Influence of Dairy Product Consumption on Children's Blood Pressure: Results from the QUALITY Cohort

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ABSTRACT
Identifying dietary factors associated with blood pressure in children and adolescents could help guide recommendations for prevention of elevated blood pressure. Our objective was to examine the association between blood pressure and dairy product consumption during preadolescence in a cross-sectional study. Baseline data from 610 children aged 8 to 10 years from the Québec Adipose and Lifestyle Investigation in Youth cohort was used for this analysis. Blood pressure was measured using a standard protocol. Children's average dairy intake was assessed from three nonconsecutive 24-hour dietary recalls, and was divided into tertiles. Linear regression models adjusted for age; sex; height; physical activity level; sugar-sweetened beverages, total energy, calcium, sodium, and saturated fat intake; parental history of hypertension; parental education; weight status; and intake of fruits and vegetables. In our fully adjusted model, high dairy intake (≥2 servings of dairy per day) was associated with 1.74 mm Hg lower systolic blood pressure ($P<0.05$) and with 0.87 mm Hg lower diastolic blood pressure ($P=0.10$) compared with low intake. We found no significant association of calcium, magnesium, or potassium intake on children's blood pressure, suggesting the role of other antihypertensive components in dairy products. Our results indicate that high intake of dairy (≥2 servings per day) has antihypertensive effects on blood pressure among youth.
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THERE IS A STRONG, GRADED ASSOCIATION BETWEEN increasing levels of blood pressure (BP) and the progression of cardiovascular and renal diseases.[1] The prevalence of elevated BP in children has increased in several countries during the past few decades.[2,3] Childhood systolic BP (SBP) and diastolic BP (DBP) track into adulthood such that children with elevated BP tend to have higher BP as adults.[4]

The habitual diet has been shown to influence BP either by its contribution to excessive energy intake or by the effect of various macronutrients or micronutrients.[5,6] The Dietary Approaches to Stop Hypertension clinical trial demonstrated the importance of diet in affecting blood pressure in adults.[5] Among subjects with borderline high BP, intake of 8 to 10 fruits and vegetables per day along with reduced total fat and saturated fat was associated with 2.8 mm Hg ($P<0.001$) and 1.1 mm Hg ($P=0.07$) lower SBP and DBP, respectively. When also supplemented with 2.7 servings of dairy per day, SBP and DBP had larger decreases (5.5 mm Hg and 3.0 mm Hg, respectively).

Because eating habits that may affect long-term BP are established in childhood,[7,8] it is essential to improve our understanding of the effects of diet on BP in this age group. Although observational studies have shown a protective effect from increased consumption of dairy products on BP,[9-14] these studies have largely been conducted among adults.[9-11,13-15] Studies investigating the effects of dietary patterns on BP among children found that a diet rich in fruits, vegetables, and dairy products was associated with lower BP levels in early adolescence.[16,17] However, studies investigating the effects of dairy products independent of fruits and vegetables intake on BP among children are limited and mixed.[17,18] Consequently, the aim of this cross-sectional study was to investigate the association between dairy product consumption with SBP and DBP levels among children aged 8 to 10 years.

SUBJECTS AND METHODS

Study Population

Québec Adipose and Lifestyle Investigation among Youth (QUALITY) is an ongoing cohort study designed to evaluate the determinants and consequences of the metabolic syndrome in children.[19] Between September 2005 and December 2008, 630 families were recruited using a school-based sampling strategy and participated in a baseline clinic visit at the Centre Hospitalier Universitaire Sainte-Justine in Montréal or Hopital Laval in Québec City, Canada. To be eligible, a child had to be white of western European ancestry, between the ages of 8 and 10 years, with at least one obese biological parent (ie, body mass index ≥30 or waist circumference >102 cm

in men and >88 cm in women) and both biological parents willing to participate. Children with type 1 or 2 diabetes; using antihypertensive medications or steroids; following a very strict diet (eg, <600 kcal/day); or with a previous diagnosis of a serious illness, psychological condition, or cognitive disorder that hindered participation were excluded from the study. Families were also excluded if the mother was pregnant or breastfeeding at baseline, or if the family was planning to move out of Québec. A more detailed sampling method has been previously described.[19] Parents provided informed written consent and children provided verbal assent. The study was approved by the Centre Hospitalier Universitaire Sainte-Justine ethics committee.

BP

BP was measured on the right arm, after a 5-minute rest, in a seated position, using an oscillometric instrument (Dinamap XL, model CR9340) and an appropriate cuff size determined by arm circumference. Five consecutive readings were recorded and the mean value of the last three readings was used to define SBP and DBP.

Dietary Assessment

Families were given a set of disposable containers (ie, bowl, plate, and glass with measure indicators) and a ruler to help estimate portion sizes and were instructed on their use. A trained registered dietitian conducted telephone-administered 24-hour dietary recalls on three nonconsecutive days (2 weekdays and 1 weekend day) with the child to assess his or her dietary intake during the past month. Additional details on food preparation were obtained from a parent. The data were entered and verified by trained data entry staff into the CANDAT software (Godin and Associates). A research dietitian who supervised the staff audited every tenth entry for completeness and accuracy. Final entries were verified for outlying values.

For this study, the mean of the three dietary recalls was used, and was organized into four mutually exclusive food groups (dairy products, fruits and vegetables, sugar-sweetened beverages, and all other foods). The micronutrient composition of each food group was defined based on the 2007 Canadian Nutrient File.[20] Canada's Food Guide was used to define daily servings of dairy and fruits and vegetables.[21]

Dairy Definition

Canada's Food Guide recommends that children aged 8 to 10 years have at least two servings of milk, yogurt, or cheese per day.[21] In accordance with Canada's Food Guide, a serving of dairy was defined as 250 mL milk, 175 g yogurt, or 50 g cheese. To assess an association between blood pressure and the recommended types of dairy foods (milk, yogurt, and cheese), all other dairy products such as dairy desserts, milk shakes, cream, ice cream, and mixed dishes were not included in our definition of dairy. These other dairy products were a small proportion of the total dairy product consumption (<10%).

Covariates

Anthropometric measurements were taken according to standardized protocols with subjects dressed in light indoor clothing without shoes, using a stadiometer for height (to the nearest 0.1 cm), and an electronic scale for weight (to the nearest 0.1 kg). Height and weight were measured in duplicate, or triplicate if the first two measurements differed from one another by >0.2 cm (height) or 0.2 kg (weight). The mean of the two closest measurements was used for this analysis. BMI was calculated as weight in kilograms divided by height in meters squared. Weight status was defined based on the age- and sex-specific Centers for Disease Control and Prevention 2000 growth charts.[22]

A 7-day recall of 28 physical activities adapted from a Sallis and colleagues[23] questionnaire was administered during the clinic visit and twice more by telephone within the year to capture seasonal variation in physical activity. Children reported the number of physical activities they performed during the past week for at least 15 minutes at a time. Because the average number of activities was not significantly different between the seasons, the mean number of activities from the three recalls was used for this analysis. Family history of hypertension was based on parental report of current or former diagnosis of hypertenision or pharmacotherapy for hypertension. A small proportion of these participants had missing data on both the maternal and paternal history of hypertension (<6%). For these participants, no parental history of hypertension was assumed; excluding these participants did not affect our results. Parental report on the highest maternal and paternal education level obtained was also collected.

Statistical Analysis

All micronutrients were energy-adjusted using the nutrient residual method.[24] Because our preliminary analysis showed a nonlinear trend between dairy consumption and BP, we analyzed dairy consumption in energy-adjusted tertiles. In all bivariate analyses, χ^2 test or analysis of variance was used to compare the differences between covariates and tertiles of dairy product intake. When basic assumptions of analysis of variance were not satisfied, a Kruskal-Wallis test was performed.

We assessed the association between dairy product consumption and BP in three linear regression models. Model 1 was unadjusted, and Model 2 was adjusted for age, sex, height, whether the child was overweight or obese (body mass index ≥85th percentile), and total energy intake.[24] Model 3 was our fully adjusted model, which adjusted for any covariate that was associated with either dairy product consumption or blood pressure at the $P<0.05$ level in the bivariate analyses. Thus, Model 3 was adjusted for all covariates adjusted for in Model 2, plus the child's average number of physical activities in the past week; parental history of hypertension; whether at least one parent had an education level less than high school; the number of fruit and vegetable servings per day; the number of sugar-sweetened beverages consumed per day; and nutrients from nondairy sources, including calcium, sodium, and saturated fat. Due to the high correlation between calcium with magnesium and potassium,[25] we assessed the association between these micronutrients with BP in subanalyses.

In addition, because several studies showed an association between being overweight or obese and BP,[26,27] and because this is a unique population in which obese parental history is part of the eligibility criteria, we were interested in assessing