Original Article

Serum fatty acids, lipoprotein(a) and apolipoprotein composition of rural, suburban and urban populations in North Vietnam

Nguyen Thi Minh Kieu[1] MD, Etsuko Yasugi[1] PhD, Do Thi Kim Lien[2] MD, PhD, Nguyen Thi Lan Anh[2] MD, Tran Thanh Do[2] BS, Ha Huy Khoi[2] MD, PhD, Toshimi Kido[3] BS, Kazuo Kondo[3] MD, PhD, Hiroshige Itakura[3] MD, PhD, Nguyen Van Chuyen[4] PhD, Shigeru Yamamoto[5] PhD and Mieko Oshima[1] PhD

[1]*Department of Biochemistry and Nutrition, Research Institute, International Medical Center of Japan, Tokyo, Japan*
[2]*The National Institute of Nutrition, Hanoi, Vietnam*
[3]*The National Institute of Health and Nutrition, Tokyo, Japan*
[4]*Department of Food and Nutrition, Japan Women's University, Tokyo, Japan*
[5]*Nutrition Department, School of Medicine, Tokushima University, Tokushima, Japan*

This study was conducted to investigate the concentrations of serum fatty acids, lipoprotein(a) and apolipoprotein of three populations in North Vietnam: rural area with low income (n = 101), suburban with average income (n = 97), and urban with high income (n = 95). The results showed the suburban and urban populations had higher fat intake than the rural. The fat intake in quality was different in these three populations. The suburban had the highest consumption of fatty foods rich in n-6 polyunsaturated fatty acid (PUFA). The rural consumed more fatty foods rich in monounsaturated fatty acid (MUFA), but less fatty foods rich in n-3 PUFA than the two other populations. The high index of thrombogenicity (IT) of the Vietnamese diet may result from their low intake of fish and vegetable oils. Risk factors for premature cardiovascular disease (CVD) assessed by serum lipoprotein(a) and apolipoprotein levels were not observed in all three populations. However, coronary heart disease (CHD) and stroke are problems that should be monitored because the increase of CVD morbidity has been reported in Vietnamese people. From a nutritional point of view, the increase of fish and vegetable oils consumption is necessary for the prevention of CVD and CHD in these Vietnamese populations.

Key words: apolipoprotein, cardiovascular disease, dietary pattern, fatty acid, fat consumption, lipoprotein(a).

Introduction

Changes in the dietary pattern of the population of each country are considered to be related to trends in cardiovascular disease (CVD) mortality. The relationship between diet and CVD in developed countries has been extensively investigated; countries that have a high mortality from coronary heart disease (CHD) tend to have a high intake of energy from fat and a high proportion of fat from animal products.[1] In comparison to developed countries, developing countries have lower levels of energy intake from fat. However, it has been estimated that by 2015, the proportion of deaths caused by CHD in developing countries will be almost twice the level in 1985.[2] In Vietnam, a country undergoing economic and nutrition transition, faced with both the old problem of nutrients deficiencies and the new problem of over nutrition, dietary habits have been greatly changed in various districts with different incomes.[3] Nutritional surveys undertaken in 1985 and 1994 in North Vietnam showed an increase of fat intake, from 8.3 to 15.4% of total energy in rural areas, and from 13.5 to 18.8% in urban areas.[4] These figures reflect a trend of increased fat consumption in various districts of Vietnam, especially in the rural. The Vietnam Heart Institute also reported an increase in the CVD mortality rate from 5.8% of adult CVD cases admitted to a hospital in 1980 to 18.7% in 1996.[5] In order to obtain more information on the fat intake in quality and risk factors for premature CVD of Vietnamese populations, we analysed serum fatty acids, lipoprotein(a) and apolipoprotein composition of subjects who were randomly selected from three districts with different incomes in North Vietnam: the rural, the suburban, and the urban areas of Hanoi city. From this analysis, we clarified the fat intake in quality, estimate dietary and lipidaemia risk factors for premature CVD of these populations. The profiles of serum fatty acids, lipoprotein(a) and apolipoprotein compositions of Vietnamese populations described in this paper are reported for the first time.

Correspondence address: Nguyen Thi Minh Kieu, Department of Gastroenterology, Research Institute, International Medical Center of Japan, 1-21-1, Toyama, Shinjuku-Ku, Tokyo 162-8655, Japan.
Tel: 81-3-3202-7181; Fax: 81-3-3202-7364
Email: nguyen@ri.imcj.go.jp
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Methods

Population samples

This study was carried out in three districts in North Vietnam: Cua Dong, Thanh Luong and Yen So. Cua Dong is a trading area located in the centre of Hanoi city. The majority of people living in Cua Dong are small traders. The average per capita income of Cua Dong is classified as high. Thanh Luong is a suburban area of labourers with medium income and most of them are workers. Yen So is an agricultural commune with people living on rice cultivation and their income is low. In each area, 36 households were randomly selected from the resident registered list provided by the Local People's Committee. All members aged over 18 in these selected households were participants. The total number of subjects was 293, consisting of the rural population (n = 101), the suburban population (n = 97), and the urban population (n = 95). Some characteristics of the subjects participating in the study are given in Table 1.

Measurements of serum fatty acids, lipoprotein(a) and apolipoprotein concentrations

Blood was collected from the participants, who were instructed not to eat breakfast in preparation for a fasting blood test in the morning. The measurements were approved by the Medical Ethical Committee of the Institute. Serum was separated and stored at –80°C until analysis. Biochemical measurements were completed within 3 months.

For fatty acid analysis, the serum fatty acids were first esterified with 3% HCl/methanol reagent, and then 50 µL of pentadecanoic acid in hexane (1.5 mg/mL) was added to the sample as an internal standard to quantify serum fatty acids. The samples were heated at 100°C for 2 h under argon gas. Gas liquid chromatography was performed with a gas chromatograph (Shimadzu GC-14B; Kyoto, Japan). Fatty acid methyl esters were analysed with a silica Ulbon/HR-SS-10 capillary column (0.32 mm i.d. × 50 m, Ulbon; Kyoto, Japan). The carrier gas was helium at a flow rate of 3.4 mL/min. The split ratio was 30:1. Both the injection port and detector temperatures were kept at 250°C. The column temperature was programmed from 130 to 220°C at a rate of 3°C/min. The fatty acid methyl esters were detected by a flame ionization detector and were quantified using a data processor (Shimadzu CR4 A; Kyoto, Japan). The fatty acids from 14:0 to 22:6 in serum were measured in both absolute weight concentration and percentage composition from the fatty acid peak areas of the gas chromatogram.

The determination of lipoprotein(a) and apolipoprotein concentrations was performed at the Clinical Nutrition Laboratory of the National Institute of Health and Nutrition of Japan, with an immunoturbidimetric assay using an auto-analyser (Roche COBAS MIRA).

Table 1. Characteristics of the subjects

Characteristics	Rural population n = 101	Suburban population n = 96	Urban population n = 97
Age (years)	40 ± 14.7	44.0 ± 16.3	49.0 ± 16.8
Weight (kg)	46.4 ± 5.8^a	49.9 ± 7.1^b	52.6 ± 7.9^c
Female/male	1.3	1.1	1.0

a,b; b,c: $P < 0.01$. a,c: $P < 0.001$. Values in a row with different superscript letters (a–c) are significantly different at $P < 0.05$.

Statistical analysis

Data were expressed with both the mean and the standard deviation. One-way analysis of variance was followed by an F-test to compare the means of continuous variables and to evaluate significant differences between groups.

Results

Serum total fatty acids and fatty acids composition of the three Vietnamese populations

Table 2 shows the amount of total fatty acids (TFA) in serum. This amount was significantly higher in the suburban and urban populations than in the rural. The concentrations of fatty acids, saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and n-3 polyunsaturated fatty acids (n-3 PUFA) were also significantly higher in the suburban and urban populations than in the rural. Particularly, n-6 polyunsaturated fatty acid (n-6 PUFA) such as linoleic acid (18 : 2 n-6) was highest in the suburban population, lower in the urban, and lowest in the rural. Serum SFA, MUFA, n-3 PUFA and n-6 PUFA contents calculated as percentages are shown in Table 3. The percentage of SFA in serum total lipid was not statistically different among the three populations. Meanwhile, the percentage of MUFA in serum total lipid was highest in the rural population, the percentage of n-6 PUFA

Table 2. Serum total fatty acids and fatty acids composition (µg/mL) of rural, suburban and urban populations in North Vietnam

Fatty acid	Rural population n = 101	Suburban population n = 96	Urban population n = 97
TFA	2783 ± 1156^a	4174 ± 1424^b	3862 ± 1430^b
SFA	939.7 ± 411.6^a	1413.8 ± 530.3^b	1326.2 ± 514.5^b
14 : 0	25.9 ± 19.7^a	39.5 ± 25.3^b	40.4 ± 25.8^b
16 : 0	681 ± 296.8^a	1015.3 ± 407.8^b	965.2 ± 381.2^b
18 : 0	202.9 ± 94.1^a	312.0 ± 104.7^b	277.6 ± 106^c
20 : 0	5.7 ± 2.8^a	9.9 ± 3.0^b	8.7 ± 3.6^c
22 : 0	10.8 ± 4.2^a	18.3 ± 5.7^b	16.1 ± 5.9^c
24 : 0	13.5 ± 7.8^a	18.9 ± 6.8^b	18.2 ± 7.7^b
MUFA	955.5 ± 498.9^a	1309.8 ± 560.2^b	1203.1 ± 585.3^b
16 : 1	90.6 ± 55.3^a	113.0 ± 75.2^b	119.1 ± 74.4^b
18 : 1	841.7 ± 449.9^a	1161.2 ± 493.4^b	1084 ± 523.9^b
24 : 1	23.3 ± 9.2^a	35.6 ± 9.3^b	33.8 ± 12.1^b
PUFA	887.8 ± 277.3^a	1450.2 ± 407.0^b	1298.8 ± 400.3^c
n–6 PUFA	809.7 ± 251^a	1308 ± 359.3^b	1165.8 ± 357.5^c
18 : 2	624.8 ± 207.6^a	1027.5 ± 293.7^b	893.8 ± 282.4^c
18 : 3	8.5 ± 5.0^a	11.1 ± 7.6^b	11.6 ± 8.9^b
20 : 3	37.5 ± 11.1^a	49.9 ± 21.2^b	46.4 ± 18.4^b
20 : 4	138.9 ± 44.3^a	219.5 ± 69.8^b	214.1 ± 71.7^b
n–3 PUFA	78.1 ± 29.7^a	142.1 ± 56.7^b	133.1 ± 50.0^b
18 : 3	18.7 ± 12.4^a	31.3 ± 21.9^b	26.7 ± 15.6^b
20 : 5	9.0 ± 4.2^a	15.4 ± 7.8^b	14.7 ± 7.9^b
22 : 5	13.2 ± 4.9^a	18.5 ± 6.6^b	19.4 ± 8.9^b
22 : 6	37.2 ± 14.2^a	76.9 ± 32.2^b	72.3 ± 25.4^b

TFA, total fatty acids; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. Values in a row with different superscript letters (a–c) are significantly different at $P < 0.05$. Values in a row with the same superscript letters (a–c) are not statistically different.

in serum total lipid was highest in the suburban population, and the percentage of N-3 PUFA in serum total lipid was significantly higher in the suburban and urban populations than in the rural.

Serum lipoprotein(a) and apolipoprotein concentrations of the three Vietnamese populations

The distribution curve of serum lipoprotein (a) levels of Vietnamese populations did not show normal distribution; however, it was skewed towards the lower level (Fig. 1). Mean lipoprotein (a) level was 10.8 mg/dL for the rural population, 12.3 mg/dL for the suburban and 15.2 mg/dL for the urban. Lipoprotein (a) values at the 25th, median, 75th, and 90th percentiles are 6.0, 9.1, 14.5, and 26.7 mg/dL, respectively. The 90th percentile (26.7 mg/dL) of lipoprotein (a) distribution is considered to be the cut-off level for the Vietnamese populations in this study. Serum levels of apolipoprotein A–I, A–II, B, C–II, C–III and E of the three populations are shown in Table 4. These values were significantly higher in the suburban and urban populations than in the rural.

Table 3. The percentage composition of serum fatty acids of rural, suburban and urban populations in North Vietnam

Fatty acid (%)	Rural population *n* = 101	Suburban population *n* = 96	Urban population *n* = 97
SFA	33.6 ± 2.1	33.7 ± 3.1	34.3 ± 2.7
MUFA	33.3 ± 3.9[a]	30.8 ± 3.5[b]	31.1 ± 4.1[b]
PUFA	33.1 ± 4.7[a]	35.5 ± 4.9[b]	34.6 ± 4.9[b]
n–6 PUFA	30.2 ± 4.5[a]	32.1 ± 4.6[b]	31.1 ± 4.6[a]
18 : 2	23.2 ± 3.7[a]	25.2 ± 4.2[b]	23.9 ± 4.1[a]
n–3 PUFA	2.9 ± 0.5[a]	3.4 ± 0.8[b]	3.5 ± 0.7[b]
S: M: *P* *	1.00 : 1.01 : 0.94	1.00 : 0.92 : 1.02	1.00 : 0.90 : 0.97
n–6/N–3†	10.8 ± 2.0	9.8 ± 2.4	9.2 ± 2.0

Values are mean ± SD. Values in a row with different superscript letters (a–c) are significantly different at $P < 0.05$. Values in a row with the same superscript letters (a–c) are not statistically different. SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA polyunsaturated fatty acids. * The ratio of SFA to MUFA to PUFA, S: M: *P* = 1.00: 0.78: 1.43 in rural Japanese, S: M: P = 1.00: 0.72: 1.25 in urban Japanese. † the ratio of n-6 PUFA against n-3 PUFA, n-6/n-3 = 3.6 ± 1 in rural Japanese, n-6/n-3 = 3.7 ± 0.9 in urban Japanese.

Discussion

Serum fatty acids composition and fat consumption of the three Vietnamese populations

From the results in Tables 2 and 3, it was found that the suburban and urban populations had a higher fat intake than the rural. In their fat intake, the rural population consumed more fatty foods rich in MUFA than the two other populations. However, the suburban had the highest consumption of fatty foods rich in n-6 PUFA among the three populations. The suburban and urban groups had a higher consumption of fatty foods rich in n-3 PUFA than the rural, as they may consume more fish. Thus, the fat intake in quality was different in these Vietnamese populations.

It is known that the type of fat consumed may induce both atherosclerosis and thrombosis in CVD. In this study, based on the indices of thrombogenecity (IT) and atherogenecity (IA) calculated from fatty acids content cited by Ulbricht and Southgate,[6] Vietnamese populations have an IT of 0.97 and IA of 0.42 in the rural diet, 0.98 and 0.41 in the suburban diet, 1.0 and 0.43 in the urban diet, respectively. The IT of Vietnamese diets resemble closely that of the UK diet[7] (IT: 0.93, IA: 1.21), but the IA of Vietnamese diets is similar to that of the Japanese diet[1] (IA: 0.4, IT: 0.4). The CHD mortality rate of the UK was about eight times higher than that of Japan in 1985,[7] while the indices of the Japanese diet resembled those

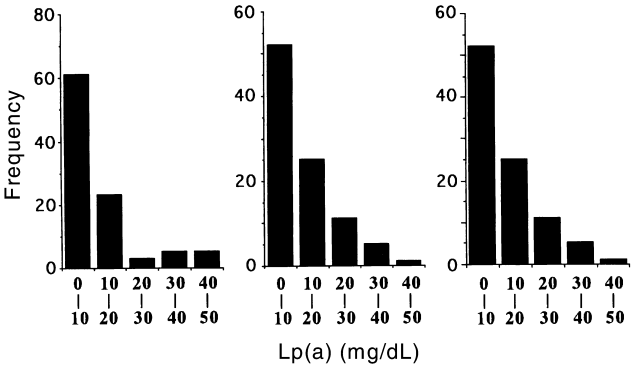

Figure 1. Distribution of serum lipoprotein (a) concentrations in rural (*n* = 101), suburban (*n* = 96) and urban (*n* = 97) populations in North Vietnam.

Table 4. Serum lipoprotein(a) and apolipoprotein levels of rural, suburban, and urban populations in North Vietnam and the Japanese

Lipoprotein(a) and apolipoprotein (mg/dL)	Vietnamese populations Rural *n* = 101	Suburban *n* = 96	Urban *n* = 97	Japanese 1995
ApoA–I	109.5 ± 21.5[a]	130.6 ± 27.2[b]	126.1 ± 35.1[b]	159.9 ± 27.7*
ApoA–II	31.9 ± 5.3[a]	35.9 ± 6.4[b]	37.6 ± 7.3[b]	37.6 ± 6.0*
ApoB	67.9 ± 22.2[a]	86.2 ± 28.1[b]	94.7 ± 35.7[c]	105.5 ± 31.3*
ApoC–II	2.8 ± 1.9[a]	3.7 ± 2.5[b]	4.4 ± 3.1[b]	4.0 ± 2.0*
ApoC–III	6.5 ± 2.9[a]	9.2 ± 5.2[b]	9.2 ± 5.5[b]	11.2 ± 4.7*
ApoE	3.6 ± 1.8[a]	4.8 ± 3.1[b]	4.7 ± 3.1[b]	5.2 ± 1.7*
Lipoprotein(a)	11.4 ± 11.8[a]	12.2 ± 9.2	15.2 ± 15.2[b]	8.8†

Values are mean ± SD. * Serum apolipoprotein levels were determined in 406 healthy Japanese. † Serum lipoprotein (a) levels were determined in 1513 healthy Japanese. Values in a row with different superscript letters (a–c) among the three Vietnamese populations are significantly different at $P < 0.05$. Values in a row with the same superscript letters (a–c) among the three Vietnamese populations are not statistically different.

of Greenland Inuit, which were 0.28 and 0.39, respectively.[1] The average per capita fish consumption of the Inuit was estimated to be about 400 g per day[8] and their low death rate from CHD has been attributed to their high intake of fish.[9] The low incidence of myocardial infarction in Japan has also been attributed to the high intake of fish and other seafood, where the amount consumed is approximately 100 g per capita per day.[10] On the contrary, fish consumption of the Vietnamese has been investigated. The results indicate only about 10 g per capita per day in the rural, 19.3 g in the suburban and 30.5 g in the urban areas. The intake of vegetable oils has also been found to be lower in the Vietnamese than in the Japanese (data not shown). Furthermore, the data in this study showed that Vietnamese diet was higher in MUFA but lower in PUFA than the Japanese diet[11] (Table 3). The ratio of n-6 to n-3 PUFA was much higher in the Vietnamese than in the Japanese[11] (Table 3). Thus, it was estimated that the low consumption of fish and vegetable oils may be a cause of the higher index of thrombogenecity in Vietnamese populations.

Serum lipoprotein(a) and apolipoprotein concentrations, risk factors for premature cardiovascular disease (CVD) of the three Vietnamese populations

Many early studies showed that lipoprotein (a) has been a strong, independent risk factor for premature CHD.[12,13] Physiologically and clinically, the atherogenic properties of lipoprotein (a) are expressed over 30 mg/dL serum concentration.[14] The cut-off levels of lipoprotein (a) of Vietnamese populations were below the range that induces atherogenic properties. Serum lipoprotein (a) levels of the Japanese also showed a distribution skewed toward the lower level, with a mean lipoprotein (a) level of 13.2 mg/dL and a cut-off level (90th percentile) of 30 mg/dL.[15]

Serum levels of apolipoprotein have also been considered to be better parameters of premature CVD than are traditional lipid risk factors. Even when the CVD patients are normolipidaemic, changes have been observed in apolipoprotein concentration. The intervention value at the 90th percentile of apolipoprotein–B is 150 mg/dL.[16] In the present study, the suburban and urban populations, with their higher total fat intake than the rural, had the higher serum levels of apolipoprotein A–I, A–II, B, C–II, C–III, and E. The values of apolipoprotein A–I and apolipoprotein–B were also observed to be substantially higher in the Japanese than in the Vietnamese populations (Table 4). The serum apolipoprotein–B levels of the three Vietnamese populations are all below this intervention value of apolipoprotein–B (150 mg/dL). Thus, risk factors for premature CVD were not observed in Vietnamese populations. However, recent 5-year statistics of the Vietnam Heart Institute showed the increase of CVD morbidity, both in CHD and hypertension related to stroke.[5] Coronary heart disease was reported to be 3.9% in 1992 and 4.5% in 1996, with hypertension diagnosed in 26.1% and 28.5% of adult CVD cases admitted to the hospital in those years, respectively.[5] The incidence of stroke also increased 3.5 to 3.7 times from 1989 to 1994 in urban areas.[17] Although the present nutritional situation of Vietnam shows that, fat intake in energy is low, a trend of increased fat consumption is observed and the increase in CVD morbidity is also reported as two major types of CVD, both coronary heart disease and stroke. These conditions may increase in the future for Vietnamese men and women. This problem will require an appropriate improvement of fat consumption habits of Vietnamese people. The problem is how to elevate the amount of dietary fat along with the balance of type of fat consumed in the diet. From a nutritional point of view, the increase of fish and vegetable oils in the Vietnamese diet is necessary for the prevention of CVD and CHD.

Conclusion

The results of this study demonstrated serum fatty acids, lipoprotein(a) and apolipoprotein compositions of the rural, suburban and urban populations in North Vietnam. From these results, the quality fat intake and risk factors for premature CVD in Vietnamese populations were estimated. The fat consumption habit of the Vietnamese was shown to be different in various districts with different incomes. These basic data may contribute to the improvement of Vietnamese diet with appropriate fat intake, not only fat quantity, but also fat quality. Even though risk factors for premature CVD were not observed in Vietnamese populations, incidents of CHD and stroke should be monitored in these populations.

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