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Original article

Nutrient patterns and chronic inflammation in a cohort of community dwelling middle-aged men

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SUMMARY

Background & aims: There is limited data relating to the effect of the combination of nutrients on inflammation and the interactions with lifestyle factors and chronic conditions. We examined the association between nutrient patterns and inflammatory markers C-reactive protein (CRP) and interleukin 6 (IL-6) in community dwelling middle-aged and elderly Australian men.

Methods: Participants (mean age 59.7 y) with complete data relating to diet and fasting serum inflammatory markers in the Men Androgen Inflammation Lifestyle Environment and Stress cohort were analysed (n = 1577 for CRP, n = 1557 for IL-6). Food intake was assessed using a food frequency questionnaire, and nutrient patterns were identified by factor analysis. Biomedical examinations were conducted in The Queen Elizabeth Hospital and Lyell McEwin Health Service. CRP and IL-6 were log transformed due to the skewed distribution. Linear regression models were used to assess the association between nutrient patterns and inflammation.

Results: We generated three nutrient patterns by factor analysis. An animal-sourced pattern (animal protein, cobalamin, cholesterol and omega-6) was positively associated with CRP (p for trend across quartiles 0.057). A plant-sourced pattern (beta-carotene, vitamin A, lutein and zeaxanthin) was inversely associated with CRP (p for trend across quartiles 0.005). The association between plant-sourced pattern and CRP was stronger in participants with severe sleep apnoea, smoking (p for interaction 0.019), and participants without diabetes (p for interaction 0.238) and/or with normal triglycerides (p for interaction 0.005) and high density lipoprotein (p for interaction 0.120) compared with their counterparts. No interactions were found between the animal-sourced pattern and lifestyle factors and chronic conditions. No independent associations were found between the animal/plant-sourced pattern and IL-6. No associations were found between the vitamin B and folate pattern (total folate, thiamine, riboflavin and niacin) and inflammatory markers.

Conclusions: While an animal-sourced pattern may enhance inflammation level, a plant-sourced pattern may reduce inflammation particularly in people with less healthy lifestyles and severe obstructive apnoea.

1. Introduction

A number of chronic diseases, including obesity [1], type 2 diabetes [2], cardiovascular diseases [3] and obstructive sleep apnoea (OSA) [4] are associated with inflammation. Lifestyle factors including smoking [5] and physical inactivity [6] increase inflammatory burden. Diet can modulate inflammation by suppressing or triggering pro-inflammatory markers [7]. Fibre, ω-3 polyunsaturated fatty acids, fruits and vegetables have anti-inflammatory effects; saturated fatty acids and trans-fatty acids are pro-inflammatory [8].

Studies on dietary patterns show that the Mediterranean pattern or a 'healthy' pattern characterised by vegetables, fruits, nuts and grains are anti-inflammatory, while a 'Western-like'

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pattern that is characterised by red and processed meat and snacks is pro-inflammatory [8,9]. Studies on the interactions between inflammation and chronic diseases and how they are modified by diets have shown inconsistent results. For example, in a randomized controlled trial, a diet low in saturated fat and high in fibre, plant sterols and grains reduced CRP levels in hyperlipidemic patients compared with controls [10]. Mediterranean diets have been shown to reduce inflammation in a randomized controlled trial for 12 months in patients with diabetes, or with three or more major cardiovascular risks (hypertension, obesity, dyslipidaemia etc.) [11], but have failed to reduce inflammatory markers in patients with coronary artery disease in another one year randomized controlled trial [12].

An alternative approach to evaluate dietary effects is to examine the combination of nutrients and generate nutrient patterns. Compared with dietary patterns, nutrient patterns provide an easier way to compare between populations because no matter what foods were consumed, the component nutrients in foods remained the same [13]. Among the existing studies that investigated the combination of nutrients, most focused on cancer patients [14,15], one focused on obesity [16], and few have examined the association with inflammation.

In the current study, we aimed to 1) examine the association between nutrient patterns and CRP and IL-6 levels in community middle-aged and elderly men in South Australia; 2) examine if the associations between nutrient patterns and inflammatory markers are modified by factors including lifestyles, OSA and other chronic conditions.

2. Methods

2.1. Study population

We used data from the Men Androgen Inflammation Lifestyle Environment and Stress (MAILES) cohort study, which has been described in detail previously [17]. In brief, MAILES is the harmonisation of two ongoing prospectively followed cohorts: eligible male participants from the North West Adelaide Health Study (NWHAS) [18] and all participants from the Florey Adelaide Male Ageing Study (FAMAS) [19]. MAILES stage 1 (baseline) contained participants from NWHAS at the first follow-up clinic visit (2004–2006) and participants from FAMAS at the baseline clinic visit (2002–2005) as well as a computer assisted telephone interview (CATI)/questionnaire. MAILES stage 2 occurred approximately five years after MAILES stage 1 assessments for both cohorts, and included CATI and administration of questionnaires. MAILES stage 3 was a joint follow up using CATI and questionnaire conducted in 2010–2011. Participants were recruited using the telephone to conduct interviewers and the Electronic White Pages as the sampling frame. Residential households were selected at random by a computer and randomly selection was also conducted within the household for both cohorts for interview and clinic visits [20,21]. This method of randomly selecting within the household avoids selection bias towards unemployed and retired or housewives, as those most likely to be at home when the initial call was made [22]. The general inclusion criterion were: 1) male and aged 35–80 years at the time of recruitment; 2) household with a telephone connected and telephone number listed in the Electronic White Pages. The exclusion criterion were: 1) non-English speaking; 2) mental or physical illness that disables the communication ability; 3) too ill or otherwise incapacitated to attend clinics; 4) current residence in an aged care facility. In this study, we included 1815 men with completed dietary intake from MAILES stage 2 (2007–2010), among whom, 1586 had CRP measurements and 1557 had IL-6 measurements (Fig. 1). We excluded those with

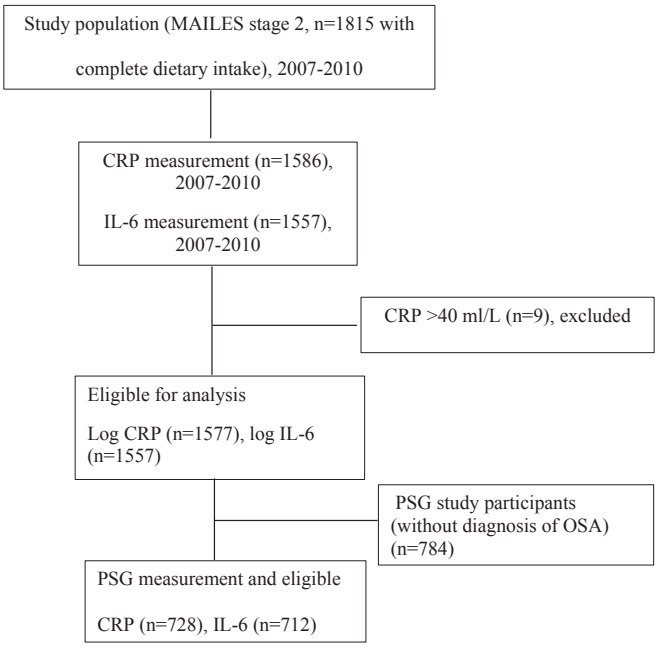

Fig. 1. Flow chart of study population.

CRP higher than 40 ml/L (n = 9) as it is suggestive of an acute infection or inflammatory disease [23]. In MAILES stage 3, polysomnography (PSG) was conducted in men identified by the CATI to be without a previous diagnosis of OSA assessed by an overnight sleep study (included in the current study n = 728). Ethics approval was obtained from the Queen Elizabeth Hospital Human Ethics Committee (number 2010054) and the Royal Adelaide Hospital Human Research Ethics Committee (number 020305h).

2.2. Dietary intake assessment

Dietary intake was measured by the Cancer Council Victoria Diet Questionnaire for Epidemiological Studies (DQES-V3.1 (FFQ)). The FFQ has been validated in an Australian population and is widely used in epidemiological studies [24]. The questionnaire asks the participant's habitual consumption of 167 foods and six alcohol beverages over the last 12-month on a 10-point frequency scale. Additional questions were asked about the use of bread, dairy products and fat spreads. Nutrient intakes were computed from the dietary data by the means of the nutrient composition tables in the NUTTAB95 database (Food Standards Australia New Zealand, Canberra, 1995). Nutrients intake from supplements were not included in the analysis because the information collected was not sufficiently detailed to calculate (by Cancer Council Victoria).

2.3. Measurement of CRP and IL-6 and other biomarkers

Biomarkers analysed in the study were from the fasting blood samples drawn during morning clinic visits in hospital-based clinics (The Queen Elizabeth Hospital and Lyell McEwin Health Service) at MAILES stage 2. Blood samples were stored on ice 0.5–3.5 h before being transported for immediate laboratory analysis. Plasma and sera from blood samples were frozen at −70 °C and thawed for subsequent analysis of inflammatory markers [20]. Clinic visit appointments were re-scheduled if participants were acutely unwell. Serum levels of high-sensitivity CRP and IL-6 were quantitated with an enzyme linked immunosorbent assay (ELISA) and Cobas auto analyser (Roche Diagnostics, Florham Park, New

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