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Lower dairy products and calcium intake is associated with adverse retinal vascular changes in older adults

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Abstract *Background and aims:* Higher consumption of dairy products and calcium is likely to play a role in maintaining optimal vascular health. In this study, we aimed to explore the associations between consumption of total-, regular- and low-fat dairy foods, and total calcium intake with retinal vascular caliber.
Methods and results: 2813 Blue Mountains Eye Study participants aged 50+ years had dietary data collected using a semi-quantitative food frequency questionnaire, and serves of dairy consumption were calculated. Fundus photographs were taken and retinal vascular caliber measured using computer-assisted techniques and summarized. After adjusting for age, sex, body mass index, smoking, mean arterial blood pressure, serum glucose, white cell count, history of diagnosed hypertension, stroke and coronary heart disease, plus retinal arteriolar caliber, participants in the lowest quintile of total dairy consumption compared to those in the remaining highest 4 quintiles had significantly wider retinal venular caliber, 227.2 versus 224.7 μm, respectively (multivariable-adjusted $p = 0.002$). Also, subjects in the lowest quintile of low-fat dairy product consumption versus those in the remaining quintiles of low-fat dairy intake had wider retinal venules (~1.7 μm, $p = 0.03$) and narrower retinal arterioles (~1.4 μm, $p = 0.04$). Participants in the lowest quintile versus highest quintile of total dietary calcium intake had ~2.3 μm wider retinal venules (multivariable-adjusted p-trend $= 0.02$).
Conclusions: A significant association was observed between lower intake of dairy products or calcium and adverse retinal vascular signs. We cannot discount the possibility of confounding from unmeasured risk factors; hence, further studies are warranted to confirm these findings.

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Introduction

Recent studies suggest that the relationship between dietary parameters and cardiovascular disease (CVD) may, in part, be mediated via the microcirculation [1,2]. Retinal blood vessels, a surrogate for the systemic microvasculature, can be viewed non-invasively and hence, offers a unique opportunity to investigate the effects of modifiable lifestyle risk factors such as diet on the microcirculation [3]. Among children and adults, modifiable lifestyle behaviors such as physical activity, screen time [4] and dietary intakes (e.g. glycemic index of foods consumed, soft drink intake) have all been associated with retinal microvascular health [1,2]. The key retinal microvascular changes are narrower retinal arteriolar caliber and wider venular caliber. These structural changes have been found to be associated with CVD risk factors, including obesity and elevated blood pressure (BP) [5,6].

Habitual consumption of dairy foods could counteract the risk of obesity, metabolic syndrome and CVD [7,8]. Adequate calcium intake is also necessary for optimal health throughout the life cycle [9]. Calcium-deficient diets could be a risk factor for CVD, hypertension, obesity and osteoporosis [9,10]. Given that systemic risk factors such as obesity and hypertension have been linked with subtle retinal microvascular signs [5,6], there is potential for consumption of dairy foods and calcium intake to influence systemic microvascular health.

To our best knowledge, the retinal microvascular benefits from consumption of dairy products and calcium intake have not established. In this exploratory study, we used a relatively large cohort of older adults aged 50+ years to examine the cross-sectional association between consumption of dairy foods (primarily milk, cheese, and yoghurt) and total dietary calcium intake with retinal vascular caliber. We also aimed to assess whether any associations found differed by the type of dairy foods consumed, that is, regular/high fat compared to low/reduced fat dairy products.

Methods

Study population

The Blue Mountains Eye Study (BMES) is a population-based cohort study of common eye diseases and other health outcomes in a suburban Australian population located west of Sydney. Study methods and procedures have been described elsewhere [11]. Participants were non-institutionalized residents aged 49 years or older invited to attend a detailed baseline eye examination after a door-to-door census of the study area. Selection bias at baseline was minimized after multiple call-back visits that included door-knocking, telephone reminders and letters at recruitment. During 1992–4, 3654 participants (participation rate of 82.4%) aged >49 years were examined. The study was approved by the Human Research Ethics Committee of the University of Sydney and was conducted adhering to the tenets of the Helsinki Declaration. Signed informed consent was obtained from all participants.

Dietary assessment

Dietary data were collected using a 145-item self-administered food frequency questionnaire (FFQ), modified for Australian diet and vernacular from an early Willett FFQ [12], and including reference portion sizes. Participants used a 9-category frequency scale to indicate the usual frequency of consuming individual food items during the past year. The FFQ was validated by comparing nutrients from the FFQ to 4-day weighed food records collected over one year ($n = 79$). Most nutrient correlations were between 0.50 and 0.60 (e.g. 0.61 for calcium) for energy-adjusted intakes, similar to other validated FFQ studies [13,14]. A dietitian coded data from the FFQ into a customized database that incorporated the Australian Tables of Food Composition 1990 (NUTTAB 90) [15]. Total dietary calcium intake refers to intake of calcium from different food sources and does not include supplement intake.

Foods listed in the FFQ were categorized into major food categories and subcategories similar to those used for the 1995 Australian National Nutrition Survey [16]. Dairy subcategorization includes regular milk, reduced fat/skim milk, low fat cheese, regular cheese, reduced fat dairy dessert (e.g. low fat yoghurt), and medium fat dairy dessert (e.g. custard and regular yoghurt). For the purpose of this analysis, total dairy included all of the aforementioned dairy foods; low/reduced fat dairy included 'reduced fat/skim milk', 'reduced fat dairy dessert' and 'low fat cheese'; while regular fat dairy included 'regular milk', 'regular cheese' and 'medium fat dairy dessert'. Quintiles of dairy product consumption were based on serves of dairy consumed per day. The serving sizes used were 250 g for milk, 200 g for yoghurt, 250 mL for custards, and 40 g for cheeses [7]. Among participants in the lowest quintile of low-fat dairy product consumption ($\leq$0.00 serves/day), ~33% consumed more than $\geq$1.53 serves/day of regular-fat dairy (i.e. were in the highest quintile of regular-fat dairy intake). Similarly, among participants in the lowest quintile of regular-fat dairy product consumption ($\leq$0.17 serves/day), ~30% consumed $\geq$1.18 serves/day of low-fat dairy product (i.e. in the highest quintile of low-fat dairy consumption).

Retinal photography

Detailed methods for grading the caliber of retinal arterioles and venules are described elsewhere [6]. In brief, at the baseline examination, 30° photographs of the macula, optic disc, and other retinal fields of both eyes were taken, after pupil dilation, using a Zeiss FF3 fundus camera (Zeiss, Oberkochen, Germany). We used methods developed by the University of Wisconsin–Madison [17], to measure the internal caliber of retinal arterioles and venules from digitized photographs. These were then summarized using established formulas [18], that account for branching patterns and combine individual vessel calibers into summary indices, and are presented as the central retinal artery equivalent (CRAE) or central retinal vein equivalent (CRVE), representing the mean caliber of these vessels. Arteriole-