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Association of consumption of dairy products and meat with retinal vessel calibers in subjects at increased cardiovascular risk

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Abstract *Background and aims:* Association of dairy products and meat consumption with macrocirculation is previously described, but such association with microcirculation is poorly investigated. We aimed to test the hypothesis that the consumption of high- and low-fat dairy products as well as red, white, and processed meat is associated with retinal vessel calibers in adults at an increased risk of cardiovascular disease (CVD).
Methods and results: In consecutive subjects (n = 181, age: 51.3 ± 12.4 years, 51.4% women) without CVD and diabetes mellitus but with increased CVD risk, we obtained digital left and right retinal images. These images were assessed with validated software to determine central retinal arteriolar and venular equivalents and the arteriolar to venular ratio (CRAE, CRVE, and AVR, respectively). The consumption of dairy products and meat was assessed through 24-h recalls in all volunteers. After adjustment for potential confounders, the following findings were obtained: (i) low-fat milk and yogurt were positively associated with CRAE ($b = 0.145$, $p = 0.031$ left; $b = 0.141$, $p = 0.038$ right) and inversely associated with CRVE ($b = -0.155$, $p = 0.026$ left; $b = -0.146$, $p = 0.041$ right); (ii) low-fat cheese was positively associated with CRAE ($b = 0.164$, $p = 0.011$ left and $b = 0.155$, $p = 0.017$ right); and (iii) red meat was inversely associated with CRAE ($b = -0.143$, $p = 0.032$ left; $b = -0.114$, $p = 0.050$ right). High-fat milk, yogurt, and cheese or white and processed meat were not found to be associated with retinal vessel calibers.
Conclusions: High consumption of low-fat milk, yogurt, and cheese and low consumption of red meat could be beneficial for retinal microvascular health. Prospective studies are needed to verify these findings.

Introduction

Studies conducted in the past decades have shown that daily consumption of dairy products is inversely associated with the risk of metabolic syndrome, hypertension, and cardiovascular disease (CVD) [1,2]. Poor calcium intake, attributed to poor dairy intake, has also been proposed as a risk factor for many diseases including, but not limited to, hypertension and CVD [2,3]. On the contrary, high

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consumption of meat, especially red and processed meat, has been implicated in the increased risk of metabolic syndrome and hypertension [4,5], whereas most international guidelines recommend reducing red meat consumption to reduce CVD risk [6]. Only limited data have been obtained on the association of nutrients with impaired and/or damaged microcirculation [7,8], providing a potential link between dietary preferences and the genesis of metabolic and hemodynamic disorders, as well as CVD.

The retinal microvasculature offers an easily accessible site to evaluate the microcirculation and measure the retinal vascular caliber in a noninvasive manner for additional information on cardiovascular risk; however, its clinical utility remains unclear [9,10]. The retinal microvasculature is closely associated with CVD risk and disease [9]. In previous studies, wider retinal venules were found to be associated with incident CVD, and narrower retinal arterioles with incident coronary heart disease and hypertension in older adults [11]. Very few studies have investigated the association between diet and retinal microcirculation. These population-based studies, conducted in children and adults, showed that a high-glycemic-index diet and low consumption of fish and fiber diet are associated with unfavorable retinal microvascular health [7]. Moreover, recent results from the Blue Mountain Eye Study in healthy adults revealed an inverse association of low dairy consumption and high intake of low-fat dairy products and calcium with retinal microvascular health [12]. In addition, the results from the Sydney Childhood Eye Study showed a positive association of yogurt consumption with retinal arteriolar caliber in adolescents, but significant associations were not observed with the intake of other dairy products [13]. To the best of our knowledge, studies relevant to meat consumption and retinal microcirculation have not been conducted.

The aim of the present cross-sectional study was to investigate the possible associations of high- and low-fat dairy product intake, as well as red, white, and processed meat consumption, with retinal vessel calibers in individuals at increased CVD risk (free of diabetes and established CVD), treated for the presence of CVD risk factors.

Methods

Study design: population

Consecutive adults at increased CVD risk due to the presence of classical or novel (chronic inflammatory diseases) CVD risk factors were systematically referred to the Cardiovascular Research Laboratory of our department for optimal CVD risk stratification and were included in the study. Participants with established CVD (defined as preexisting coronary artery disease, stroke, and peripheral arterial disease) and diabetes mellitus were excluded from the analysis. All participants underwent the same vascular investigations, and they provided written informed consent according to the World Health Organization statement on ethical principles for medical research involving human subjects developed in Helsinki. Further, the protocol was approved by the "Laiko" Hospital's institutional review board.

Definition of CVD risk factors

Hypertension was defined as the use of antihypertensive drugs and/or office blood pressure measurement >139/89 mmHg (average of three sequential readings with 1-min interval in the supine position after at least 10 min of rest; Microlife WatchBP Office, Microlife AG, Widnau, Switzerland). Dyslipidemia was defined by treatment with lipid-modifying drugs or low-density lipoprotein cholesterol level >160 mg/dl. Current smoking was defined by the use of at least one cigarette per day each day of the week; ex-smoking was defined as discontinuation of smoking for >6 months. Body mass index was calculated as weight/(height [2]) (kg/m^2), which was used as a marker of obesity. A family history of premature CVD was defined as the presence of coronary heart disease in a first-degree relative below the age of 55 years for men and 65 years for women. Required data were retrieved from the medical records of the participants.

Dietary assessment

Dietary intake was evaluated through two 24-h recalls collected over the phone by a trained dietician. The study participants were asked to recall and report to the dietician the type and amount of foods and beverages consumed the previous 24 h; this procedure was performed for one weekday and one weekend day (nonconsecutive days). Data from the recalls were analyzed for their energy, macronutrient, and selected micronutrient content via Nutritionist Pro, version 5.2 software (Axxya Systems-Nutritionist Pro, Stafford, TX, USA). The Nutritionist Pro food database was expanded by adding analyses of traditional Greek foods and recipes. For the present analysis, we used dairy and meat food groups, as well as the following subgroups: regular milk and yogurt, low-fat milk and yogurt, regular cheese, low-fat cheese, red meat, white meat, and processed meat. Serving sizes of 250 ml were used for milk, one cup for yogurt, 30 g for cheese, 60 g for red and white meat, and 30 g for processed meat. The above-mentioned servings were selected according to the food-based dietary guidelines for Greece (http://www.fao.org/nutrition/education/food-based-dietary-guidelines/regions/countries/greece/en/), to better reflect portion sizes used by a Greek population. The daily consumption of the above-mentioned subgroups in our population is presented in Table 1.

Analysis of retinal vasculature

Both eyes of each participant were photographed with a 45° digital non-mydriatic retinal camera (Topcon TRC-NW8, Tokyo, Japan) after 5 min of adapting to the dark using a validated method [14]. Retinal images were