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Dairy consumption and diet quality in a sample of Australian children

Abstract

Objective: To examine the association between intake of dairy products and indicators of diet quality among a sample of Australian children. **Methods:** Three 24-hour recalls were collected from 222 children aged 8–10 years living in western Sydney. Analysis of covariance was used to examine differences in mean intakes of foods and nutrients among 3 dairy consumption groups (<1 >serve, 1–2 serves, ≥ 2 serves per day). The percentage of children meeting healthy eating guidelines for foods and estimated average requirements (EAR) for nutrients was also assessed. **Results:** Higher dairy consumption was associated with higher intakes of energy, protein, calcium, phosphorus, magnesium, potassium, zinc, vitamin A, riboflavin, and niacin as well as foods from the bread and cereal group but lower intakes of mono- and polyunsaturated fats, foods from the meat and alternatives group, and energy-dense, nutrient-poor foods. Children who consumed ≥ 2 serves of dairy products per day (38%) were more likely to meet food and nutrient recommendations. Body mass index z-score and waist circumference were not associated with dairy consumption. Milk intake was inversely associated with the intake of sugar-sweetened beverages, and children who did not meet their minimum dairy serve recommendations consumed higher quantities of sugar-sweetened beverages than milk. **Conclusions:** Adequate dairy consumption was associated with diets of higher nutritional quality but also higher intakes of energy, suggesting a potential benefit from shifting consumption from regular-fat to reduced-fat dairy products in line with current national recommendations.

Keywords

australian, sample, children, quality, dairy, diet, consumption

Disciplines

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Original Research

Dairy Consumption and Diet Quality in a Sample of Australian Children

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Key words: child nutrition, dietary intake, dairy consumption, Australia

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Methods: Three 24-hour recalls were collected from 222 children aged 8–10 years living in western Sydney. Analysis of covariance was used to examine differences in mean intakes of foods and nutrients among 3 dairy consumption groups (<1 serve, 1–2 serves, ≥ 2 serves per day). The percentage of children meeting healthy eating guidelines for foods and estimated average requirements (EAR) for nutrients was also assessed.

Results: Higher dairy consumption was associated with higher intakes of energy, protein, calcium, phosphorus, magnesium, potassium, zinc, vitamin A, riboflavin, and niacin as well as foods from the bread and cereal group but lower intakes of mono- and polyunsaturated fats, foods from the meat and alternatives group, and energy-dense, nutrient-poor foods. Children who consumed ≥ 2 serves of dairy products per day (38%) were more likely to meet food and nutrient recommendations. Body mass index z-score and waist circumference were not associated with dairy consumption. Milk intake was inversely associated with the intake of sugar-sweetened beverages, and children who did not meet their minimum dairy serve recommendations consumed higher quantities of sugar-sweetened beverages than milk.

Conclusions: Adequate dairy consumption was associated with diets of higher nutritional quality but also higher intakes of energy, suggesting a potential benefit from shifting consumption from regular-fat to reduced-fat dairy products in line with current national recommendations.

INTRODUCTION

Good nutrition in childhood is an important contributor to health and well-being and the prevention of chronic diseases prevalent in Australia. Inadequate intakes of calcium and other nutrients during childhood may increase the risk of developing osteoporosis in later life. The best protection against osteoporosis and consequent fracture risk is the attainment of a high peak bone mass achieved by consuming a diet high in calcium during childhood and adolescence [1]. Accumulating evidence suggests that a diet high in dairy products may also confer

some protection against high blood pressure, cardiovascular disease, and overweight and obesity [2–5].

The 2007 national dietary survey of children in Australia reported that a substantial proportion of preteen children and adolescents had intakes below the recommendations for calcium: 35–50% of boys aged 9–16 years, 55% of girls aged 9–11 years, and 82–89% of girls aged 12–16 years [6]. These results were consistent with those of the 1995 National Nutrition Survey (1995 NNS) in which girls aged 12–15 years were most likely to have intakes below recommendations [7].

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Anna M. Rangan and Victoria L. Flood worked at the Boden Institute of Obesity, Nutrition, Exercise and Eating Disorders at the time this study was undertaken.

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Abbreviations: CAPS = Children's Asthma Prevention Study, EAR = estimated average requirements, NNS = 1995 National Nutrition Survey, NZ = New Zealand.

Dairy foods are an important dietary source of several nutrients including calcium, protein, potassium, magnesium, phosphorous, riboflavin, niacin, vitamin A, and vitamin B12. In the 1995 NNS, two thirds (66%) of calcium intake was derived from milk products and dishes for children aged 2–11 years [7]. Further, both surveys showed that children fall well below the recommended number of daily serves of dairy products as outlined in the Australian Guide to Healthy Eating (aged 4–11 years: 2 serves, older children: 3 serves) [8]. Approximately 30% of children aged 2–18 years consumed less than 1 serve of dairy products, 50% consumed between 1 and 3 serves, and 20% consumed 3 or more serves [1]. Intakes were lowest in adolescent girls, with 44% consuming less than 1 serve and only 12% consuming more than 3 serves.

Consuming less than the recommended amounts of dairy products has been shown to be associated with many indicators of poor diet quality, including micronutrient intakes below recommended levels for magnesium, potassium, zinc, folate, thiamin, riboflavin, and vitamins B6, B12, A, D, and E [9–14]; higher consumption of noncore foods [15]; and higher consumption of sugar-sweetened soft drinks [11,12,16,17].

The displacement of milk intake with soft drinks and other sugar-sweetened beverages (SSB) is of particular concern. National dietary surveys in the United States between 1977 and 2001 have shown an increase in sweetened beverage consumption and a decrease in milk consumption among children and adults. Energy intake from sweetened beverages increased 135%, while energy from milk decreased by 38% [18]. Larger portions and more frequent consumption accounted for much of the increase in SSB, while smaller portions and less frequent consumption contributed to the reduction in milk intake. Similar trends have been seen in Australia between 1983 and 1995 [19].

In this study, we examine the dietary intakes of a sample of 8- to 10-year-old Australian children participating in the longitudinal Childhood Asthma Prevention Study (CAPS). In particular, we report on the cross-sectional associations between intake of dairy products and selected indicators of diet quality (meeting food and nutrition recommendations) and the relationship between the consumption of milk and SSB.

METHODS

Study Background and Subjects

The subjects were part of CAPS, a longitudinal study that began as a randomized controlled trial to assess the effects of 2 interventions on the primary prevention of asthma: an omega-3-supplemented diet and house dust mite reduction for the first 5 years of life. Pregnant women whose unborn children were at risk of developing asthma were recruited from antenatal clinics of 6 hospitals in western and southwestern Sydney, Australia, from 1997 to 2000. Ethics approval for the study was obtained

from the human research ethics committees of each of the participating hospitals, the Area Health Services in which the hospitals were located, and the University of Sydney.

Of 7171 pregnant women screened, 2095 (29%) were eligible for inclusion and 538 (25.7% of those eligible and 7.5% of those initially screened) completed an assessment when their child was 18 months old. Further details about the intervention, recruitment, and the extent to which the study population differed from the women who satisfied the selection criteria and the local population of comparable age have been reported by Mahrshahi et al. [20]. In brief, a higher proportion of fathers and mothers of CAPS children had tertiary education and were Australian born, compared with those who did not participate in the study and the population of western Sydney in general.

The first dietary assessment in CAPS was undertaken between 1999 and 2002, when the children were 18 months of age. Three-day weighed food records were completed satisfactorily on 429 children [21]. The second dietary assessment (reported in this article) was undertaken in 2007–2008 on a subgroup of children aged approximately 9 years of age. Because of budgetary constraints, only 280 of the 429 children who participated in the first dietary assessment were contacted and invited to participate in a second dietary assessment. The invited children did not differ from the uninvited children by weight, height, body mass index (BMI), or energy intake at age 18 months, but father's education levels were higher in the sample of invited children and mother's age at birth of child was lower. Of these 280 children, 43 children (15.3%) were unwilling to participate and 15 children were excluded from the analysis because they did not complete all 3 days of recalls ($n = 12$) or misreported their energy intake ($n = 3$). Criteria for underreporting and overreporting were based on the Goldberg cutoff points for EI:BMR for children (4.5 MJ and 12.6 MJ, respectively) [22]. The final number of children for whom there were 3 days of recall was 222. Interviewers sought to obtain recalls on 2 weekdays and 1 weekend day, and this was achieved for 70% of the children. Participants were provided with 2 movie passes after successful completion of 3 dietary interviews as an incentive to participate.

Dietary Intake and Data Analysis

Food and nutrient intakes were assessed from 3 nonconsecutive 24-hour recalls using the multiple-pass approach [23]. All interviews were conducted on the telephone by trained research dietitians. Children themselves were the respondents with adult input as needed regarding brand names, food descriptions, ingredients in mixed dishes, cooking methods, and estimates of portion sizes. A food model booklet similar to that used in the 2007 Children's Survey [23] was mailed ahead to all participants to assist in estimating portion sizes. The booklet contained life-size diagrams and drawings depicting various serving sizes and food containers.

Twenty-four hour recall data were entered during the interview into a custom-designed interviewer-scripted data collection/entry/coding and analysis program. The use of this automated data entry method contributed to greater consistency in interviewing and coding reported foods. The NUTTAB 2006 food composition database was used to derive estimates of food groups and nutrient intakes [24]. A sample of recalls was taped for each interviewer and reviewed for quality assurance by a supervising research dietitian, who provided regular feedback on interviewing and entry procedures. Food lists for each subject were exported and checked, and coding and data entry errors were corrected.

Data from this program were exported into SPSS for further checking and analysis. The distributions of selected foods and nutrients were reviewed for extreme values, and the recalls for these subjects were further checked for errors or verified before further analysis. Usual food group and nutrient intakes were estimated for each individual by adjusting for within-person variability using the Multiple Source Method (MSM) [25,26]. Nutrients contributed from vitamin and mineral supplements have not been considered in this analysis.

Serves of dairy products were calculated by adding weights consumed of milk (258 g or 250 ml of any type of fluid milk), cheese (40 g of hard or soft cheese, including from composite dishes), yoghurt (200 g of any type of yoghurt), and custard (280 g of any type of custard made with milk). Dairy products were classified as regular fat (milk >3.5%, cheese >20%, yoghurt >3%) or reduced fat (milk <2%, cheese <20%, yoghurt <0.5%) products. Fruit included all types of raw, dry, and cooked fruit but excluded fruit juice. A serve of fruit was calculated as 150 g of fresh/canned fruit or 20 g of dried fruit. Vegetables included all types of raw and cooked vegetables and legumes but excluded hot chips. A serve of vegetables was calculated as 75 g. "Meat and alternatives" included all red and white meats, fish, eggs, nuts, and seeds. If meat or fish was a major ingredient in a composite dish (e.g., bolognese sauce, meat pie, hamburger), 50% of the weight of the dish was assigned to the meat category. A serve of meat or alternatives was calculated as 80 g of red/white meat, 100 g of fish and eggs, or 50 g of nuts and seeds. Bread and cereals included breads, rolls, breakfast cereals, pasta, and rice but excluded noncore cereal foods such as cakes and biscuits. If the major ingredient in a composite dish was cereal (e.g., macaroni cheese, spaghetti in meat sauce, lasagne), 50% of the weight of the dish was assigned to the cereal category. A serve of bread and cereals was calculated as 60 g of bread, 40 g of breakfast cereals and flour, 180 g of pasta and rice, or 230 g of porridge. Nondairy core foods included all fruit, vegetables, bread and cereals, and meat and alternatives. SSB included soft drinks, cordials, fruit drinks, fruit juice, and infant juice but excluded artificially sweetened beverages. Total extra foods included all foods coded as extra or

noncore based on the criteria used by Webb et al. [21]. In brief, extra foods were mainly energy-dense, nutrient-poor foods containing substantial amounts of fat and/or sugar such as cakes, biscuits, confectionery, soft drinks, crisps, fried take-away foods, and fats.

Anthropometric Measures

Children's weight, in kilograms, and height and waist circumference, in centimeters, were measured by research nurses when children were 8 years old (range, 7.8–9.2 years), approximately 1 year prior to dietary assessment. Weight was measured to the nearest 0.1 kilogram and height to the nearest 1 cm. Waist circumference was measured with a flexible steel tape at the level of the narrowest point between the lower costal border and the iliac crest. If there was no obvious narrowing, the measurement was taken at the midpoint between the 2 landmarks. Children were dressed in light clothing without shoes. The proportion of children overweight or obese was based on Centers for Disease Control and Prevention growth charts [27] (overweight >85th and <95th percentile, obese >95th percentile).

Demographic and Health Information

Data on the following potential confounding factors were collected at baseline: child's age and sex, mother's age at birth of child, mother's and father's education level (defined as primary/secondary education or vocational/university education), mother's and father's countries of birth (Australia/New Zealand or other), postcode (used to derive a Socio-Economic Index for Areas score) [28], and mother's smoking status during pregnancy (yes/no).

Statistical Analysis

Children's intakes of dairy foods were classified into 3 categories (<1 serve, 1 to >2 serves, ≥ 2 serves/day) to examine associations between the intake of dairy products and other aspects of the diet, as well as sociodemographic characteristics. A fourth category of dairy intake was considered (≥ 3 serves/day), but due to small numbers ($n = 21$), these children were grouped with those consuming ≥ 2 serves/day.

Significant differences between children in the 3 categories of dairy intake in relation to sociodemographic variables and intakes of foods and nutrients were examined using analysis of covariance (ANCOVA). All models were adjusted for age, sex, parental education, and total energy intake. Mean intakes and standard errors (SE) are presented in Tables 1–3. If ANCOVA was significant, post hoc tests were used to examine differences between the groups using the Tukey test. Tests for linear trends were performed across the 3 categories to examine trends between an increase in dairy consumption and variables of

Table 1. Characteristics of Children by Category of Dairy Consumption

	Dairy Serves/d			<i>p</i> Value Trend
	<1, n = 31	1–<2, n = 106	≥2, n = 85	
Age (y)	9.0 (0.09) ^a	9.1 (0.05) ^{ab}	9.3 (0.06) ^b	↑0.007
Gender (% male)	45.2	54.7	57.6	0.27
Body mass index (kg/m ²) at age 8	16.8 (0.47)	17.3 (0.23)	17.6 (0.40)	0.48
Body mass index z-score (kg/m ²) at age 8	0.27 (0.19)	0.53 (0.09)	0.45 (0.12)	0.48
Waist circumference (cm) at age 8	58.0 (1.2)	59.4 (0.66)	59.6 (1.1)	0.64
Living in least disadvantaged area quartile (%)	28.6	24.5	28.6	0.82
Mother's age (y)	29.9 (0.95)	29.2 (0.49)	29.4 (0.50)	0.73
Mother's education level >12 y (%)	35.5	50.0	57.6	↑0.039
Father's education level >12 y (%)	38.7	51.9	56.5	0.11
Mother born in Australia/New Zealand (%)	89.7	82.1	77.9	0.17
Father born in Australia/New Zealand (%)	82.8	76.8	68.8	0.11
Mother smoking during pregnancy (%)	17.2	15.8	13.0	0.82

^{a,b} Significant differences between groups denoted by different superscripts.

interest. ANCOVA was also used to examine the association between the consumption of milk and SSB.

Selected measures of diet quality were assessed including the percentage of children meeting recommendations for nutrient intakes based on estimated average requirements (EAR) [29] and the percentage of children meeting national food-based recommendations described in the Australian Guide to Healthy Eating [8]. Chi-square analysis was used to examine associations between categorical data. *p* Values less than 0.05 were considered statistically significant. PASW release 18 (SPSS Inc., Chicago, IL) was used for all analyses.

RESULTS

Descriptive Statistics

Table 1 describes characteristics of the study sample, which included 121 boys and 101 girls with a mean age of 9.2 years (range, 8.2–10.5 years). More than one quarter of children were found to be overweight (19.6%) or obese (7.4%). Age at dietary interview showed a significant positive association with dairy consumption, although the mean differences between dairy intake categories were small. In addition, higher parental education was associated with higher dairy consumption. BMI,

Table 2. Differences in Food Intake (Mean [SE]) and Percentage Meeting Recommendations by Category of Dairy Consumption, Adjusted for Age, Sex, Parental Education, and Total Energy Intake

Food	Dairy Serves/d			<i>p</i> Value Trend*
	<1, n = 31	1–<2, n = 106	≥2, n = 85	
Dairy serves	0.82 (0.08) ^a	1.59 (0.04) ^b	2.63 (0.05) ^c	↑<0.001
Milk (g)	114 (22.8) ^a	223 (12.0) ^b	393 (14.1) ^c	↑<0.001
Cheese (g)	19.1 (2.5) ^a	25.6 (1.3) ^b	38.2 (1.6) ^c	↑<0.001
Yoghurt (g)	10.2 (5.4) ^a	18.5 (2.8) ^a	28.9 (3.3) ^b	↑0.011
Custard (g)	3.1 (3.7)	6.2 (1.9)	5.2 (2.3)	0.73
Fruit (serves)	0.79 (0.11)	0.81 (0.08)	0.93 (0.07)	0.38
Vegetables (serves)	1.71 (0.14)	1.50 (0.07)	1.66 (0.08)	0.22
Meat and alternatives (serves)	1.92 (0.08) ^a	1.81 (0.04) ^a	1.48 (0.05) ^b	↓<0.001
Bread and cereals (serves)	2.76 (0.14) ^{ab}	2.80 (0.07) ^a	3.05 (0.09) ^b	↑0.076
Nondairy core foods (serves)	7.15 (0.30)	6.88 (0.16)	7.04 (0.18)	0.65
Sugar-sweetened beverages (g)	369 (32.6)	328 (17.2)	305 (20.2)	0.28
Total "extra" foods (g)	642 (39.1) ^a	590 (20.7) ^a	505 (24.2) ^b	↓0.007
% Meeting recommendations†				
Dairy products (2 serves)	0	0	100	↑<0.001
Fruit (1 serve)	35.5	26.4	38.8	0.35
Vegetables (3 serves)	6.5	2.8	8.2	0.37
Meat and alternatives (1 serve)	100	93.4	89.4	0.052
Bread and cereals (3 serves)	35.5	31.1	57.6	↑0.002

^{a,b,c} Different superscripts refer to significant means between categories, tested using Tukey's test.

* Tested using trend analysis by linear regression.

† Tested using chi-square analysis.

Table 3. Differences in Energy and Nutrient Intakes (Mean [SE]) by Category of Dairy Consumption, Adjusted for Age, Sex, Parental Education, and Total Energy Intake

Nutrient	Dairy Serves/d			<i>p</i> Value Trend*
	<1, n = 31	1–<2, n = 106	≥2, n = 85	
Energy (MJ)	7.42 (0.19) ^a	7.84 (0.10) ^b	8.61 (0.11) ^c	↑<0.001
Protein (g)	68.2 (1.9) ^a	73.2 (1.0) ^b	76.4 (1.1) ^c	↑0.002
Total fat (g)	72.5 (1.4)	70.7 (0.08)	69.8 (0.9)	0.30
Sat (g)	29.8 (0.9)	30.8(0.49)	31.3 (0.57)	0.45
Mono (g)	25.6 (0.58) ^a	24.0 (0.31) ^b	22.8 (0.36) ^c	↓0.001
Poly (g)	9.3 (0.25) ^a	8.9 (0.13) ^a	8.3 (0.15) ^b	↓0.004
Carbohydrates (g)	244 (3.4)	245 (1.8)	244 (2.1)	0.95
Sugars (g)	109 (4.2) ^a	117 (2.2) ^{ab}	120 (2.6) ^b	0.14
Starch (g)	133 (2.6) ^a	128 (1.4) ^{ab}	125 (1.6) ^b	0.051
Protein (%E)	14.5 (0.37) ^a	15.5 (0.20) ^b	16.2 (0.23) ^c	↑0.001
Total fat (%E)	32.6 (0.64)	31.8 (0.34)	31.4 (0.40)	0.36
Sat (%E)	13.2 (0.40)	13.9 (0.21)	14.1 (0.25)	0.20
Mono (%E)	11.5 (0.26) ^a	10.8 (0.14) ^b	10.3 (0.16) ^c	↓0.001
Poly (%E)	4.2 (0.11) ^a	4.0 (0.06) ^a	3.8 (0.07) ^b	↓0.007
Carbohydrates (%E)	52.1 (0.70)	51.9 (0.37)	51.6 (0.43)	0.84
Dietary fiber (g)	18.1 (0.68)	17.1 (0.36)	17.9 (0.42)	0.23
Cholesterol (mg)	196 (7.5)	205 (4.0)	211 (4.6)	0.30
Calcium (mg)	582 (31.8) ^a	757 (16.8) ^b	1062 (19.7) ^c	↑<0.001
Phosphorus (mg)	1051 (31.5) ^a	1180 (16.6) ^b	1323 (19.5) ^c	↑<0.001
Magnesium (mg)	224 (6.0) ^a	234 (3.2) ^{ab}	252 (3.7) ^c	↑<0.001
Potassium (mg)	2369 (67.7) ^a	2390 (35.7) ^{ab}	2556 (41.9) ^c	↑0.009
Sodium (mg)	2649 (67.7)	2608 (35.8)	2600 (41.9)	0.83
Iron (mg)	10.0 (0.37)	10.5 (0.19)	10.6 (0.23)	0.34
Zinc (mg)	8.9 (0.32) ^a	9.5 (0.17) ^{ab}	10.0 (0.20) ^b	↑0.019
Vitamin A (RE, mcg)	541 (37.6) ^a	576 (19.8) ^a	700 (23.2) ^b	↑<0.001
Thiamin (mg)	1.76 (0.13)	1.91 (0.07)	1.94 (0.08)	0.51
Riboflavin (mg)	1.58 (0.14) ^a	2.17 (0.07) ^b	2.56 (0.09) ^c	↑<0.001
Niacin (NE, mg)	31.1 (0.97) ^a	34.0 (0.51) ^b	33.5 (0.60) ^{bc}	0.030
Vitamin C (mg)	125 (10.7)	109 (5.6)	113 (6.6)	0.40
% Meeting EAR†				
Calcium (mg)	39.3%	72.2%	98.6%	↑<0.001
Phosphorus (mg)	73.2%	87.6%	98.6%	↑<0.001
Magnesium (mg)	85.7%	89.7%	97.1%	↑0.025
Iron (mg)	100%	100%	100%	NA
Zinc (mg)	100%	100%	100%	NA
Vitamin A (RE, mcg)	83.9%	89.7%	97.1%	↑0.012
Thiamin (mg)	100%	100%	100%	NA
Riboflavin (mg)	100%	100%	100%	NA
Niacin (NE, mg)	100%	100%	100%	NA
Vitamin C (mg)	100%	100%	100%	NA

EAR = estimated average requirements, RE = retinol equivalents, NE = niacin equivalents, NA = not applicable.

^{a,b,c} Different superscripts refer to significantly different means between categories.

* Tested using trend analysis by linear regression.

† Tested using chi-square analysis.

BMI z-score, and waist circumference measured 1 year previously (at age 8 years) were not associated with dairy intake at age 9 years.

Nearly all children (98.2%) consumed at least some dairy products during the 3 days of dietary recall, with a median intake of 1.8 dairy serves per day. Three quarters of dairy serves (74.0%) consisted of regular-fat dairy products, with 66.2% of milk, 89.1% of cheese, 67% of yoghurt, and 100% of custard being regular fat. There were no significant differences

between boys and girls in the consumption of regular-fat or reduced-fat dairy products (boys consumed 76.0% of dairy products as regular-fat varieties, compared with 73.2% for girls, $p = 0.37$).

In all 3 groups of dairy consumers, milk contributed more than 50% of total dairy serves, while approximately one third came from cheese and 10% from yoghurt and custard. There were no significant differences or trends in the types of dairy products consumed between the 3

categories of consumers. In addition, there were no significant differences in the proportion of reduced-fat dairy products consumed between the 3 categories of consumers (19%, 28%, and 25% for those consuming <1 serve, 1 to <2 serves, and ≥ 2 serves per day, respectively; $p = 0.29$), and the proportion of children who consumed only regular-fat dairy products (47%) was also similar between the three categories ($p = 0.23$).

The associations between consumption of dairy products and other core foods, as well as extra foods, is shown in Table 2. The consumption of meat and alternatives and total extra foods was lower among children with higher dairy consumption, whereas consumption of bread and cereals was higher. Children who consumed 2 or more serves of dairy products and therefore met the minimum recommended intake for dairy were more likely to also meet the recommendations for bread and cereals. For the overall sample, only 38% of children consumed 2 dairy serves per day. The minimum recommendations for fruit (1 serve), vegetables (3 serves), and bread and cereals (three serves) were met by 32%, 5%, and 42% of children, respectively. In contrast, the majority of children (93%) consumed the recommended amount of meat and alternatives (1 serve).

Table 3 shows the energy and nutrient intakes of the children across the categories of dairy consumption. Increasing dairy intake was associated with increased intake of energy and most nutrients including protein (g and %E), calcium, phosphorus, magnesium, potassium, zinc, vitamin A, riboflavin, and niacin. However, increasing dairy intake was associated with reduced intake of monounsaturated fat (g and %E) and polyunsaturated fat (g and %E).

In addition, the percentages of children who met the EAR for selected micronutrients (i.e., those who have been assigned an EAR) are shown in Table 3. Higher dairy consumption was associated with children being more likely to meet the EAR for calcium, phosphorus, magnesium, vitamin A, and riboflavin. For the overall sample, the EAR for calcium intake was met by 71% of children: 84% of 8-year-olds and 60% of 9- to 10-year-olds.

As the fat content of dairy products may affect nutrient intake, we examined the differences in the intakes of fat, saturated fat, and vitamin A of children who consumed only regular-fat dairy products versus those who consumed a mixture of reduced-fat and regular-fat dairy products (only 4 children consumed reduced-fat dairy products alone). Regular-fat dairy consumers had higher intakes of total fat (%E) and saturated fat (%E) compared with children who consumed a mixture of reduced-fat and regular-fat dairy products (total fat: 32.7% vs 31.1%, $p = 0.001$; saturated fat: 14.4% vs 13.5%, $p = 0.001$). There were, however, no significant differences in the proportions of children who met the EAR for vitamin A (regular-fat milk group: 93% vs mixed group: 90%, $p = 0.38$).

Milk and SSB

In addition, the relationship between the consumption of milk and SSB was explored. This model, adjusted for age, sex, parental education, and energy intake, showed an inverse relationship between the consumption of milk and SSB ($p = 0.008$). Post hoc tests revealed that children in the highest tertile of milk consumption (i.e., >318 g milk per day) had a significantly lower intake of SSB than those in the lowest tertile (i.e., <179 g milk per day); 277 (21.1) g versus 373 (20.5) g of SSB per day. Both total energy intake and parental education were significant confounders in this model.

DISCUSSION

This study describes the differences in nutritional quality of diets, by quantity of dairy food consumption, among a sample of 8- to 10-year-old Australian children. Greater dairy consumption was associated with higher intakes of bread and cereals but lower intakes of meat and alternatives and total extra foods. Intakes of nutrients including protein, calcium, phosphorus, magnesium, potassium, zinc, vitamin A, and riboflavin were higher among children with greater dairy consumption, but so were intakes of energy. These results were reflected in the finding that a higher percentage of children who consumed at least 2 serves of dairy products met the recommended core food intakes and the EARs. Nevertheless, BMI z-scores and waist circumference (measured 1 year prior to dietary assessment) did not differ between children who consumed low or high intakes of dairy products.

Although nearly all children consumed at least some dairy products over the 3 days of recall assessment, fewer than half consumed the minimum recommended amount of 2 dairy serves per day, and two thirds met the EAR for calcium intake. These results are similar to those reported using the 2007 Children's Survey, in which 89% of 4- to 8-year-olds and 55% of 9- to 11-year-olds met the EAR for calcium intake [6]. In our study, fluid milk was the highest contributor to dairy consumption at more than 60%, followed by cheese. Regular-fat dairy products were consumed more commonly than reduced-fat products, with three quarters of all dairy products consumed being regular fat. These findings are inconsistent with current national guidelines that recommend a shift to the consumption of reduced-fat dairy products among children older than 2 years [1].

Children with dairy intakes of at least 2 serves per day consumed diets that were characterized by higher intakes of energy, protein, calcium, magnesium, potassium, phosphorus, zinc, vitamin A, riboflavin, and niacin but lower intakes of monounsaturated and polyunsaturated fat (percentage energy) and no differences in total fat or saturated fat intake. Although all children met the EAR for iron, zinc, thiamin, riboflavin, niacin, and vitamin C, there were differences in other nutrient

intakes between the dairy consumption categories. Children who consumed <1 dairy serve per day were at highest risk of not meeting the EAR for calcium, with only 40% having adequate intakes. This increased to 72% of children who consumed between 1 and 2 dairy serves per day. Other nutrients at risk for children who consumed less than 2 serves of dairy per day included magnesium, phosphorous, and vitamin A. In contrast, more than 95% of children who consumed ≥ 2 dairy serves per day met the EARs for calcium, phosphorus, magnesium, vitamin A, and riboflavin.

These findings are consistent with those of numerous other studies that dairy consumption has a substantial influence on the quality of children's diets, particularly micronutrient intakes [9–14,30]. The intake of fatty acids by dairy consumers is also of interest. Intakes of total fat and saturated fat were similar among the three groups of dairy consumers, whereas intakes of mono- and polyunsaturated fat were lowest among the children who consumed >2 dairy serves per day. Children who consumed only regular-fat dairy products, however, had higher intakes of total fat and saturated fat (%E) compared with children who also consumed reduced-fat dairy products. These patterns have been described previously [12,31,32].

A recent Australian intervention study in 4- to 13-year-old children showed that replacing regular-fat dairy products with reduced-fat products resulted in a 3.3% reduction in saturated fat intake (as % energy) after 24 weeks and a 4.8% reduction in total fat (% energy) [33]. Concomitantly, energy intake was 195 kJ lower in the intervention group after 24 weeks but was not statistically significant, and no changes in measures of adiposity were found. In addition, no differences were found in vitamin A content between the control and intervention group. Similarly, we found that children who consumed reduced-fat dairy products (with lower vitamin A content) were just as likely to meet the EAR for vitamin A as children who consumed regular-fat dairy products. These findings suggest that replacing regular-fat products with reduced-fat products is an appropriate intervention in a healthy population with no adverse effects on meeting vitamin A requirements.

Food group consumption data showed that intakes of bread and cereals were greater among higher dairy consumers whereas intakes of meat and alternatives and total extra food intake were lower. Other studies have reported a positive association between fruit and dairy consumption in adults [31,32] and an inverse association between meat and dairy consumption [31]. The amounts of extra or energy-dense, nutrient-poor foods and beverages consumed was approximately 140 g higher among children who consumed <1 dairy serve per day compared with children who consumed ≥ 2 dairy serves per day. Also of concern, children who consumed <2 dairy serves a day were found to drink higher quantities of SSB (soft drinks, cordials, fruit drinks, and fruit juices) than milk. Only children who consumed ≥ 2 dairy serves per day drank more milk (390 g or 1.6 cups) than SSB (310 g or 1.2 cups).

Further analysis of milk consumption alone revealed an inverse trend between the consumption of milk and SSB. These findings are supported by many other cross-sectional [16,34–39] and longitudinal studies [11,40–42]. In the US Iowa Fluoride Study, this relationship started as early as age 2, with milk intakes being inversely associated with intakes of juice drinks, soda pop, and added-sugar beverages [11]. A longitudinal study of children aged 6–13 years found that excessive consumption of sweetened drinks (>360 ml) displaced half a cup of milk (125 ml) from their diet [40], whereas another study reported that children who consumed soda at age 5 had lower milk and milk-related nutrient intakes between 5 and 15 years [43].

It is likely that a higher consumption of dairy foods not only is a contributor to increased nutrient intake, in particular calcium, vitamin A, and riboflavin, but may also be a marker for healthier eating habits. (i.e., lower extra food intake in high-dairy consumers). Parental education and energy intake were significant confounders in the models, with parental education being associated with higher dairy consumption and lower consumption of SSB. There were no differences between boys and girls, but we cannot exclude the possibility of other confounders that were not measured in this study.

The collection of 3 days of dietary recall data enables the estimation of usual intake, which is one of the main advantages of this study. One of the limitations, however, is that the children involved in the CAPS study cannot be considered a random sample of the Australian population. Although the socioeconomic status of their families as indicated by postcode was similar to that of the Australian population (Australian median score of 1000 compared with the CAPS median score of 995), parents were more likely to be tertiary educated and Australian born, and study children all had a family history of asthma [20]. The proportion of children overweight or obese was similar to the Australian population [6]. Another limitation was the collection of dietary data and anthropometric data at separate time points, approximately 1 year apart. This was unavoidable as dietary data were collected by phone with no opportunity for research staff to measure height, weight, or waist circumference.

In conclusion, a higher dairy intake by a select group of Australian children was associated with diets that came closer to meeting nutrient and food intake recommendations. Of concern, many children fail to meet the minimum recommended number of dairy serves and calcium requirements and consume regular-fat dairy products in preference to reduced-fat varieties.

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REFERENCES

1. National Health and Medical Research Council: "Dietary Guidelines for Children and Adolescents in Australia." Canberra: Commonwealth of Australia, 2003.
2. Huth PJ, DiRienzo DB, Miller GD: Major scientific advances with dairy foods in nutrition and health. *J Dairy Sci* 89:1207–1221, 2006.
3. Elwood PC, Pickering JE, Givens DI, Gallacher JE: The consumption of milk and dairy foods and the incidence of vascular disease and diabetes: an overview of the evidence. *Lipids* 45:925–939, 2010.
4. Ralston RA, Lee JH, Truby H, Palermo CE, Walker KZ: A systematic review and meta-analysis of elevated blood pressure and consumption of dairy foods. *J Hum Hypertens* 26:3–13, 2012.
5. Louie JC, Flood VM, Hector DJ, Rangan AM, Gill TP: Dairy consumption and overweight and obesity: a systematic review of prospective cohort studies. *Obes Rev* 12:e582–e592, 2011.
6. Australian Government Department of Health and Ageing: "2007 Australian National Children's Nutrition and Physical Activity Survey—Main Findings." Canberra: Commonwealth of Australia, 2008. Accessed February 29, 2012, at: <http://www.health.gov.au/internet/main/publishing.nsf/Content/phd-nutrition-childrens-survey>
7. McLennan W, Podger A: "National Nutrition Survey User's Guide 1995," ABS Catalogue No. 4801.0. Canberra, Australia: AGPS Press, 1998.
8. Smith A, Kellett E, Schmerlaib Y: "The Australian Guide to Healthy Eating: Background Information for Nutrition Educators." Canberra: Commonwealth Department of Health and Family Services, 1998.
9. Fleming KH, Heimbach JT: Consumption of calcium in the U.S.: food sources and intake levels. *J Nutr* 124(Suppl):1426S–1430S, 1994.
10. Fulgoni VL III, Huth PJ, DiRienzo DB, Miller GD: Determination of the optimal number of dairy servings to ensure a low prevalence of inadequate calcium intake in Americans. *J Am Coll Nutr* 23:651–659, 2004.
11. Marshall TA, Eichenberger Gilmore JM, Broffitt B, Stumbo PJ, Levy SM: Diet quality in young children is influenced by beverage consumption. *J Am Coll Nutr* 24:65–75, 2005.
12. Ranganathan R, Nicklas TA, Yang SJ, Berenson GS: The nutritional impact of dairy product consumption on dietary intakes of adults (1995–1996): the Bogalusa Heart Study. *J Am Diet Assoc* 105:1391–1400, 2005.
13. Fiorito LM, Mitchell DC, Smiciklas-Wright H, Birch LL: Dairy and dairy-related nutrient intake during middle childhood. *J Am Diet Assoc* 106:534–542, 2006.
14. Fulgoni V III, Nicholls J, Reed A, Buckley R, Kafer K, Huth P, DiRienzo D, Miller GD: Dairy consumption and related nutrient intake in African-American adults and children in the United States: continuing survey of food intakes by individuals 1994–1996, 1998, and the National Health And Nutrition Examination Survey 1999–2000. *J Am Diet Assoc* 107:256–264, 2007.
15. Kant AK: Reported consumption of low-nutrient-density foods by American children and adolescents: nutritional and health correlates, NHANES III, 1988 to 1994. *Arch Pediatr Adolesc Med* 157:789–796, 2003.
16. Bowman SA: Beverage choices of young females: changes and impact on nutrient intakes. *J Am Diet Assoc* 102:1234–1239, 2002.
17. Lyytikäinen A, Lamberg-Allardt C, Kannas L, Cheng S: Food consumption and nutrient intakes with a special focus on milk product consumption in early pubertal girls in Central Finland. *Public Health Nutr* 8:284–289, 2005.
18. Nielsen SJ, Popkin BM: Changes in beverage intake between 1977 and 2001. *Am J Prev Med* 27:205–210, 2004.
19. Cook T, Rutishauser I, Seelig M: "Comparable Data on Food and Nutrient Intake and Physical Measurements from the 1983, 1985 and 1995 National Nutrition Surveys." Canberra: Australian Food and Nutrition Monitoring Unit, 2001.
20. Mhrshahi S, Vukasin N, Forbes S, Wainwright C, Krause W, Ampon R, Mellis C, Marks G, Peat J: Are you busy for the next 5 years? Recruitment in the Childhood Asthma Prevention Study (CAPS). *Respirology* 7:147–151, 2002.
21. Webb KL, Lahti-Koski M, Rutishauser I, Hector DJ, Knezevic N, Gill T, Peat JK, Leeder SR; CAPS Team: Consumption of "extra" foods (energy-dense, nutrient-poor) among Australian children from western Sydney aged 16–24 months. *Public Health Nutr* 9:1035–1044, 2006.
22. Torun B, Davies PS, Livingstone MB, Paolisso M, Sackett R, Spurr GB: Energy requirements and dietary energy recommendations for children and adolescents 1 to 18 years old. *Eur J Clin Nutr* 50(Suppl):S37–S80, 1996.
23. Australian Government Department of Health and Ageing (2008): "2007 Australian National Children's Nutrition and Physical Activity Survey—User Guide." Canberra: Commonwealth of Australia, 2008. Accessed May 21, 2009 at: <http://www.health.gov.au/internet/main/publishing.nsf/Content/phd-nutrition-childrens-survey-userguide>
24. Food Standards Australia and New Zealand: NUTTAB 2006. Accessed May 20, 2009, at: <http://www.foodstandards.gov.au/monitoringandsurveillance/nuttab2006/>
25. Harttig U, Haubrock J, Knüppel S, Boeing H, on behalf of the EFCOVAL Consortium: The MSM program: web-based statistics package for estimating usual dietary intake using the Multiple Source Method. *Eur J Clin Nutr* 65:S87–S91, 2011.

26. Souverein OW, Dekkers AL, Geelen A, Haubrock J, de Vries JH, Ocké MC, Harttig U, Boeing H, van't Veer P, on behalf of the EFCOVAL Consortium: Comparing four methods to estimate usual intake distributions. *Eur J Clin Nutr* 65:S92–S101, 2011.
27. National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity and Obesity: “CDC Growth Charts.” Atlanta, GA: Centers for Disease Control and Prevention, 2008. Accessed November 2, 2008, at: <http://www.cdc.gov/nccdphp/dnpa/growthcharts/resources/sas.htm>
28. Australian Bureau of Statistics: “ABS Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia—Data Only, 2006.” Catalogue No. 2033.0.55.001. Canberra, Australia: AGPS Press, 2008.
29. National Health and Medical Research Council: “Nutrient Reference Values for Australia and New Zealand.” Canberra: Commonwealth of Australia, 2006.
30. Ballew C, Kuester S, Serdula M, Bowman B, Dietz W: Nutrient intakes and dietary patterns of young children by dietary fat intakes. *J Pediatr* 136:181–187, 2000.
31. O’Neil CE, Nicklas TA, Liu Y, Franklin FA: The impact of dairy product consumption on nutrient adequacy and weight of Head Start mothers. *Public Health Nutr* 12:1693–1701, 2009.
32. Goldbohm RA, Chorus AM, Galindo Garre F, Schouten LJ, van den Brandt PA: Dairy consumption and 10-y total and cardiovascular mortality: a prospective cohort study in the Netherlands. *Am J Clin Nutr* 93:615–627, 2011.
33. Hendrie GA, Golley RK: Changing from regular-fat to low-fat dairy foods reduces saturated fat intake but not energy intake in 4-13-y-old children. *Am J Clin Nutr* 93:1117–1127, 2011.
34. Guenther PM: Beverages in the diets of American teenagers. *J Am Diet Assoc* 86:493–499, 1986.
35. Harnack L, Stang J, Story M: Soft drink consumption among US children and adolescents: nutritional consequences. *J Am Diet Assoc* 99:436–441, 1999.
36. Frary CD, Johnson RK, Wang MQ: Children and adolescents’ choices of foods and beverages high in added sugars are associated with intakes of key nutrients and food groups. *J Adolesc Health* 34:56–63, 2004.
37. Skinner JD, Ziegler P, Ponza M: Transitions in infants’ and toddlers’ beverage patterns. *J Am Diet Assoc* 104(Suppl 1):S45–S50, 2004.
38. Rajeshwari R, Nicklas T, Berenson G: Secular trends in children’s sweetened-beverage consumption (1973 to 1994): the Bogalusa Heart Study. *J Am Diet Assoc* 105:208–214, 2005.
39. Yamada M, Murakami K, Sasaki S, Takahashi Y, Okubo H: Soft drink intake is associated with diet quality even among young Japanese women with low soft drink intake. *J Am Diet Assoc* 108:1997–2004, 2008.
40. Mrdjenovic G, Levitsky DA: Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children. *J Pediatr* 142:604–610, 2003.
41. 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* 79:698–706, 2004.
42. Striegel-Moore RH, Thompson D, Affenito SG, Franko DL, Obarzanek E, Barton BA, Schreiber GB, Daniels SR, Schmidt M, Crawford PB: Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *J Pediatr* 148:183–187, 2006.
43. Fiorito LM, Marini M, Mitchell DC, Smiciklas-Wright H, Birch LL: Girls’ early sweetened carbonated beverage intake predicts different patterns of beverage and nutrient intake across childhood and adolescence. *J Am Diet Assoc* 110:543–550, 2010.

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