

CLINICAL STUDY

C-reactive protein and nutrition

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Abstract

High sensitivity C-reactive protein (hsCRP) is a proven method to better predict the cardiovascular risk and target therapeutic interventions. Serum concentrations of hsCRP were measured in an adult apparently healthy population aged 19–75 years of different nutrition: a vegetarian group (lacto- and lacto-ovo-vegetarians who consumed plant food, dairy products and eggs) and a group of non-vegetarians (general population) on traditional mixed diet. The average hsCRP concentration was significantly reduced in the vegetarian group (0.72 ± 0.07 vs 1.62 ± 0.12 mg/l) with no risk values >3 mg/l vs 14 % in non-vegetarians. In non-vegetarians, a positive linear correlation of hsCRP values and age ($r=0.35$, $p<0.001$) was recorded vs horizontal trend line in vegetarians. Low and age independent concentration of hsCRP in vegetarians is the consequence of a long-term consumption of fruits and vegetables. These food commodities are important sources of dietary salicylates as well as other anti-inflammatory compounds (Tab. 1, Fig. 1, Ref. 15).

Key words: high sensitivity C-reactive protein, vegetarians.

High sensitivity C-reactive protein (hsCRP), a marker of inflammation, predicts incidence of myocardial infarction, stroke, peripheral arterial disease and sudden cardiac death among healthy individuals with no history of cardiovascular disease and recurrent events and death in patients with acute or stable coronary syndromes (Bassuk et al, 2004). High sensitivity CRP confers additional prognostic value at all concentrations of cholesterol, Framingham coronary risk score, severity of the metabolic syndrome, blood pressure and in those with and without subclinical atherosclerosis. To date, more than 20 prospective epidemiological studies have demonstrated that hsCRP independently predicts vascular risk, 6 cohort studies have confirmed that hsCRP evaluation adds prognostic information beyond that available from the Framingham risk score, and 8 cohort studies have demonstrated additive prognostic value at all levels of metabolic syndrome or in prediction of type 2 diabetes (Ridker et al, 2004).

Interventions that lower hsCRP include diet, exercise, smoking cessation, statin therapy and improved glycemic control (Ridker, 2004; Willerson and Ridker, 2004). The aim of this study was to assess the concentrations of hsCRP in relation to nutrition.

Subjects and methods

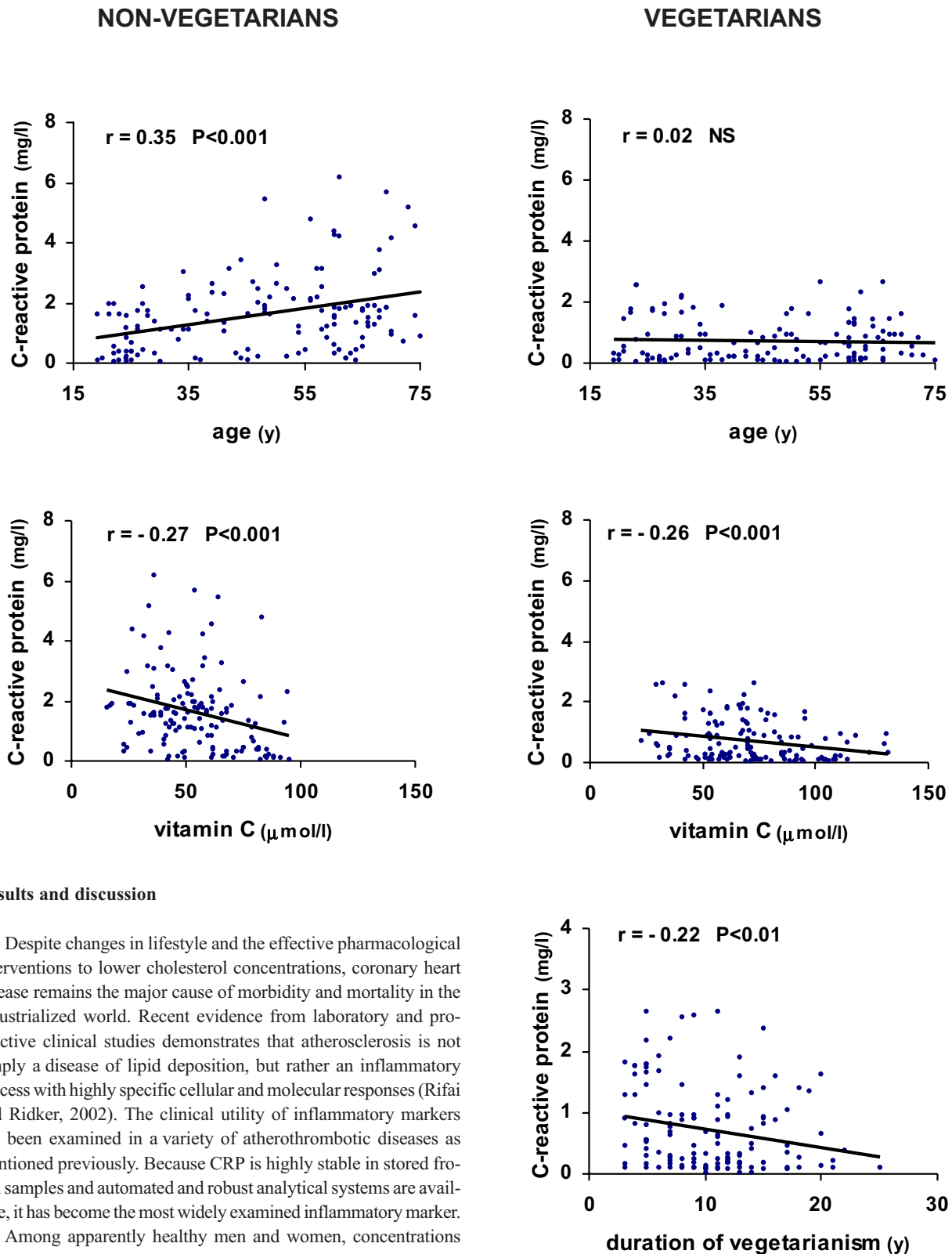
Randomly selected apparently healthy subjects aged 19–75 years were distributed into two groups characterized by a differ-

ent nutrition: the vegetarian group – long-term lacto-vegetarians and lacto-ovo-vegetarians (duration of vegetarianism 10.4 ± 0.4 years) consuming plant food, dairy products and eggs ($n=133$) and the non-vegetarian group – subjects of general population on a traditional mixed diet ($n=137$). Characteristic of groups is showed in Table 1. The subjects were non-smokers. Both groups had a similar mean age. In vegetarian group, the body mass index was significantly lower with an incidence of overweight 11 % vs 30 % in non-vegetarians. Obese subjects were found only in non-vegetarian group (7 %) vs 0 % in vegetarian group.

Blood samples were collected using standard technique. EDTA was used as an anticoagulant. Serum C-reactive protein concentrations were detected by immunoturbidimetric method using a high sensitivity test (Randox, UK). Plasma vitamin C concentrations were measured by HPLC method (Cerhata et al, 1994). The survey was carried out in spring. Intake of vitamins, mineral and trace elements was considered only in their natural form (no supplementation). Student's t-test and regression analysis were used for final evaluation.

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Results and discussion

Despite changes in lifestyle and the effective pharmacological interventions to lower cholesterol concentrations, coronary heart disease remains the major cause of morbidity and mortality in the industrialized world. Recent evidence from laboratory and prospective clinical studies demonstrates that atherosclerosis is not simply a disease of lipid deposition, but rather an inflammatory process with highly specific cellular and molecular responses (Rifai and Ridker, 2002). The clinical utility of inflammatory markers has been examined in a variety of atherothrombotic diseases as mentioned previously. Because CRP is highly stable in stored frozen samples and automated and robust analytical systems are available, it has become the most widely examined inflammatory marker.

Among apparently healthy men and women, concentrations of hsCRP of less than 1, from 1 to 3 and more than 3 mg/l are associated with low, moderate and higher risks for future cardiovascular disease, respectively (Torres and Ridker, 2003). The mean

Fig. 1. Correlation between C-reactive protein concentrations and age, vitamin C concentrations or duration of vegetarianism.

Tab. 1. Groups characteristic, values of C-reactive protein and vitamin C and risk values incidence in %.

	Non-vegetarians	Vegetarians
n (m+w)	137 (51+86)	133 (45+88)
age range (y)	19-75	19-75
mean age (y)	47.2±1.4	46.2±1.4
body mass index (kg/m ²)	24.7±0.3	22.9±0.2*
>25	30 %	11 %
>30	7 %	0 %
>35	0 %	0 %
smokers	0	0
duration of vegetarianism (y)	-	10.4±0.4
C-reactive protein (mg/l)	1.62±0.12	0.72±0.07*
<1	33 %	75 %
1-3	53 %	25 %
>3	14 %	0 %
vitamin C (µmol/l)	54.0±1.6	70.9±2.1*

Results are expressed as mean±SEM, * p<0.001

concentration of hsCRP in vegetarians is significantly reduced as compared to non-vegetarians (Tab. 1). Values less than 1 expressing a low or no risk were found in 75 % in vegetarian group vs 33 % in non-vegetarian group. A moderate risk for future cardiovascular disease was observed in 25 % of vegetarians vs 53 % of non-vegetarians. A higher risk was observed in 14 % in general population group vs none in vegetarian group. The highest value of hsCRP was 2.64 in vegetarian group and 6.19 in non-vegetarian group.

High sensitivity CRP as a marker of inflammation may be useful in identifying persons most likely to benefit from aspirin in the prevention of cardiovascular disease (Oparil and Oberman, 1999). Lawrence and co-workers (2003) measured amounts of salicylic and salicylic acids excreted daily in the urine of non-vegetarians, vegetarians and patients taking 75 or 150 mg aspirin/day. Significantly more of both acids was excreted in urine of vegetarians than in non-vegetarians, although amounts were lower than those excreted by patients taking aspirin. A higher excretion of acids in vegetarians is connected with frequent and sufficient consumption of fruits and vegetables. These food commodities are important sources of dietary salicylates.

Vitamin C is derived from fruits and vegetables. We have found a significant direct relationship between fruit and vegetable consumption and plasma vitamin C concentration (Krajčovičová-Kudláčková et al, 2003 a). It means that plasma vitamin C value can be an effective indicator of sufficient fruit and vegetable consumption, which is also associated with an intake of salicylates. In both groups, we have found a significant inverse correlation between hsCRP and plasma vitamin C concentrations (Fig. 1). In our repeated studies we have shown that vegetarians have higher antioxidant status than non-vegetarians and a high plasma concentrations of vitamin C (Tab. 1) (Krajčovičová-Kudláčková et al, 2003 b, 2004). Due to a significantly higher consumption of fruits and vegetables in healthy vegetarians, compared to healthy non-vegetarians, (Krajčovičová-Kudláčková et al, 2004) are vitamin C and salicylate intakes significantly higher (and probably also the intake of other anti-inflammatory compounds) and hsCRP blood concentrations are lower. The hsCRP concen-

trations decrease with duration of vegetarianism (Fig. 1). The reduced values of hsCRP in vegetarians are in accord with observations of other authors (Szeto et al, 2004; Fontana et al, 2005).

Risk hsCRP values predict the future incidence of chronic age-related diseases. HsCRP values in vegetarians express a horizontal trend line when correlated with age (Fig. 1) while values in non-vegetarians significantly increase with age. The low and age independent values of hsCRP in vegetarians are a consequence of a protective effect of long-term sufficient intake of fruits and vegetables. Protective effect of nutrition is important in each age – in younger or older adults with a potential risk of age related diseases including atherosclerosis and in elderly subjects with a potential risk of a variety of complications. The low and age independent hsCRP values we observed also in elderly vegetarians (Krajčovičová-Kudláčková et al, 2005).

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