Short Communication

Pattern and predictors of dairy consumption during adolescence

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We aimed to prospectively assess dairy intake among adolescents, and determine the predictors of adequate dairy consumption during adolescence. 634 Sydney schoolchildren (351 girls and 283 boys) who had dietary data at both age 12 and 17 were included for analyses. Dairy consumption was assessed from validated semi-quantitative food frequency questionnaires. At age 12, mean total dairy intake was 1.62 serves/day which decreased to 1.40 by age 17 ($p<0.0001$). Mean serves/day of milk decreased from 1.11 to 0.92 during adolescence. Moreover, 90% of the decrease in serves/day of total dairy was due to reduced milk consumption. At age 12, 8.5% of children consumed ≥3.5 serves/day of total dairy and this decreased to 6.2%, 5 years later at age 17 ($p=0.001$). A lower proportion of girls compared with boys consumed ≥3 serves/day of total dairy at both ages 12 ($p=0.005$) and 17 ($p=0.01$). Participants with tertiary qualified parents at baseline were 85% more likely to have intakes of the dairy food group above the median during the 5 years, OR 1.85 (95% CI 1.18-2.91). Frequent flavored milk consumption (≥2 serves/week) at baseline was associated with ~5-fold greater likelihood of maintaining intakes of dairy foods above the median during adolescence. Dairy food consumption decreased significantly during adolescence, driven primarily by a decrease in milk consumption. Most adolescents did not meet national recommended guidelines for the dairy food group intake. These findings highlight the need for further research into intervention strategies aimed at sustaining dairy consumption.

Key Words: dairy, adolescence, milk, cohort, Sydney Childhood Eye Study

INTRODUCTION

Dairy products provide an abundant source of protein, vitamins and minerals, such as calcium, magnesium, and vitamins B_{12} and A,[1] and thus, have demonstrated beneficial roles in relation to a variety of chronic diseases, including: hypertension, metabolic syndrome, type 2 diabetes, and cardiovascular disease.[1-4] Because milk and other dairy products are nutrient-dense foods, their intake improves the overall nutritional quality of children's[5] and adolescents' diets.[6,7] Previously, the Bogalusa Heart Study provided data on food consumption trends in 10-year old children over two decades (1973-1994) in the US. This study showed that the proportion of children consuming milk decreased while the proportion consuming cheese increased.[8] Similar trends have been observed in other US studies.[9,10] More recently, an Australian study reported that adolescents decrease their dairy intake from age 14 to 17 years, and that lower milk consumption was responsible for the largest decrease as the adolescents grew older.[7] Further, weight category was a significant predictor of dairy consumption during adolescence.[7] While there are longitudinal data on the pattern of dairy

food consumption during adolescence; a more comprehensive understanding of the correlates of dairy intake and/or the factors that have the strongest and most proximal influence on habitual dairy consumption during adolescence would be useful. These epidemiological data could provide insight into developing effective public health strategies that aim to address the under-consumption of the dairy food group during childhood and adolescence. Therefore, we used a relatively large community-based sample of Sydney schoolchildren to determine: 1) the pattern of dairy food consumption, including the intake of dairy foods such as milk, cheese and yoghurt from age 12 to 17; 2) tracking of intakes of these foods during adolescence and predictors of high con-

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sumption of these dairy foods over the 5 years; and 3) the predictors of maintaining an adequate intake of these dairy foods during adolescence, including gender, socio-economic factors (eg, parental education and employment status), dietary parameters (eg, soft drink consumption, type of milk consumed such as whole fat versus reduced fat milk and flavored versus non-flavored milk), time spent in activity behaviors (eg, physical activity, screen time) and body mass index.

Experimental methods

The Sydney Childhood Eye Study is a population-based survey of eye conditions and other health outcomes in schoolchildren living within the Sydney Metropolitan Area, Australia. It was approved by the Human Research Ethics Committee, University of Sydney, the Department of Education and Training, and the Catholic Education Office, New South Wales, Australia.[11] We obtained informed written consent from at least one parent of each child, as well as the verbal assent and written consent from each child/ adolescent before the examinations. Study methods have been previously describe.[11] Briefly, students with a mean age 12.7 years in a stratified random cluster sample of 21 high schools across Sydney were eligible to participate. Stratification was based on socio-economic status data and led to a proportional mix of public, private or religious high-schools. Of the 3144 eligible 12-year-old children, 2367 were given parental permission to participate and 2353 underwent examinations (74.9%). Data for the 12-year-old cohort were collected during 2004-5 and then 5 years later during 2009-11; 1216 were re-examined (51.7% of baseline participants).

Dietary data were collected using a 120-item self-administered food-frequency questionnaire, designed for specific use in Australian children and adolescents.[12] An allowance for seasonal variation of fruit and vegetables was made during analysis by weighting seasonal fruits and vegetables. The validity of the food-frequency questionnaire has previously been reported in children.[12] The de-attenuated, energy adjusted Pearson's correlation coefficient for calcium was 0.51, and the proportion of individuals correctly classified into the same quintile for calcium was 68%, when compared with weighed food records (WFR).[12] Food-frequency questionnaire items were translated into daily food and nutrient intakes using a purpose-built query in Microsoft Access 2007, using various nutrient databases.[13-15] Serves of dairy foods were calculated by adding intakes of core dairy foods: milk serves (258 g or 250 mL of any type of fluid milk including plain and flavored milk, smoothies and milkshakes), cheese serves (40 g of any type of hard or soft cheese, including on composite dishes), and yoghurt serves (200 g of any type of yoghurt). Estimates of non-dairy alternatives, specifically, soy and rice milk, were also made. Australian Dietary guidelines advise that children aged 12 and 17 should consume ≥3.5 serves/day of milk, yoghurt and cheese.[16]

Data on the frequency of soft drink consumption were also obtained from the food-frequency questionnaire. Parents also completed a comprehensive 193-item questionnaire. Socio-demographic information covering ethnicity, country of birth, education, occupation and parental age was collected. The questions relating to physical activity comprised a list of nine common activities in which Sydney school-aged children typically participated such as athletics, swimming, soccer etc. Children self-reported the usual number of hours per week they spent in each of these activities and whether the activity was done outdoors or indoors (hall gym, classroom). The time spent in each activity was summated and the average hours per day spent in total physical activity was calculated. Total screen time (hours/day) was calculated as the time reported that was spent on the following activities: watching TV, playing video games, and using a computer for both recreational and educational purposes. Weight in kilograms was measured using a professional portable weighing machine, after removing any heavy clothing. Height was measured with shoes off using a freestanding SECA height rod (Model 220, Hamburg, Germany). Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2).

Statistical analyses were performed using SAS (v9.2, SAS Institute, NC). Descriptive statistics were used to report the proportion of adolescents consuming the recommended intake of dairy foods and mean dairy food intake. Paired sample t-tests were used to assess changes in individual intakes over time. Analyses of variances was used to assess associations between various potential predictors eg, age, sex, ethnicity, weight status, parental education and employment status, physical activity, screen time, soft drink consumption and type of milk consumed (whole versus reduced fat, and flavored milk), and change in dairy intake. Logistic regression was used to assess associations between potential predictors and meeting the recommended daily intake of dairy.

RESULTS

Pattern of dairy food consumption during adolescence

A significant decrease in serves/day of total dairy (milk, yoghurt, and cheese), and in particular, milk, was observed from age 12 to 17 years in the overall cohort and in boys and girls separately (Table 1). 90% of the decrease in mean serves/day of total dairy foods was attributed to a decrease in serves/day of milk over the 5 years; with a more marked decrease in milk consumption observed in girls compared to boys. Overall mean (±SD) dietary calcium intake at age 12 and 17 was 920 and 894 mg/day (p=0.18), respectively. Mean calcium intake from dairy products at age 12 was 507 mg/day, this decreased to 411 mg/day at age 17 (p<0.0001). Calcium intake from non-dairy foods (eg, breads, fortified cereals) at age 12 contributed a mean of 414 mg/day which increased to 484 mg/day at the 5-year follow-up (p<0.0001). At age 12 and 17, 67 (3.2%) and 69 (4.1%) participants were consuming non-dairy alternatives i.e. soy and/or rice milk, respectively.

Figure 1 shows the contribution of milk, yoghurt and cheese to intake of the food group as a whole at age 12 and 17 years. Despite the fall in overall milk consumption, milk still accounted for over half of consumption of the milk, yogurt, cheese and/or alternatives food group in terms of daily serves at both age 12 and 17 years. At age 12, only 54 (8.5%) of participants were adhering to the

2013 Australian Dietary Guidelines which recommend a minimum daily intake of 3.5 serves of the milk, yogurt, cheese and/or alternatives food group,[16] and this decreased even further to 39 (6.2%) participants at the 5-year follow-up. Given the small numbers of participants adhering to recommended guidelines, we thought it more appropriate to use a cut-point of ≥3 serves of dairy/day for all subsequent analyses. At age 12, 13.1% (n=83) of children consumed ≥3 serves/day of milk, cheese and yoghurt, and this decreased to 8.8% (n=56), 5 years later at age 17 (p=0.001; Figure 2). A lower proportion of girls than boys consumed ≥3 serves/day total dairy at both age 12 (p=0.005) and 17 years (p=0.01). A significant decrease in the proportion of girls (p=0.01) and boys (p=0.02) consuming ≥3 serves/day was observed (Figure 2).

Predictors of adequate dairy food intake during adolescence

Having tertiary qualified parents at baseline was associated with a higher likelihood of adolescents consuming ≥3 serves/day, 5 years later, multivariable-adjusted OR 1.96 (95% CI 1.01-3.81). Soft drink consumption, weight status, gender, ethnicity, parental employment status, type of milk consumed (whole versus reduced fat), physical activity and screen time were not significant predictors of consuming the recommended daily intake of dairy foods during adolescence (data not shown). Tracking analyses involved examining participants who consumed above or below the median intake of total dairy foods over the 5 years. Median dairy food group intake at baseline and follow-up were 1.29 and 1.16 serves/day, respectively. There were 218 participants (34.4%) who had intakes above the median at both baseline and follow-up examinations. Additionally, there were 99 participants who had intakes of the dairy food group below the median but consumed above the median at follow-up, and vice-versa. Significant predictors of maintaining consumption of dairy foods above the median at both baseline and 5-year follow-up were: 1) male gender – OR 1.97 (95% CI 1.11-3.47); 2) male gender – OR 2.14 (95% CI 1.37-3.44); 3) parental tertiary qualifications – OR 1.85 (95% CI 1.18-2.91); and 4) frequent flavored milk consumption (≥2

serves/week) – OR 4.74 (95% CI 2.66-8.44). Again, other factors such as ethnicity, parental employment status, BMI, time spent in physical activity, soft drink consumption and whole-fat or reduced-fat milk intake were not significant predictors of high consumption of dairy foods over the 5 years.

DISCUSSION

Adolescence is a critical period during which lifetime habits are established.[9] We showed in this prospective longitudinal study of Australian adolescents that from age 12 to 17, there was a significant decrease in the consumption of the dairy food group, driven by a decline in milk intake. Only 8% of 12-year olds and 6% of 17-year olds adhered to the recommended intake of ≥3.5 serves/day[16] of the dairy food group. Male gender, parental tertiary qualifications and flavored milk consumption were significant predictors of above the median intakes of the dairy food group, during the 5 years. Mean calcium intakes from dairy foods decreased significantly while mean calcium intake from non-dairy foods increased appreciably during adolescence.

Our finding that consumption of dairy foods decreased significantly during adolescence is consistent with prior Australian[7,17] and US studies.[9,10] This decrease was primarily attributed to reduced milk consumption among adolescents. In contrast, cheese and yoghurt consumption remained low (each accounting for about 25% of intake in terms of serves) but stable between the ages of 12 and 17 in males and females. This contrasts with other longitudinal studies that have observed a small increase in cheese consumption in males but not females as they reach late adolescence.[7,18] However, the increased cheese intake in older males was too small to counterbalance the decline in milk consumption.[7,18] It has been suggested that the reason the mean intake of a food would change with age is either a change in frequency of consumption or a change in the amount consumed at each eating occasion, or both.[17] Baird et al suggested that strategies that focus on increasing both the daily occasions where dairy foods are consumed and the amount eaten on each occasion could be effective in increasing the total intake of dairy foods among adolescents.[17]

Table 1. Consumption of the dairy food group at age 12 and 17 years among participants of the Sydney Childhood Eye Study during 2004-5 to 2009-11

| Dairy food (serves/day)	12 years Mean (SD)	17 years Mean (SD)	Change in intake Mean (SD)	p-value
All (n=634)				
Total dairy	1.62 (1.24)	1.40 (1.20)	-0.21 (1.29)	<0.0001
Milk	1.11 (1.05)	0.92 (0.90)	-0.19 (1.03)	<0.0001
Cheese	0.27 (0.33)	0.27 (0.36)	0.002 (0.36)	0.92
Yoghurt	0.25 (0.39)	0.22 (0.38)	-0.02 (0.45)	0.18
Girls (n=351)				
Total dairy	1.44 (1.14)	1.21 (1.01)	-0.26 (1.02)	<0.0001
Milk	0.96 (0.97)	0.75 (0.83)	-0.20 (0.88)	<0.0001
Cheese	0.27 (0.36)	0.25 (0.30)	-0.02 (0.27)	0.12
Yoghurt	0.23 (0.34)	0.22 (0.33)	-0.004 (0.37)	0.84
Boys (n=283)				
Total dairy	1.83 (1.37)	1.64 (1.37)	-0.196 (1.59)	0.04
Milk	1.31 (1.11)	1.128 (0.95)	-0.179 (1.19)	0.01
Cheese	0.26 (0.30)	0.294 (0.42)	0.032 (0.45)	0.23
Yoghurt	0.27 (0.45)	0.222 (0.43)	-0.049 (0.54)	0.12
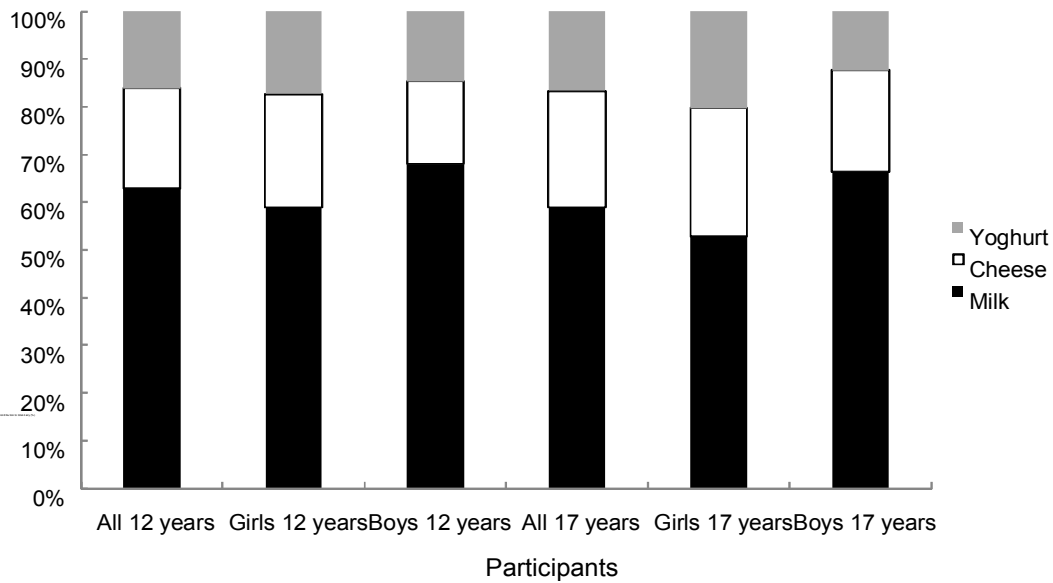
Figure 1. Percentage contribution of dairy foods (milk, cheese, and yoghurt) to total consumption at age 12 and 17 years among participants of the Sydney Childhood Eye Study (n=634).
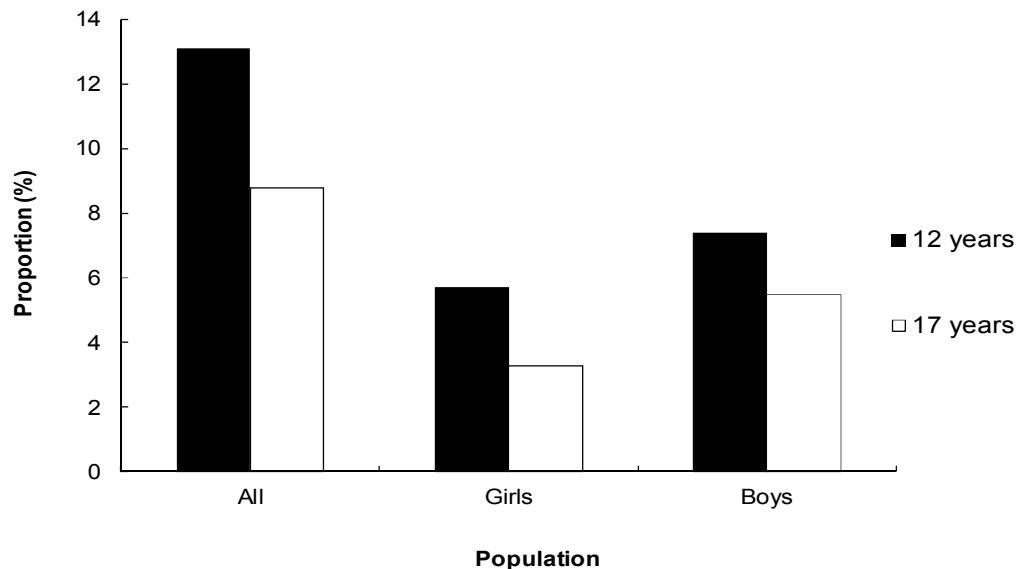

Figure 2. Proportion of participants aged 12 and 17 years in the Sydney Childhood Eye Study who consumed ≥3 serves/ day of the milk, yogurt, cheese, and/or alternatives Food Group during 2004-5 to 2009-11 (n=634).

At age 12, only 8.5% of children consumed ≥3.5 serves/day of total dairy and this decreased to 6.2%, 5 years later at age 17. The low proportion of adolescents adhering to national dietary guidelines is of concern, given that habitual dairy consumption plays an important role in the prevention of several chronic diseases eg, diabetes, hypertension and metabolic syndrome.[1-4] Despite the Australian Dietary Guidelines concluding that consumption of dairy foods is not associated with weight change or risk of obesity,[16] we speculate that there could be a misperception among adolescents and their families that dairy foods are fattening.[19] Hence, girls in particular could be conscious of their weight and body image, and so, were more likely to engage in nutritional practices such as dieting, which could lead to inadequate intake of certain foods groups such as dairy.[9,20] This observation is particularly problematic, as girls who had an inadequate

consumption of dairy foods during adolescence could be at a higher risk of developing osteoporosis and thus, bone fracture in later life. Other possible barriers to adequate dairy consumption during the teenage years could be a change in eating patterns in parallel with a change in lifestyle such as skipping breakfast (i.e. eating breakfast has a positive effect on milk intake, and skipping this meal could reduce overall dairy intake) or frequently eating meals away from home (i.e. milk is not readily available at fast-food establishments, and so, adolescents are less likely to adhere to the recommended serves of dairy).[7,19]

Our study adds new knowledge by comprehensively examining a range of correlates associated with optimal dairy intake among adolescents. Having tertiary qualified parents at baseline was associated with having intakes of dairy foods above the median over the 5 years in adolescents. This finding is intuitive as parents with a higher

educational level may be more informed about the importance of establishing healthy dietary patterns in their children, including an adequate intake of dairy products in the diet.[21] Moreover, these parents themselves are more likely to follow a healthier eating pattern, including habitual consumption of dairy foods and thus, could act as role models for their own children and positively influence their children's eating habits.[21] Other factors such as weight status and soft drink consumption were not significant predictors of dairy consumption during adolescence. However, flavored milk consumption at baseline was associated with having higher dairy intake at both ages 12 and 17. Given the increasing overall popularity of flavored milk among youth in Australia,[17] it was not surprising that flavored milk was positively associated with dairy intake during adolescence. It also needs to be highlighted that in Australian children, flavoured milk contributed on average 2.3% of the overall 64 g/day added sugars intake, which could be considered negligible.[22] Hence, this is unlikely to significantly dilute the nutrient intake as flavoured milk is a very good source of calcium.

Suboptimal calcium intake has been previously identified in Australian adolescents.[7] Our study makes a similar observation, as participants were not meeting the Australian recommended daily intake of calcium for children and adolescents of 1000-1300 mg/day[23] at either age 12 or 17. Mean calcium intake from dairy foods decreased significantly during adolescence while mean calcium intake from non-dairy foods increased significantly over the 5 years. It is possible that adolescents are consuming other non-dairy foods that are good sources of calcium such as nuts and seeds and/or products fortified with calcium such as breads and breakfast cereals.[7]

These epidemiological data could help facilitate public health interventions in order to tackle the inadequate consumption of the dairy food group and calcium intake during adolescence. Strategies such as taste exposure and prompting practice in effective interventions have been shown to increase dairy intake.[24] Additional strategies which might be effective include, encouraging all milk consumption, including flavored milk intake and integrating dairy foods into meal occasions where current intake is relatively low.[17,24] Finally, increasing the public's knowledge and awareness through effective media and marketing messages on the importance of adequate consumption of dairy foods could be useful. If these interventions were to achieve an increase in dairy of one serving daily, the potential health implications for adolescents would be significant.[24]

Strengths of this study include the random cluster sample of a large number of representative adolescent schoolchildren and its prospective design, eliminating recall bias. Further, the validity of the long FFQ tool has been previously reported,[12] and performs moderately well for calcium. While we assessed a range of correlates that could influence consumption of dairy foods during adolescence, we did not have data on societal factors (eg, peer-group influences) and parental lifestyle and dietary data, which could have confounded the observed associations. Finally, we estimated the amount of serves/day of dairy food intakes and no quantitative data on food intakes were collected. A possible change in serving size with increasing age that has not been estimated may have confounded the results.

Conclusions

In summary, this study provides insight into adolescent dairy food intake, including the predictors of habitual dairy consumption during the teenage years. Specifically, we show that less than 1 in 12 schoolchildren were consuming the national recommended intake of the dairy food group (≥3.5 serves/day) during adolescence. Underconsumption of dairy products was most apparent among adolescent girls compared with boys over the 5 years. Tertiary qualifications of the parents and flavored milk consumption were significant predictors of dairy food group consumption during adolescence. The observed decrease in dietary contribution from this important food group among Australian adolescents is of concern, and could have implications for the future development of non-communicable diseases, and targeted measures should be introduced to address this.

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青少年日消耗量的模式和预测

我们前瞻性测量青少年每日摄入量，从而预测他们的日消耗量。有膳食数据的 634 位年龄在 12-17 岁悉尼在校学生（351 个女孩，283 个男孩）包括在最后分析里。乳品摄入量是用验证的半定量食物频率问卷评估的。12 岁青少年的乳品摄入量是 1.62 份/天，而到 17 岁，则降为 1.40 份/天（$p<0.05$）。青少年的日均牛奶的摄入量从 1.11 降至 0.92。而且，90%的每日摄入乳品份数的下降量是有牛奶的摄入减少引起的。12 岁时，有 8.5%的儿童乳品摄入大于 3.5 份/天，5 年之后，即 17 岁时，降为 6.2%（$p=0.001$）。无论是 12 岁还是 17 岁，女孩乳品摄入≥3 份/天的比例都少于于男孩（$p=0.005$ 和 $p=0.01$）。在 5 年期间，有 85%父母具有高等教育学历的志愿者基线时的乳品摄入高于中位数 OR 1.85 (95% CI 1.18-2.91)。青少年基线调味乳品摄入频率（≥2 份/周）与约 5 倍高维持乳品摄入在中位数以上相关。青少年乳品摄入的下降主要是牛奶摄入的大量下降所引起。大部分青少年没有达到国家指南推荐的乳品摄取量的标准。这些结果表明，需要对如何维持乳品摄入的干预措施进行深入研究。

关键词：每日、青少年、牛奶、队列、悉尼儿童眼研究中心