Comparison of food constituents in the diet of female agricultural workers in Japan with high and low concentrations of high density lipoprotein in their sera

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SUMMARY   Over 300 female farmers from 18 regions in various parts of Japan were examined for high density lipoprotein cholesterol (HDL) in the serum. Based on the HDL levels, three examinees with the highest HDL and another three with the lowest HDL were selected from each region to form the high HDL group (high group, 54 subjects) and the low HDL group (low group, 54 subjects), respectively, so that any geographical effects on HDL could be excluded. The 108 subjects were examined for serum lipid biochemistry, anthropometry, and nutrient intake (by collection and analyses of 24–hour duplicates of the diet). While the HDL level in the high group (64·8 ± 11·2 mg/100 ml, mean ±SD) was significantly ($p<0·01$) higher than in the low group (31·4 ± 5·6 mg/100 ml), the low group had a higher serum triglyceride level and was more obese than the high group. Nutritional analyses of the diets taken by each group member revealed that the diets of both groups were typically Japanese (ie, low calorie intake at *ca* 2000 kcal/day, higher dependency on carbohydrate, equal amounts of protein from animals and vegetables, and large fish intake) and essentially similar ($p<0·05$) in nutritional constituents, such as total energy, carbohydrate, fibre, saturated/unsaturated fatty acid ratio or sodium chloride, except that members of the high group took significantly ($p<0·01\sim0·05$) more protein and fat (thus more of both saturated and unsaturated fatty acids). None of the nutritional items studied appeared to explain the different HDL levels in the two groups.

Since the early work of Miller and Miller,[1] the level of high density lipoprotein cholesterol (HDL) has been evaluated as a negative risk factor of coronary heart disease (CHD). Further studies indicate that diet is the main determinant of population differences in blood lipid values,[2] and discussions were extended to the possible roles of Japanese-style diet in order to maintain a high HDL level in association with prevention of CHD,[3] in the event that CHD standardised mortality ratio in Japan stays much lower than in other industrialised countries.

In the present study, two groups of Japanese female farmers, one with high HDL and the other with low HDL, were compared with regard to diet to see if there is any association of serum HDL level with a specific food constituent in current, yet traditional, Japanese diet.

Methods

POPULATION

The volunteers were adult female farmers from 18 regions of Japan. The examinations, including blood biochemistry, anthropometry, and diet analysis, were conducted in the winter seasons of 1978–81. Of 335 examines (10 to 40 examinees per region) available, three each with the lowest and highest HDL levels were selected from each region to form the low HDL group (low group; three from each of 18 regions to make up 54 members in total) and the high HDL

group (high group; 54 members), to rule out the possible effects of geographic difference in HDL levels as detected in a previous study.[4]

HEALTH EXAMINATION PROCEDURE

Examination design and blood sampling were as previously described.[4] Body weight and body height without shoes and jacket were measured to the nearest 0·1 kg and 0·1 cm, respectively. Correction for weight of clothes other than shoes and jacket was made by subtracting 1·0 kg from the weight. Obesity index was calculated as the difference (percentage) from the ideal body weight,[5] namely:

Obesity index (%) =

$$\frac{\text{body weight (kg)} - \text{ideal body weight (kg)}}{\text{ideal body weight (kg)}} \times 100$$

where ideal body weight (kg) is defined as

$$\left[\text{body height (cm)} - 100\right] \times 0 \cdot 9.$$

Skinfold thickness in triceps and infrascapular regions was measured twice to the nearest 0·5 mm using a skinfold caliper (Meikou-sha Co, Tokyo, Japan) and the mean was taken as the representative value.

ANALYSIS OF 24 H DUPLICATE OF DIET

The collection of a 24 h duplicate of a whole day's diet[6] [7] was started from lunch on the day and included soft drinks, green tea, and even plain drinking water. Provision (eg, exclusion of any social occasion such as new year, birthday, or wedding) was made to ensure that the samples collected would be typical of the usual daily diet. The samples were taken in plastic containers, kept chilled, and sent to the laboratory via air cargo. Each diet constituent was isolated, weighed, and recorded. Total energy, protein, fat, carbohydrate (nonfibrous), and fibre were calculated according to the Standard Tables of Food Composition.[8] Calculation of saturated and unsaturated fatty acid intake was based on the Appendix (fatty acid constituent section) to the Standard Tables of Food Composition,[9] supplemented with other data[10–13] when necessary. The sodium chloride content in the diet was calculated from the chloride ion concentration in diet homogenate which was measured with a Clinical Chloride Counter (Model DL–5M; Hirayama Sangyo & Co Ltd, Mito, Japan).

LIPID BIOCHEMISTRY OF SERUM

Determinations of HDL, total cholesterol (TC) and triglyceride (TG) were carried out as previously described.[4]

STATISTICAL ANALYSES

Normal distribution was considered throughout the study to be as in the previous report.[4] The relation between HDL and other variables was evaluated using a correlation analysis. Student's t-test was used to examine the difference in HDL and other variables between the high group and the low group.

Data were analysed using a statistical package program supplied by Nippon Electric Co (Tokyo, Japan) for the ACOS System 1000 in the Computer Center, Tohoku University.

Results

Comparison of HDL and other serum lipid levels, anthropometry, and results of diet analysis between the high and low groups are summarised in table 1.

Table 1 *Comparison of HDL and other lipids, anthropometric parameters, and nutrient components between the high and low groups*

Items (units)	High	Low
Age (years)	43·9 ± 8·3	47·1 ± 7·4*
Serum lipids		
HDL[a] (mg/100 ml)	64·8 ± 11·2†	31·4 ± 5·6
TC[b] (mg/100 ml)	205·4 ± 35·4	195·8 ± 35·4
HDL/TC	0·32 ± 0·07†	0·17 ± 0·04
TG[c] (mg/100 ml)	87·2 ± 33·3	154·8 ± 97·1†
Anthropometry		
Body weight (kg)	51·0 ± 7·1	55·3 ± 7·7†
Obesity index (%)[d]	10·4 ± 16·6	20·3 ± 15·2†
Skinfold thickness (mm)	34·0 ± 16·2	40·9 ± 13·4*
Diet analysis		
Total energy (kcal/day)	2126 ± 475	1981 ± 452
Protein (g/day)	85·0 ± 26·9	71·6 ± 22·9
Animal protein (g/day)[e]	34·0 ± 15·5 (40·1 ± 12·9%[g])	30·9 ± 14·3 (42·3 ± 13·9%[g])
Fish protein (g/day)[f]	17·8 ± 12·0 (51·7 ± 26·5%[h])	19·0 ± 13·3 (60·4 ± 27·6%[h])
Fat (g/day)	49·4 ± 18·0*	41·8 ± 15·3
Saturated fatty acid (g/day)	12·9 ± 5·7*	10·3 ± 5·8
Unsaturated fatty acid (g/day)	35·0 ± 13·6*	29·2 ± 10·9
Saturated/Unsaturated ratio	3·01 ± 1·16	3·31 ± 1·17
Carbohydrate (g/day) (non-fibrous)	339·0 ± 88·9	319·3 ± 88·5
Fibre (g/day)	5·7 ± 1·9	5·2 ± 1·8
Sodium chloride (g/day)	14·3 ± 4·1	12·7 ± 3·8

Notes to Table 1
High and low groups mean high-HDL and low-HDL groups. For detailed definition, see Methods.
Numbers in the table are means ± SDs.
[a] HDL = high density lipoprotein cholesterol.
[b] TC = total cholesterol.
[c] TG = triglyceride.
[d] For definition, see Methods.
[e] Including fish and shellfish protein.
[f] Including shellfish protein.
[g] The ratio of animal protein to total protein (%).
[h] The ratio of fish protein to animal protein (%).
*,† The value is significantly (*p<0·05; †p<0·01) higher.

As the difference in age distribution between the two groups was of marginal significance ($p \doteq 0.05$), no correction for age was considered necessary in conducting the comparison. As designed, the HDL levels differed significantly ($p<0.01$) between the two groups; the mean HDL level in the high group (the three highest from each region) was more than twice as high as the corresponding HDL level in the low group (the three lowest from each region). As the TC level remained comparable, the HDL/TC ratio was also significantly ($p<0.01$) higher in the high group. Conversely triglyceride (TG) level was significantly ($p<0.01$) higher in the low group. Such a high TG level in the low group was in accord with the observation that members of the low group were more obese (heavier with larger obesity index and thicker skinfold) than the members of the high group. Other epidemiological studies have also disclosed that serum TG is higher and HDL lower in obese subjects.[14][15]

Nutrient analysis of the 24 h duplicates of diet revealed that total energy intake was essentially comparable in the two groups at a level of *ca* 2000 kcal/day, in contrast to the anthropometric results. In fact the high group took more protein and fat than the low group. Both groups obtained about 64% of total energy from non-fibrous carbohydrate. About 60% of total protein was from vegetables. Of the remaining 40% total protein from animals, fish and shellfish accounted for 50 to 60% in both groups. Further analysis showed that the intake of both saturated and unsaturated fatty acids was significantly ($p<0.05$) higher in the high group than in the low group. The ratio of saturated to unsaturated fatty acids, however, remained unchanged between the two groups.

Other nutrient constituents were essentially the same in both groups. A study of the relation of HDL to any nutrient items (ie, total energy, protein, fat, non-fibrous carbohydrate, fibre, and sodium chloride) on an individual basis failed to show significant correlations ($r = -0.13$ to 0.27, $p>0.05$) in either the high or low group.

Discussion

The Agricultural Policy Council of Japan, in its October 1980 report, characterised Japanese-style diet as follows:[16]:

1 low total energy;

2 relatively high dependence on carbohydrate as a source of energy;

3 equal quantities of animal and vegetable protein with more fish and shellfish as animal protein.

Such characteristics can be readily confirmed by a comparison of the nutritional consumption patterns of Japan and other industrialised countries (table 2). Taking these criteria as the definition for Japanese-style diet, the 24 h duplicates of diet submitted by the present volunteers can be considered typical of the food that farmers eat. Independent of HDL level, the food of the female farmers was rather low in total energy (*ca* 2000 kcal/day), about 64% of total energy being accounted for by carbohydrate. Protein was obtained from vegetables and animals, with a larger proportion from fish. Despite the fact that both groups ate a typical and similar Japanese-style diet, the HDL level in one group was twice as high as in the other. Such findings appear to suggest that the simple analysis of diet, summarised in the lower half of table 1, will not explain, from the nutritional view point, the difference in HDL level.

Saturated fatty acids in the diet have been attracting attention in relation to CHD. Keys and other participants in the Seven Countries Study observed that the risk of early death is increased by saturated fatty acids in the diet in populations in which CHD is a major cause of death,[18] and Shekelle *et al* also concluded in the Western Electric Study that the lipid composition of the diet affects the risk of coronary death in middle-aged American men,[19] whereas Becker *et al* observed that the HDL level remained unaffected by dietary fatty acid in the blood of volunteers who for 28 days took diets rich in saturated, monounsaturated or polyunsaturated fatty acids.[20] In the present study, however, the saturated: unsaturated fatty acid ratio in the diet is similar for both high and low groups, even though the high group took significantly ($p<0.05$) more fat than the low group. Thus the findings do not permit us to conclude that there is a possible selective association between either saturated or unsaturated fatty acid and a high HDL level.

It is well established that various aerobic long term exercises are associated with raised levels of HDL.

Table 2 *Comparison of food consumption in Japan and other industrialised countries*

	Japan	USA	The Netherlands	FRG
Total energy (kcal/day)	2568	3393	3421	3397
Energy from crop products (%)	79	62	60	55
Protein (g/day)	82.2	106.3	97.1	98.4
Animal protein (%)	44	70	67	68

Calculated from Organisation for Economic Co-operation and Development.[17]

For example, long-distance runners[21] and cross-country skiers[22] have higher HDL levels than matched controls. It was also observed previously that the physical load in farming is presumably variable, depending on the type of agriculture, being heaviest in dairy farming and lightest in mechanised rice production.[23] No information was, however, available in the present study to suggest a possible difference in physical activity between members of the high and low groups; because the three volunteers from the high group and the three from the low group from a given region were engaged in the same form of agriculture. Nevertheless the possibility cannot be ruled out that those in the high group are physically more active than those in the low group, as the lower body weight and lower obesity index coupled with an essentially equal calorie intake suggest, and that such higher physical activity may result in raised HDL levels.

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