Fall November 19, 2011

Relationship of serum fatty acid composition and desaturase activity to C-reactive protein in Japanese men and women (Atherosclerosis)

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ABSTRACT

Background: Although fatty acid composition in serum and desaturase activity, which alters serum fatty acid composition, has been associated with C-reactive protein (CRP) concentration in Western populations, no study has been carried out in non-Western populations. We examined the association of serum fatty acids and estimated desaturase activity with CRP concentrations in Japanese men and women.

Methods: Subjects were 489 Japanese municipal employees aged 21–67 years who participated in a survey at the time of a periodic health check-up. Serum high-sensitivity CRP concentrations were measured using the latex agglutination nephelometry method. Fatty acid composition was measured in serum cholesteryl esters and desaturase activities by fatty acid product-to-precursor ratios. Relationships were assessed using multiple regression.

Results: Serum CRP concentration was positively associated with palmitic acid (P for trend=0.002) and inversely with alpha-linolenic acid (P for trend=0.01) in men, and positively with dihomo-gamma-linolenic acid (P for trend in men or women=0.01) and inversely with delta-5-desaturase (20:4n-6/20:3n-6) (P for trend in men and women=0.05 and 0.002, respectively) in men and women.

Conclusions: Low-grade inflammation may be associated with a serum fatty acid pattern of high palmitic acid or low alpha-linolenic acid in men, and of high dihomo-gamma-linolenic acid or low delta-5-desaturase in both sexes.

Keywords: C-reactive protein, Desaturase activity, Elongase activity, Fatty acid composition

1. Introduction

Several experimental [1,2] and prospective epidemiological studies [3,4] have shown a relationship between C-reactive protein (CRP), a sensitive marker for low-grade inflammation, and atherosclerotic disease. Atherosclerosis, the major underlying cause of cardiovascular disease, is a dynamic process in which an inflammation plays an important role in the initiation and/or progression of atherosclerotic lesions [1,2].

Dietary fatty acids may be among the important underlying factors of low-grade inflammation [5]. The fatty acid composition of serum cholesteryl esters can be used as a quantitative biomarker of fatty acid intake [6]. A number of studies have examined the association between serum cholesteryl esters fatty acid composition and CRP concentration in Western populations [7–11]. CRP concentrations have been positively associated with saturated fatty acids such as stearic acid [11] and monounsaturated fatty acids such as palmitoleic acid [10,11] and oleic acid [10], but inversely associated with polyunsaturated fatty acids such as n-3 polyunsaturated fatty acids [7], alpha-linolenic acid [8,9], eicosapentaenoic acid [8] and linoleic acid [7].

Fatty acid composition can also be altered through endogenous fatty acid desaturation by a series of desaturation plus elongation reactions, which are particularly active in the liver and to a lesser extent in other tissues [12,13]. Desaturases are involved in the endogenous synthesis of polyunsaturated fatty acids and are widely expressed in human tissues, with the highest levels in liver [14,15]. The delta-9, 6, and 5 desaturases (D9D, D6D, D5D) introduce a double bond at specific positions on long-chain fatty acids [12]: D9D synthesizes mainly palmitoleic and oleic acid from palmitic and stearic acid, respectively; D6D catalyzes the conversion of linoleic acid to gamma-linolenic acid, which is elongated to dihomo-gamma-linolenic acid and then desaturated to arachidonic acid by D5D; and D5D and D6D also promote the conversion of alpha-linolenic acid into eicosapentaenoic acid. Recently, two studies in a Swedish population reported an association between increased CRP concentration and high D9D [11], high D6D [10,11], and low D5D [10].

To date, however, no study has investigated the relationship of fatty acid composition and fatty acid desaturases to CRP concentrations in Asian populations, which have a different habitual dietary fatty acid intake from western populations. For example, the mean intake of fish (71 g/d) and eicosapentaenoic acid plus docosahexaenoic acid (0.46% of energy intake) among the Japanese population is much higher than that among Western populations (32 g/d and 0.07% of energy intake, respectively) [16,17]. Thus, we considered that an investigation in a Japanese population might provide useful information about the role of these fatty acids at higher intake levels.

Here, we assessed the relationship of serum fatty acids and of enzymes involved in endogenous fatty acid desaturation to serum CRP concentrations in Japanese men and women, on the hypothesis that a higher intake of saturated fatty acids and lower intake of polyunsaturated fatty acids, as well as higher estimates of D9D and D6D and lower estimates of that of D5D and elongase, would be associated with increased serum CRP concentrations.

2. Subjects and methods

2.1. Study design

A cross-sectional survey was conducted among municipal employees of two offices in northeastern Kyushu, Japan, at the time of their periodic health examination, in July and November 2006, as described elsewhere [18]. All full-time employees were invited to participate in the study except those on long sick leave or maternity leave. Demographic, lifestyle, anthropometric, and biochemical measurements at the two offices were conducted using the same survey protocol.

2.2. Subjects

Of 601 eligible employees, 547 (323 men and 224 women) agreed to participate in the study (response rate 91%). Subjects who had no information on serum CRP concentration ($n = 11$) or serum fatty acid level ($n = 11$); a serum CRP concentration ≥ 5 mg/L ($n = 17$); a history of cerebrovascular disease ($n = 4$), cardiovascular disease ($n = 6$), liver disease ($n = 4$), or cancer ($n = 8$); hyperlipidemia under medication ($n = 3$); or who were currently pregnant ($n = 2$) were excluded, giving a final study population of 489 subjects (286 men and 203 women). The study was approved by the Ethics Committee of the National Center for Global Health and Medicine, Japan, and written informed consent was obtained from all subjects prior to the survey.

2.3. Serum CRP concentration

Blood samples were obtained from 536 subjects after an overnight fast during their health checkup. 7 ml of venous blood was drawn into an evacuated tube, transported in a cooler box to the laboratory, and centrifuged for 15 min. The separated serum was stored in a maximum of six tubes (0.5 ml each), one of which was immediately sent to an external laboratory (Mitsubishi Chemical Medience Corp, Tokyo, Japan), where serum CRP concentration was measured by the latex agglutination nephelometry method. Coefficients of variation at CRP levels of 0.05 and 0.98 mg/L were 6.3% and 1.7%, respectively.

2.4. Fatty acid measurement and estimation of desaturase activity

After serum lipids were extracted by Folch method [19], cholesterol esters were separated by thin-layer chromatography on silica gel G. The plate to which the serum lipid extracts were

spotted developed with petroleum ether/diethylether/acetic acid (82:18:1, vol/vol/vol). Fatty acids liberated from cholesterol ester were methylated with sulfuric acid/methanol (1:115, vol/vol). The resulting fatty acid methyl esters were analyzed by gas-liquid chromatography in Shimadzu GC-17A. Fatty acid methyl esters were also analyzed using OMEGAWAX 320 FUSED SILICA Capillary Column (30 m long, 0.32 mm i.d., 0.25 mm film thickness) purchased from SUPELCO Japan (Tokyo, Japan). This methylated FA was used to determine the percentage composition.

The product-to-precursor ratios of individual fatty acids in serum cholesterol esters were used to estimate desaturase activities as follows: D9D = 16:1n-7/16:0 and 18:1n-9/18:0; D6D = 18:3n-6/18:2n-6, D5D = 20:4n-6/20:3n-6 and elongase = 18:0/16:0.

2.5. Lifestyle assessment and anthropometry

Body height and weight were measured at the health check-up to the nearest 0.1 cm and 0.1 kg, respectively, with subjects wearing light clothing without shoes ($n = 546$). Body mass index (BMI) was calculated as body weight in kilograms divided by the square of body height in meters. Physical activity during leisure-time and on commuting to work was assessed in hours per week spent on common leisure-time physical activities expressed as metabolic equivalent hours per week (MET-h/wk) on the basis of the usual frequency and duration of five different activities (walking, low-, moderate-, and high-intensity activities, and gardening), as self-reported in the lifestyle questionnaire. Alcohol consumption and smoking status were measured as mean intake (g/day) and number of cigarettes per day, respectively.

2.6. Statistical analyses

All analyses were done for men and women separately. Student's t test and the chi-square test were used to assess differences in demographics, lifestyle, anthropometry, and serum fatty acid intake between men and women for continuous variables and categorical variables, respectively. The relationship between serum CRP concentration and serum fatty acid (sex-specific quartiles) was assessed using multiple regression. To better approximate normal distributions, serum CRP concentrations were log-transformed prior to analysis. The means and their 95% confidence intervals (CIs) of log-transformed serum CRP concentrations were calculated for each quartile of serum fatty acid, then back-transformed. The multivariate model adjusted for age (years, continuous), BMI (kg/m², continuous), workplace (A or B), current alcohol drinking (yes or no), current smoking (yes or no), physical activity during leisure-time and on commuting to work (0, 0 < to <5, 5 to <10, or ≥ 10 MET-hr/wk), and the use of non-steroidal anti-inflammatory drugs (yes or no). Trend associations were calculated using ordinal numbers 0–3 assigned to quartile categories of fatty acids. All p values were two-sided, and values less than 0.05 were considered statistically significant. Analyses were performed with SAS statistical software version 9.1 (SAS Institute, Inc., Cary, NC).

3. Results

The mean age of subjects was 44.1 for men and 40.6 for women. There were sex differences in anthropometric and lifestyle characteristics (Table 1). Men were more likely to smoke or drink or do physical exercise and had a higher mean BMI and serum CRP concentration than women.

Regarding the bivariate relationship of serum CRP concentration to anthropometric and lifestyle characteristics, serum CRP concentrations were significantly increased as BMI increased in both men

Table 1
Characteristics of subjects.

	Men	Women
No. of subjects	286	203
Age (years)	44.1 (10.9)	40.6 (10.4)
Body mass index (kg/m ²)	23.5 (3.2)	20.8 (2.8)
Physical activity during leisure-time and on commuting to work ^a	110 (38.5)	37 (18.2)
Current smoking	126 (44.0)	5 (2.5)
Current alcohol drinking	246 (86.0)	134 (66.0)
C-reactive protein (mg/L) ^b	0.39	0.22

Values are means $\pm$ standard deviation for continuous variables.

Values are number of subjects (proportion) for categorical variables.

p-Values based on the Student *t* test for continuous variables and chi-square test for categorical variables were less than 0.01 for all variables mentioned in the table.

^a Physical activity during leisure-time and on commuting to work: 5 metabolic equivalent hours per week or more.

^b Geometric means.

and women ($p < 0.05$) and as age increased in women ($p < 0.05$). Furthermore, higher levels of physical activity were associated with lower CRP concentrations in men, although the relationship was not statistically significant ($p = 0.07$). Other variables did not show a measurable bivariate association with CRP concentration in the study population (data not shown).

The proportion of fatty acid composition in serum cholesteryl esters and desaturase activities is shown in Table 2. The saturated fatty acids (palmitic acid, stearic acid), monounsaturated fatty acids (palmitoleic acid, oleic acid) and n-3 polyunsaturated fatty acids were significantly higher in men than in women, except for alpha-linolenic acid, whereas n-6 polyunsaturated fatty acids, linoleic acid, and D5D were significantly higher in women than in men.

The relationship between the proportion of fatty acid composition in serum cholesteryl esters and desaturase activities and CRP concentration is shown in Table 3. Mean CRP concentrations were significantly increased with an increasing proportion of palmitic acid and decreasing proportion of alpha-linolenic acid in men (*P* for trend = 0.002 and 0.01, respectively), and with decreasing D5D in women (*P* for trend = 0.002). Mean CRP concentration tended to decrease with increasing D5D in men (*P* for trend = 0.052). A tendency to a positive association between CRP concentration and palmitoleic acid was seen in women (*P* for trend = 0.09). Mean

Table 2
Fatty acid composition in serum cholesterol esters and desaturase activities.

Fatty acids (%)	Men	Women
Saturated fatty acids		
16:0 (palmitic acid)	10.9 (1.2)	10.5 (1.0)
18:0 (stearic acid)	0.8 (0.2)	0.7 (0.1)
Monounsaturated fatty acids		
16:1n-7 (palmitoleic acid)	2.9 (1.1)	2.4 (0.7)
18:1n-9 (oleic acid)	20.1 (2.4)	18.5 (1.2)
n-3 Polyunsaturated fatty acids	4.6 (1.9)	4.0 (1.5)
18:3n-3 (alpha-linolenic acid)	0.6 (0.1)	0.7 (0.2)
20:5n-3 (eicosapentaenoic acid)	2.7 (1.6)	2.2 (1.2)
22:6n-3 (docosahexaenoic acid)	1.2 (0.4)	1.1 (0.4)
n-6 Polyunsaturated fatty acids	60.7 (4.6)	63.8 (3.2)
18:2n-6 (linoleic acid)	52.7 (5.0)	56.3 (3.7)
18:3n-6 (gamma-linolenic acid)	0.6 (0.3)	0.5 (0.2)
20:3n-6 (dihomo-gamma-linolenic acid)	0.6 (0.1)	0.5 (0.1)
20:4n-6 (arachidonic acid)	6.8 (1.5)	6.4 (1.4)
Desaturase and elongase enzymes		
D9D-16 (16:1n-7/16:0)	0.3 (0.09)	0.2 (0.07)
D9D-18 (18:1n-9/18:0)	25.1 (5.0)	25.5 (4.9)
D6D (18:3n-6/18:2n-6)	0.01 (0.006)	0.009 (0.005)
D5D (20:4n-6/20:3n-6)	12.9 (3.7)	14.9 (3.9)
Elongase (18:0/16:0)	0.08 (0.02)	0.07 (0.01)

D9D, delta-9-desaturase; D6D, delta-6-desaturase; D5D, delta-5-desaturase.

Values are means $\pm$ standard deviation. *p*-Values based on the Student *t* test were less than 0.01 for all variables mentioned in the table except for D9D-18 ($p = 0.40$).

CRP concentration was significantly increased with an increasing proportion of dihomo-gamma-linolenic acid in both sexes (*P* for trend = 0.01). In addition, mean CRP concentration tended to decrease with an increasing proportion of docosahexaenoic acid or linoleic acid in men, arachidonic acid in women, and total n-6 polyunsaturated fatty acids in both sexes, albeit without statistical significance.

4. Discussion

In this study in a Japanese working population, we found that mean CRP concentration increased with an increasing proportion of palmitic acid and a decreasing proportion of alpha-linolenic acid in men, and with an increasing proportion of dihomo-gamma-linolenic acid in both sexes. To our knowledge, this is the first study to investigate the relation of CRP concentration to serum fatty acids and the estimated activities of enzymes involved in endogenous fatty acid synthesis in an Asian population.

In men, a high proportion of palmitic acid was associated with an increased concentration of CRP, at 58% among men with the highest proportion of palmitic acid compared to the lowest. Only one study to date, in Swedish men, has reported a positive association of palmitic acid to CRP concentration, although the relationship was not statistically significant [11]. Another study in Sweden [20] reported that the risk of cardiovascular disease was increased among subjects with a high proportion of palmitic acid, a finding which indirectly supports our results. Our findings are also supported by mechanistic studies which link inflammation to palmitic acid [21–23], which showed that palmitic acid can induce the expression of interleukin-6 (IL-6) in human myotubes through a proteasome-dependent mechanism that leads to the rapid and chronic activation of nuclear factor-kB. Furthermore, systemic production of this IL-6 might induce the acute phase response in liver, which entails the production of CRP and supports the development and propagation of inflammation [23].

In the present study, mean CRP concentration in men in the highest quartile of alpha-linolenic acid was 33% lower than that in men in the lowest quartile. This finding confirms the presence of a protective association between dietary intake of alpha-linolenic acid and serum CRP concentrations in Japanese men [24,25]. Similarly, studies among French [8] and Italian [9] populations have also revealed an inverse association between serum alpha-linolenic acid and CRP concentration. Our results might be supported by mechanistic studies showing that the anti-inflammatory effect of alpha-linolenic acid occurs via pathways in which alpha-linolenic acid is converted into long-chain n-3 polyunsaturated fatty acids, such as eicosapentaenoic acid and docosahexaenoic acid [26], which in turn inhibit the production of inflammatory factors in endothelial cells by down-regulating nuclear factor-kB, and thereby possibly decreasing inflammation [27–29].

We found that a high proportion of dihomo-gamma-linolenic acid and low D5D were associated with a higher CRP concentration in both sexes. To date, only two Swedish studies have explored the relationship between desaturase and CRP concentration [10,11] one of which showed similar results to ours [10]. Our results suggest that high D5D is protective against inflammation, although the mechanism of this effect is unclear.

Several limitations of our study deserve comment. First, our hypothesis that serum fatty acids influence inflammation was based on findings in the literature, including a longitudinal study [10]. However, the possibility of reverse causality must be considered, namely that inflammation may influence serum fatty acid pattern, a possibility which the cross-sectional design of our study prevents us from ruling out. To minimize the potential influence of inflammatory status on fatty acid composition, we excluded

Table 3

Multivariate-adjusted means of serum CRP concentrations according to the quartile of fatty acids in serum cholesterol esters and desaturase activities.

	Men					Women				
	Q1 (low)	Q2	Q3	Q4 (high)	P for trend ^a	Q1 (lowest)	Q2	Q3	Q4 (highest)	P for trend ^a
<i>SFA</i>										
16:0	0.31	0.34	0.45	0.49	0.002	0.22	0.20	0.23	0.23	0.67
(Palmitic acid)	(0.24–0.39)	(0.27–0.43)	(0.35–0.56)	(0.38–0.63)		(0.16–0.30)	(0.15–0.27)	(0.17–0.31)	(0.17–0.32)	
18:0	0.35	0.41	0.42	0.40	0.45	0.26	0.19	0.24	0.22	0.70
(Stearic acid)	(0.27–0.44)	(0.32–0.52)	(0.32–0.53)	(0.31–0.50)		(0.19–0.35)	(0.13–0.25)	(0.17–0.32)	(0.16–0.29)	
<i>MUFA</i>										
16:1n-7	0.34	0.37	0.45	0.42	0.12	0.22	0.16	0.26	0.27	0.09
(Palmitoleic acid)	(0.26–0.43)	(0.29–0.47)	(0.35–0.57)	(0.33–0.54)		(0.16–0.29)	(0.12–0.22)	(0.19–0.35)	(0.19–0.36)	
18:1n-9	0.33	0.45	0.38	0.42	0.32	0.19	0.23	0.23	0.24	0.38
(Oleic acid)	(0.26–0.42)	(0.35–0.57)	(0.30–0.48)	(0.33–0.53)		(0.14–0.26)	(0.17–0.31)	(0.17–0.31)	(0.17–0.32)	
<i>n-3 PUFAs</i>										
18:3n-3	0.44	0.38	0.35	0.41	0.52	0.22	0.24	0.21	0.23	0.97
(Alpha-linolenic acid)	(0.34–0.57)	(0.29–0.48)	(0.27–0.44)	(0.31–0.52)		(0.15–0.29)	(0.17–0.32)	(0.15–0.28)	(0.16–0.31)	
20:5n-3	0.46	0.43	0.38	0.31	0.01	0.19	0.21	0.23	0.26	0.11
(Eicosapentaenoic acid)	(0.36–0.59)	(0.34–0.55)	(0.29–0.48)	(0.24–0.40)		(0.14–0.26)	(0.15–0.29)	(0.17–0.32)	(0.19–0.35)	
22:6n-3	0.45	0.38	0.34	0.41	0.53	0.27	0.18	0.22	0.24	0.83
(Docosahexaenoic acid)	(0.34–0.58)	(0.29–0.48)	(0.26–0.43)	(0.31–0.53)		(0.19–0.36)	(0.13–0.24)	(0.16–0.29)	(0.17–0.32)	
22:6n-3	0.45	0.40	0.37	0.36	0.19	0.23	0.23	0.21	0.22	0.67
(Docosahexaenoic acid)	(0.35–0.57)	(0.31–0.51)	(0.28–0.46)	(0.28–0.46)		(0.17–0.31)	(0.17–0.31)	(0.15–0.28)	(0.15–0.30)	
<i>n-6 PUFAs</i>										
18:2n-6	0.47	0.39	0.35	0.36	0.12	0.24	0.26	0.21	0.19	0.15
(Linoleic acid)	(0.36–0.61)	(0.31–0.50)	(0.27–0.44)	(0.28–0.46)		(0.17–0.33)	(0.19–0.35)	(0.15–0.28)	(0.14–0.26)	
18:3n-6	0.49	0.38	0.33	0.38	0.16	0.20	0.28	0.24	0.19	0.54
(Gamma-linolenic acid)	(0.37–0.63)	(0.30–0.48)	(0.26–0.42)	(0.30–0.49)		(0.14–0.27)	(0.20–0.37)	(0.17–0.32)	(0.13–0.25)	
20:3n-6	0.34	0.44	0.40	0.40	0.46	0.19	0.24	0.22	0.25	0.33
(Dihomo-gamma-linolenic acid)	(0.26–0.43)	(0.34–0.56)	(0.31–0.51)	(0.31–0.51)		(0.14–0.26)	(0.17–0.32)	(0.16–0.29)	(0.18–0.33)	
20:4n-6	0.34	0.32	0.44	0.50	0.01	0.18	0.21	0.20	0.33	0.01
(Arachidonic acid)	(0.27–0.44)	(0.25–0.40)	(0.34–0.55)	(0.38–0.63)		(0.13–0.25)	(0.15–0.28)	(0.14–0.27)	(0.24–0.45)	
20:4n-6	0.41	0.35	0.44	0.38	0.98	0.23	0.25	0.25	0.17	0.18
(Arachidonic acid)	(0.32–0.52)	(0.27–0.44)	(0.34–0.56)	(0.29–0.48)		(0.17–0.32)	(0.18–0.33)	(0.18–0.33)	(0.12–0.24)	
D9D-16	0.41	0.35	0.42	0.39	0.84	0.20	0.20	0.26	0.24	0.20
(16:1n-7/16:0)	(0.31–0.53)	(0.27–0.44)	(0.33–0.54)	(0.30–0.50)		(0.14–0.27)	(0.14–0.27)	(0.19–0.34)	(0.17–0.33)	
D9D-18	0.39	0.46	0.32	0.42	0.81	0.24	0.23	0.17	0.26	0.97
(18:1n-9/18:0)	(0.30–0.49)	(0.36–0.59)	(0.24–0.40)	(0.33–0.53)		(0.17–0.32)	(0.17–0.31)	(0.12–0.23)	(0.19–0.35)	
D6D	0.35	0.42	0.40	0.41	0.38	0.20	0.24	0.21	0.25	0.41
(18:3n-6/18:2n-6)	(0.27–0.44)	(0.33–0.53)	(0.31–0.50)	(0.32–0.52)		(0.14–0.27)	(0.17–0.32)	(0.15–0.29)	(0.18–0.34)	
D5D	0.47	0.41	0.35	0.35	0.052	0.35	0.22	0.20	0.17	0.002
(20:4n-6/20:3n-6)	(0.36–0.60)	(0.32–0.52)	(0.27–0.44)	(0.27–0.44)		(0.25–0.47)	(0.16–0.29)	(0.14–0.26)	(0.12–0.23)	
Elongase	0.41	0.39	0.44	0.34	0.37	0.23	0.21	0.24	0.21	0.95
(18:0/16:0)	(0.32–0.52)	(0.31–0.50)	(0.34–0.55)	(0.26–0.43)		(0.16–0.31)	(0.15–0.29)	(0.17–0.32)	(0.15–0.29)	

D9D, delta-9-desaturase; D6D, delta-6-desaturase; D5D, delta-5-desaturase; LA, linoleic acid; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids.

Values are geometric means of C-reactive protein (mg/L); 95% Confidence Interval in parentheses (all such values). Adjusted variables in multivariate models included age (years, continuous), body mass index (kg/m², continuous), workplace (A, survey conducted in July 2007, or B, survey conducted in November 2007), current alcohol drinking (yes or no), current smoking (yes or no), physical activity during leisure-time and on commuting to work (metabolic equivalent hours per week; MET-hr) (0, 0 < to <5, 5 to <10, or ≥ 10 MET-hr/wk), and taking of non-steroidal anti-inflammatory drug (yes or no).^a P for trend values were based on the multiple linear regression analysis, with ordinal numbers 0–3 assigned to quartile categories of serum fatty acids.

subjects with chronic diseases and serum CRP concentrations >5 mg/L. Second, we measured serum CRP concentrations at a single time point. Given that serum CRP concentration in healthy subjects is stable over time, however, any influence of this on our present results would likely have been minor [30]. Third, we did not measure desaturase activity directly, but rather estimated it from the ratio of the specific substrate to the corresponding product of the respective enzyme. Nevertheless, estimated desaturase activity has been used in previous studies of the association between fatty acid metabolism and inflammatory markers [10,11]. Fourth, although we adjusted for factors known to influence fatty acid metabolism and inflammation, the possibility of residual confounding cannot be excluded. Finally, our study subjects did not represent a random sample of the Japanese population, and thus caution is required in generalizing the present results to the entire Japanese population.

In conclusion, among a Japanese working population, we found that a fatty acid composition with a high proportion of palmitic acid or low proportion of alpha-linolenic acid in men, and high proportion of dihomo-gamma-linolenic acid or low D5D in both sexes, was associated with an increased CRP concentration. Further prospective studies to confirm the role of fatty acids with desaturase against inflammation are warranted.

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