27.
45. Dennison BA, Erb TA, Jenkins PL. Predictors of dietary milk fat intake by preschool children. *Prev Med* 2001;33:536–542. [PubMed: 11716648]
46. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. National Academies Press; Washington, DC: 1998.
47. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. National Academies Press; Washington, DC: 2000.
48. Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. National Academies Press; Washington, DC: 2001.

Table 1

Height, weight, and body mass index (BMI) across age 5 to 11 years of predominantly middle-class, exclusively non-Hispanic white girls in central Pennsylvania surveyed for dairy and dairy-related nutrient intake (n=151)

Measure	Age 5 y	Age 7 y	Age 9 y	Age 11 y
	<i>mean ± standard deviation</i>			
Height (cm)	111.1±4.7 ^w	123.7±5.4 ^x	135.8±6.3 ^y	149.0±7.3 ^z
Weight (kg)	19.6±3.1 ^w	25.4±5.2 ^x	34.3±8.5 ^y	44.7±11.3 ^z
BMI (calculated as kg/m ²)	15.8±1.6 ^w	16.5±2.4 ^x	18.4±3.4 ^y	20.0±3.9 ^z
BMI-for-age percentile ^a	59.1±26.4 ^w	58.3±27.0 ^w	64.0±26.7 ^x	64.1±27.2 ^x
	%			
At risk for overweight ^b	13.3	8.6	16.6	15.2 ^{***}
Overweight ^c	4.0	8.0	11.9	12.6 ^{***}

^a BMI-for-age percentiles were calculated using growth charts from the Centers for Disease Control and Prevention (25).

^b At risk for overweight is defined as ≥85th and <95th BMI-for-age percentile.

^c Overweight is defined as ≥95th BMI-for-age percentile.

*** Significant difference in prevalence at age 5 y and age 11 y, $P < 0.001$.

^{wxyz} Values with different superscripts indicate significant difference across ages at $P < 0.0001$.

Table 2

Mean dairy intake across ages 5 to 11 years of predominantly middle class, exclusively non-Hispanic white girls in central Pennsylvania surveyed for dairy and dairy-related nutrient intake (n=151)

Measure	Intake			
	Age 5 y	Age 7 y	Age 9 y	Age 11 y
% Meeting dairy recommendations	67	38	34	39
	<i>mean ± standard deviation</i>			
Dairy (servings/d) ^a	2.7±1.3 ^y	2.8±1.3 ^y	2.8±1.3 ^y	2.8±1.4 ^y
Total milk (servings/d)	1.6±1.1 ^y	1.6±1.1 ^y	1.5±1.1 ^{y,z}	1.4±1.1 ^z
Milk as a beverage (servings/d)	1.1±0.9 ^y	0.9±0.8 ^{y,z}	0.9±0.8 ^{y,z}	0.9±0.9 ^z
Cheese (servings/d)	0.4±0.4 ^y	0.5±0.4 ^y	0.5±0.4 ^{y,z}	0.6±0.5 ^z
Yogurt (servings/d)	0.1±0.1 ^y	0.1±0.1 ^y	0.1±0.1 ^y	0.04±0.1 ^y
Dairy desserts (servings/d)	0.5±0.5 ^y	0.7±0.7 ^z	0.7±0.6 ^z	0.7±0.6 ^z

^aThe Dietary Guidelines for Americans (5) recommends three servings of dairy group foods daily for children who require 1,600 kcal/d or more; two servings per day for those with lower energy needs.

^{y,z}Values with different superscripts indicate significant difference across ages at $P<0.05$, except for cheese and dairy desserts, which are significant at $P<0.01$.

Table 3

Percentage of predominantly middle-class, exclusively non-Hispanic white girls in central Pennsylvania (n=151) consuming dairy at age 5, 7, 9, and 11 years and number of servings consumed

Dairy product	Intake			
	Age 5 y	Age 7 y	Age 9 y	Age 11 y
Total milk				
Percent consumers (%) ^a	99.3	98.7	98.7	96.0
Servings/d (mean±SD) ^b	1.6±1.1 ^y	1.6±1.1 ^y	1.6±1.1 ^y	1.5±1.1 ^y
Milk as a beverage				
Percent consumers (%)	90.7	90.1	86.1	78.1 ^{***}
Servings/d (mean±SD)	1.2±0.9 ^y	1.0±0.8 ^y	1.1±0.8 ^y	1.1±0.9 ^y
Cheese				
Percent consumers (%)	92.7	92.7	89.4	94.0
Servings/d (mean±SD)	0.5±0.4 ^y	0.5±0.4 ^y	0.6±0.4 ^{y,z}	0.7±0.5 ^z
Yogurt				
Percent consumers (%)	19.2	19.9	21.8	13.2
Servings/d (mean±SD)	0.3±0.2 ^y	0.3±0.2 ^y	0.3±0.2 ^y	0.3±0.2 ^y
Dairy desserts				
Percent consumers (%)	71.5 ^y	78.2 ^y	80.1 ^y	79.5 ^y
Servings/d (mean±SD)	0.7±0.5 ^y	0.9±0.6 ^z	0.9±0.6 ^z	0.9±0.5 ^z

^aPercentage of consumers is based on percentage of participants in the total sample (n=151).

^bSD=standard deviation.

*** Significant change in percentage of consumers at age 5 y to age 11 y, $P<0.001$.

^{y,z}Values with different superscripts indicate significant difference across ages at $P<0.01$.

Table 4

Mean energy, macronutrient intake, and dairy contribution to energy and macronutrient intake across ages 5 to 11 years for predominantly middle-class, exclusively non-Hispanic white girls in central Pennsylvania (n=151)

Nutrient	Intake			
	Age 5 y	Age 7 y	Age 9 y	Age 11 y
	<i>mean ± standard deviation</i>			
Total energy (kcal) ^a	1,514.0±324.2 ^x	1,685.9±325.2 ^y	1,824.6±350.9 ^z	1,862.9±455.1 ^z
Energy from total dairy (%)	21.7±8.1 ^x	20.8±8.1 ^y	19.8±7.5 ^x	20.0±8.6 ^x
Energy from total milk (%)	11.7±6.7 ^x	9.8±5.5 ^y	9.3±6.3 ^{yz}	8.2±5.8 ^z
Energy from other dairy (%) ^b	10.0±6.3 ^x	10.9±6.0 ^x	10.5±5.6 ^x	11.8±6.9 ^x
Total carbohydrate (% of energy) ^c	57.4±5.8 ^x	56.8±5.6 ^{xy}	56.2±5.9 ^{xy}	55.6±5.5 ^y
Carbohydrate from total dairy (% of energy)	8.2±4.3 ^x	8.0±3.8 ^x	7.5±3.5 ^x	7.4±4.0 ^x
Carbohydrate from total milk (% of energy)	4.9±3.1 ^x	4.0±2.3 ^y	3.9±2.8 ^y	3.6±2.7 ^y
Carbohydrate from other dairy (% of energy)	3.3±3.2 ^x	4.0±3.2 ^x	3.6±2.7 ^x	2.9±2.7 ^x
Total protein (% of energy) ^c	13.9±2.6 ^x	13.5±2.3 ^x	13.8±2.5 ^x	13.8±2.6 ^x
Protein from total dairy (% of energy)	4.9±2.1 ^x	4.5±2.0 ^{xy}	4.3±1.9 ^y	4.3±2.0 ^y
Protein from total milk (% of energy)	3.0±1.8 ^x	2.5±1.5 ^y	2.4±1.7 ^{yz}	2.2±1.6 ^z
Protein from other dairy (% of energy)	1.9±1.3 ^x	2.0±1.2 ^x	1.9±1.1 ^x	2.1±1.4 ^x
Total fat (% of energy) ^c	30.4±4.9 ^x	31.4±4.8 ^{xy}	31.6±4.5 ^{xy}	32.0±4.5 ^y
Fat from total dairy (% of energy)	8.7±4.1 ^x	8.5±4.0 ^x	8.3±3.6 ^x	8.5±4.1 ^x
Fat from total milk (% of energy)	3.8±2.8 ^x	3.3±2.5 ^{xy}	3.1±2.6 ^y	2.5±2.3 ^z
Fat from other dairy (% of energy)	4.9±3.2 ^x	5.2±2.9 ^{xy}	5.2±3.0 ^{xy}	6.0±3.7 ^y

^a A range of energy estimate requirements (EER) was created for girls aged 4 to 8 y and 9 to 18 y. Girls' mean age, weight, and height and physical activity coefficients (sedentary, low active, active, and very active) were used to create the ranges. The range of values in EER reflects possible differences in the physical activity coefficients of participants (21). For girls aged 3 to 8 y the range of EER was 1,233 to 2,140 kcal/d, and for girls aged 9 to 18 y the range of EER was 1,500 to 2,700 kcal/d.

^b Other dairy includes cheese, yogurt, and dairy desserts.

^c The percent of energy consumed from carbohydrate, protein, and fat were compared with the acceptable macronutrient distribution ranges (AMDR) for these macronutrients. For children aged 3 to 18 y the AMDR is 45% to 65% carbohydrates, 32% to 35% fat, and 10% to 30% protein.

^{xyz} Values with different superscripts indicate significant difference across ages at $P < 0.0001$, except for % of protein from total dairy and % of energy from total fat, which are significantly different at $P < 0.01$, and except for % of energy from total carbohydrate and % of fat from other dairy, which are significantly different at $P < 0.05$.

Table 5

Mean nutrient intake across ages 5 to 11 years for predominantly middle-class, exclusively non-Hispanic white girls in central Pennsylvania surveyed for dairy and dairy-related nutrient intake (n=151)

Nutrient	Intake ^a			
	Age 5 y	Age 7 y	Age 9 y	Age 11 y
Girls meeting AI for vitamin D	46	44	89	82
	<i>mean ± SD^c</i>			
Total vitamin D (μg) ^b	8.9±5.3 ^y	7.8±4.9 ^{xy}	7.6±4.7 ^y	6.2±4.3 ^z
Dietary vitamin D (μg)	5.3±2.5 ^x	5.2±2.3 ^x	5.3±2.6 ^x	4.6±2.8 ^y
Total vitamin D per 1,000 kcal (μg) ^b	6.0±3.7 ^x	4.8±3.2 ^y	4.2±2.6 ^y	3.4±2.4 ^z
Vitamin D from dairy (%)	48.1±23.5 ^x	52.4±21.7 ^{xy}	51.5±23.0 ^{xy}	55.0±26.2 ^y
Vitamin D from total milk (%)	45.5±22.7 ^x	47.7±21.4 ^x	47.4±23.2 ^x	50.0±26.8 ^x
Vitamin D from other dairy (%) ^d	2.6±4.3 ^x	4.7±7.1 ^y	4.1±6.8 ^{xy}	5.0±7.5 ^y
	<i>%</i>			
% meeting AI for calcium	98	99	31	27
	<i>mean ± SD</i>			
Total calcium (mg) ^b	848.5±339.8 ^x	865.6±296.8 ^x	925.0±316.5 ^y	945.7±415.2 ^y
Dietary calcium (mg)	824.3±325.3 ^x	850.0±290.3 ^x	908.9±313.7 ^y	931.6±409.5 ^y
Total calcium per 1,000 kcal (mg) ^b	557.7±184.7 ^x	517.6±162.6 ^y	510.3±159.5 ^y	509.7±188.5 ^y
Calcium from total dairy (%)	69.0±13.5 ^x	68.8±11.9 ^x	65.8±14.0 ^{xy}	65.2±14.6 ^y
Calcium from total milk (%)	45.7±17.7 ^x	42.3±16.4 ^y	38.9±19.1 ^z	35.9±19.2 ^z
Calcium from other dairy (%) ^d	23.3±14.1 ^x	26.5±13.9 ^y	26.9±14.8 ^y	29.3±16.7 ^y
	<i>%</i>			
Girls meeting RDA for phosphorus	67	65	63	46
	<i>mean ± SD</i>			
Dietary phosphorus (mg)	982.1±300.8 ^x	1,034.3±263.8 ^x	1,100.7±288.0 ^y	1,107.5±352.5 ^y
Phosphorus per 1,000 kcal (mg)	649.2±137.9 ^x	619.3±129.6 ^y	607.8±126.1 ^y	599.0±127.3 ^y
Phosphorus from total dairy (%)	48.6±14.3 ^x	47.4±12.8 ^x	44.7±12.5 ^y	44.8±14.3 ^y
Phosphorus from total milk (%)	31.4±14.4 ^x	28.2±12.5 ^y	26.1±13.8 ^{yz}	24.4±14.1 ^z
Phosphorus from other dairy (%) ^d	17.2±10.9 ^x	19.2±9.8 ^{xy}	18.6±10.3 ^{xy}	20.4±11.9 ^y

^aFor children aged 4 to 8 y the Dietary Reference Intakes (DRIs) recommend 5 $\mu\text{g}/\text{d}$ vitamin D, 800 mg/d calcium, and 500 mg/d phosphorus. For girls aged 9 to 13 y the DRIs recommend 5 $\mu\text{g}/\text{d}$ vitamin D, 1,300 mg/d calcium, and 1,250 mg/d phosphorus. Adequate Intake (AI) values are listed for vitamin D and calcium and Recommended Dietary Allowance (RDA) listed for phosphorus (22,46-48).

^bIncluding calcium and vitamin D intake from supplements.

^cSD=standard deviation.

^dOther dairy includes cheese, yogurt, and dairy desserts.

^{xyz}Values with different superscripts indicate significant difference across ages at $P<0.01$, except for total vitamin D, dietary phosphorus, vitamin D and phosphorus per 1,000 kcal, and calcium and phosphorus from total milk, which are significant at $P<0.0001$, and except for vitamin D from dairy and phosphorus from other dairy, which are significant at $P<0.05$.