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A Comparative Study of Serum Proteins, Lipids, Calcium and Inorganic Phosphorus between Japanese and Dutch University Students.

Yoshimi OHNO*[1], Kazuko HIRAI*[2] and Hisa HIGUCHI*[3]

*[1]*Department of Food Sciences and Nutrition, School of Human Environmental Sciences, Mukogawa Women's University, Hyogo*
*[2]*Department of Nutritional Biochemistry, Faculty of Human Life Science, Osaka City University, Osaka*
*[3]*Osaka Joshigakuen Junior College, Osaka*

Abstract

The levels of serum proteins, lipids and minerals in Japanese and Dutch students measured by biochemical methods were compared and their correlation with the nutritional status were investigated. The mean values of serum total proteins (TP), albumin (Alb), globulin (Glb) and albumin/globulin (A/G) ratio in the Japanese students (7.8±0.5, 4.7±0.3 and 3.2±0.4g/dl, and 1.5±0.2, respectively) were similar to those of the Dutch students (7.8±0.5, 4.7±0.3 and 3.0±0.3g/dl, and 1.6±0.2, respectively). However, the mean value of TP in males (8.0±0.5g/dl for the Japanese and 8.0±0.4g/dl for the Dutch) was significantly higher than this in females (7.7±0.3g/dl for the Japanese and 7.5±0.5g/dl for the Dutch) in the each group ($p<0.01$) and the mean value of Alb of male Dutch students (4.9±0.2g/dl) was higher than that in females (4.5±0.3g/dl, $p<0.01$). No significant differences were found between the two groups in serum lipid and mineral levels. The serum phospholipid (PL) level in female Dutch students (217±37mg/dl) was significantly higher than that in males (188±25mg/dl, $p<0.01$), while the serum triglyceride (TG) level in female Japanese students (60±25mg/dl) was significantly lower than that in males (74±33mg/dl, $p<0.05$), which agreed with the frequency distribution patterns of these lipids. Comparing the two student groups of both countries, there were significant positive correlations between TP and Alb ($p<0.001$ for both groups), TP and Glb ($p<0.001$ for both groups) and Alb and A/G ratio ($p<0.001$ for the Japanese and $p<0.01$ for the Dutch) in each group. A significant negative correlation between Glb and A/G ratio ($p<0.001$) was also found in each group. Significant positive correlations were also observed between PL and TG ($p<0.01$ for the Japanese and $p<0.05$ for the Dutch), PL and total cholesterol (TC) ($p<0.001$ for each group) and TG and TC ($p<0.01$ for the Dutch). The serum PL and TC increased significantly with the serum TP in the Japanese students ($p<0.01$ for PL and TP, $p<0.05$ for TG and TP) but not in the Dutch students. The authors concluded that serum protein, lipid and mineral profiles between the two groups did not differ much in spite of their different eating patterns.

Key words: Serum proteins, Serum calcium, Serum lipids, Young Japanese, Young Dutch

Introduction

According to epidemiological studies, dietary fat content and excess intake of animal foods can influence the levels of serum lipids and can cause diseases such as hypertension, cardiovascular diseases and arteriosclerosis.[1-4] On the other hand, in Japan, low calcium intake has been indicated in the occurrence of osteoporosis in elderly people. These findings remind us the importance of food intake in maintaining good health. The average daily food consumption pattern of Japanese differs greatly from that of the Dutch.[5-9] The consumption of fish and legumes by the Dutch is very low (about one-fourth and a half of the Japanese, respectively) while the consumption of milk and dairy products, edible fats and sugars and sweets by the Dutch is about 3 to 5 times, 3 times and 2.6 to 3 times more than that by the Japanese, respectively.[5-9]

Recently, blood profiles are used as one of the methods for

Reprint requests to: Yoshimi Ohno,
Department of Food Science and Nutrition, School of Human Environmental Sciences, Mukogawa Women's University, 6-46, Ikebiraki, Nishinomiya, Hyogo 663, Japan.
TEL: +81 (798) 47-1212 (Ext. 5726), FAX:+81 (798) 45-3566

the evaluation of nutritional status of people. It would be interesting to investigate whether these food preferences influence blood components. Therefore, the authors examined the serum proteins, lipids, calcium and inorganic phosphorus components of university students in Japan and the Netherlands. The values for the two groups were compared and the nutritional status of these young adults was evaluated.

Methods

Subjects

Healthy university students (18-23 years old, 58 males and 45 females in Osaka, Japan; 18-28 years old, 20 males and females each in Wageningen, the Netherlands) participated in the present study. Blood samples were taken in the early morning after an overnight fast.

Blood components examined

The items examined were total protein (TP), albumin (Alb), globulin (Glb), Alb/Glb (A/G) ratio, phospholipids (PL), triglycerides (TG), total cholesterol (TC), calcium (Ca), inorganic phosphorus (IP) and Ca/IP ratio. TP, Alb, Ca and IP were measured by colorimetric methods (TP, Alb, Ca: Daiichi Chem. Co., Tokyo; IP: Wako Pure Chem. Ltd., Osaka, Japan). Serum Glb was calculated by subtracting the Alb value from the TP value, and the A/G ratio was estimated. PL, TG and TC were analyzed by enzymatic methods using clinical chemicals (TG and TC: Daiichi Chem. Co., Tokyo; PL: Wako Pure Chem. Ltd., Osaka, Japan).

Statistical analysis

Results are expressed as mean ± SD and were treated by Student's t-test. Pearson's correlation coefficients were used to examine the relationship between the variables.

Results

The mean values of serum protein, lipid, Ca and IP contents are summarized in Table 1. The mean values of serum TP, Alb and Glb levels of Japanese students were 7.8±0.5, 4.7±0.3 and 3.2±0.4g/dl, respectively. These values did not differ significantly from those of Dutch students (7.8±0.5, 4.7±0.3 and 3.0±0.3g/dl, respectively). Significant differences were observed between genders with regard to levels of serum TP (in both groups) and Alb (in the Dutch), which were higher in males than in females ($p<0.01$).

The PL level of female Dutch students was significantly higher than that of the males ($p<0.01$, Table 1), while the TG in female Japanese students was significantly lower than that in males ($p<0.05$). The serum lipid levels did not differ significantly between the two student groups, but the frequency distribution patterns of these three lipids for Japanese students differed from those for Dutch students (Fig. 1). The percent of female Dutch students with over 220mg/dl of PL was much higher than that of Japanese or male Dutch students. The frequency distribution patterns of TG and TC in each group were similar, respectively. However the proportion of TG for the male students in both groups shifted to be higher ranges and that of over 190mg/dl of TC tended to be lower ranges for male Dutch students.

No significant statistical differences in serum Ca and IP concentrations were observed between the two student groups and genders (Table 1). However, as shown in Fig. 2, the frequency distribution pattern of IP for Japanese was similar to that of Ca for Dutch students. The proportion of over 3.5mg/dl of IP was lower for Japanese students (about 20%) and that of Ca ranged 9.0-10.2mg/dl was higher for Dutch students which constituted of 50% of the total.

Table 2 shows the correlation coefficients for the serum parameters examined. There were significant positive correlations between TP and Alb ($p<0.001$ for both group), TP and Glb ($p<0.001$ for both groups), and Alb and the A/G ratio ($p<0.001$ for the Japanese, $p<0.01$ for the Dutch). A significant negative relationship between Glb and the A/G ratio ($p<0.001$) was observed in both groups. However, significant negative correlation between TP and the A/G ratio ($p<0.001$) was only observed in the Japanese group.

Positive correlations between PL and TC ($p<0.001$ for both groups) and PL and TG ($p<0.01$ for the Japanese, $p<0.05$ for the Dutch) were found in both groups while the correlation between TG and TC was significant only among the Dutch students ($p<0.01$). Significant positive correlations were found between TP and PL ($p<0.01$) and TP and TG ($p<0.05$) in the Japanese. Moreover, the significant correlations between Ca and TP ($p<0.05$), between Ca and Alb ($p<0.05$) and between Ca and IP ($p<0.05$) found in the Japanese were not observed in the Dutch students. A positive correlation was also shown between Ca and the Ca/IP ratio ($p<0.001$ for the Japanese, $p<0.01$ for the Dutch) but a negative correlation between IP and the Ca/IP ratio ($p<0.001$) was shown in both groups.

Table 1 Serum protein, lipid and mineral levels in Japanese and Dutch students (*Mean±SD).

		Japanese students			Dutch students		
		Total (n=103)	Males (n=58)	Females (n=45)	Total (n=40)	Males (n=20)	Females (n=20)
TP	(g/dl)	7.8 ± 0.5	8.0 ± 0.5**	7.7 ± 0.3**	7.8 ± 0.5	8.0 ± 0.4**	7.5 ± 0.5**
Alb	(g/dl)	4.7 ± 0.3	4.7 ± 0.3	4.6 ± 0.3	4.7 ± 0.3	4.9 ± 0.2**	4.5 ± 0.3**
Glb	(g/dl)	3.2 ± 0.4	3.3 ± 0.4	3.0 ± 0.3	3.0 ± 0.3	3.1 ± 0.3	3.0 ± 0.3
A/G	Ratio	1.5 ± 0.2	1.5 ± 0.2	1.5 ± 0.2	1.6 ± 0.2	1.6 ± 0.2	1.5 ± 0.2
PL	(mg/dl)	195 ± 28	192 ± 28	200 ± 26	202 ± 35	188 ± 25**	217 ± 37**
TG	(mg/dl)	68 ± 30	74 ± 33*	60 ± 25*	65 ± 31	65 ± 34	64 ± 29
TC	(mg/dl)	196 ± 29	192 ± 30	201 ± 26	187 ± 36	178 ± 34	195 ± 38
Ca	(mg/dl)	10.5 ± 1.2	10.6 ± 1.1	10.3 ± 1.4	10.2 ± 1.0	10.4 ± 1.3	10.0 ± 0.7
IP	(mg/dl)	3.2 ± 0.4	3.2 ± 0.4	3.3 ± 0.3	3.5 ± 0.5	3.4 ± 0.5	3.6 ± 0.4
Ca/IP	Ratio	3.3 ± 0.6	3.4 ± 0.6	3.2 ± 0.6	3.0 ± 0.6	3.1 ± 0.7	2.8 ± 0.4

Statistical differences between the genders (*$p<0.05$, **$p<0.01$).
Abbreviations: TP, total proteins; Alb, albumin; Glb, globulin, A/G Ratio, albumin/globulin ratio; PL, phospholipids; TG, triglycerides; TC, total cholesterol; Ca, calcium; IP, inorganic phosphorus; Ca/IP Ratio, calcium/inorganic phosphorus ratio.

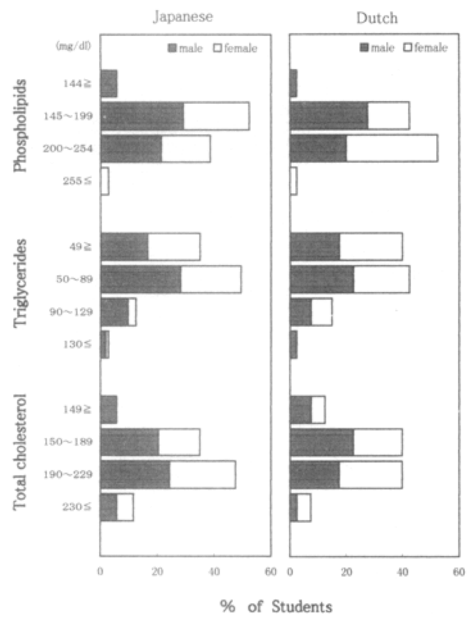

Fig. 1 Frequency distribution patterns of serum phospholipids (upper), triglycerides (middle) and total cholesterol (lower) contents of Japanese and Dutch students.

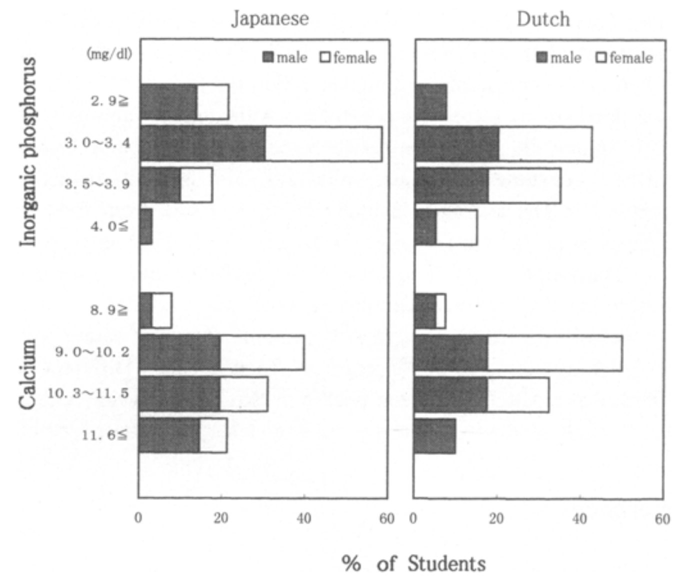

Fig. 2 Frequency distribution patterns of serum inorganic phosphorus (upper) and Calcium (lower) contents of Japanese and Dutch students.

Table 2 Correlation between various parameters examined.

	TP	Alb	Glb	A/G Ratio	PL	TG	TC	Ca	IP	Ca/IP Ratio
TP		0.499***	0.798***	-0.482***	0.270**	0.208*	0.165	0.200*	0.040	0.118
Alb	0.759***		-0.153	0.501***	0.305**	0.179	0.259**	0.233*	-0.062	0.151
Glb	0.746***	0.132		-0.912***	0.085	0.106	0.001	0.133	0.087	0.018
A/G Ratio	-0.222	0.459**	-0.807***		0.056	0.002	0.116	-0.047	-0.104	0.047
PL	-0.159	-0.297	0.061	-0.262		0.273**	0.804***	0.150	0.020	0.105
TG	-0.084	-0.114	-0.011	-0.061	0.397*		0.170	0.200*	0.010	0.150
TC	-0.021	-0.118	0.089	-0.178	0.902***	0.430**		0.089	-0.025	0.273**
Ca	0.182	0.265	0.007	0.162	-0.184	-0.085	-0.246		-0.213*	0.788***
IP	0.085	0.004	0.125	-0.139	0.143	0.034	0.165	-0.009		-0.760***
Ca/IP Ratio	0.028	0.159	-0.120	0.239	-0.184	-0.085	-0.238	0.554**	-0.810***	

Upper right, Japanese (n=103); lower left, Dutch students (n=40).
*p<0.05, **p<0.01, ***p<0.001
Abbreviations: see Table 1.

Discussion

The mean values of various parameters examined in Japanese and Dutch students except for a few results, were similar and mostly within normal ranges. The levels of serum TP (in both groups) and Alb (in the Dutch) were higher in males than in females (p<0.01) while the PL level of female Dutch students was significantly higher than that of the males (p<0.01). Moreover, the TG in female Japanese students was lower than that of the males (p<0.01). These differences could not be explained clearly because there was no data of actual food intakes for the two groups. Therefore in the light of food intake the authors need to utilize results reported by other researchers.[5-9]

Serum TP and Alb levels suggested that whether the subjects have consumed enough food for their nutritional requirements. Recently, it has been pointed out that the fatty acid composition of lipids contained in food is as important as their contents[10-13] and that not only the quantity but also the quality of dietary proteins and fats affect the metabolic process.[14, 15] Serum lipid levels change with aging, obesity, dietary factors and the physiological status of the people.[16, 17] Aubert et al reported that the serum PL content was higher in obese mice than in normal ones.[18] Energy and carbohydrate intakes are related to the serum TG concentration. The proportion of energy intake from cereals (which contain much carbohydrate) among the Japanese (about 1200kcal/person/day) was higher than that of the Dutch (620kcal/person/day).[5-9] Dietary assessment of the Dutch revealed that 40.5% of their total energy intake was derived from fat, while it was 25.5% among the Japanese.[5-9,16] However, the authors found that young females in Japan tend to restrict the intake of carbohydrate in order to control their body weight (unpublished data). Although it was not clear whether the PL level of female Dutch students was significantly higher among the subjects in this study, the low levels of TG of female Japanese students might reflect such eating patterns. The significant positive correlation between PL and TC (p<0.001) agrees with the finding of another report.[19]

The rate of Ca absorption in the intestine differs greatly with food[20-22] and the amounts of Ca contained in food items (the bioavailabilities of Ca in milk, small fish and vegetables are about 50, 39 and 24%, respectively). An increase of the amount of potein intake increases the demand of Ca.[23] However, the serum Ca level does not elevate markedly even in the case of its higher bioavailability.[20] Another factor needed to be considered is the dietary Ca/IP ratio which is related to the bioavailability of Ca.[24] Akimoto et al showed that in rats, excess phosphorus in the diet resulted in a decrease of food intake, which led to lower Ca intake and a decrease in serum Ca content.[25] Although the amounts of protein intake did not differ between the Netherlands and Japan, the Dutch consume more meat, milk and dairy products than the Japanese.[5-9] The average Ca intake of the Japanse from food is 539mg/person/day[5] while that of the Dutch is 1121±382mg/person/day.[9] The dietary Ca/IP ratio was 0.8 for the Dutch and 0.4 for the Japanese as calculated from recent reports of food intake.[5-9]

All of these findings suggest the important role of eating patterns, such as excessive or "appropriate" food intakes. Differences in food intake patterns between people in two countries may affect their physiological metabolic processes and lead to differences of frequency distribution patterns of lipids and minerals, even though the mean values of each parameter examined may not differ significantly. Therefore, such physiological metabolic status may also explain the correlation of TP or Alb with PL, TG, TC or Ca. Food intake surveys and additional experimental studies in both counties need to be performed in order to elucidate the relationship between eating patterns and physiological status.

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References

1) Kagawa Y et al. Eicosapolyenoic acids of serum lipids of Japanese islanders with low incidence of cardiovascular diseases. J Nutr Sci Vitaminol 1982; **28**: 441-53.
2) Herold PM, Kinsella JE. Fish oil consumption and decreased risk of cardiovascular disease. A comparison of findings from animal and human feeding trials. Am J Clin Nutr 1986; **43**: 566-78.
3) Sattery ML, Randall DE. Trends in coronary heart disease mortality and food consumption in the United States between 1909 and 1980. Am J Clin Nutr 1988; **47**: 1060-7.
4) Stephen AM, Wald NJ. Trends in individual consumption of dietary fat in the United States, 1920-1984. Am J Clin Nutr 1990; **52**: 457-67.
5) Ministry of Health and Welfare: Kokumin no eiyo no genjo (The results of National Nutrition Survey, 1994, Japanese), 1996.
6) van Dokkum W, de Vos RH, Cloughley FA, Hulshof KFAM, Dukel F, Wijisman JA. Food additives and food components in total diets in the Netherlands. Br J Nutr 1982; **48**: 223-31.
7) Baeck JAH, van Staveren WA, Burema J. Food consumption, habitual physical activity, and body fatness in young Dutch adults. Am J Clin Nutr 1983; **37**: 278-86.
8) Kromhout D et al. Food consumption pattern in the 1960s in seven countries. Am J Clin Nutr 1989; **49**; 889-94.
9) Kromhout D, Coulander C de L, Obermann de Boer GL, van Kampen-Donker M, Goddija E, Bloemberg BPM. Changes in food and nutrient intake in middle-aged men from 1960 to 1985 (the Zutphen study). Am J Clin Nutr 1990; **51**: 123-9.
10) Kinsella JE. Food components with potential therapeutic benefits: The n-3 polyunsaturated fatty acids of fish oils. Food Technol 1986; **146**: 89-97.
11) Lee JH, Sugano M, Ide T. Effects of various combination of ω-3 and ω-6 polyunsaturated fats with saturated fat on serum lipid levels and eicosanoid production in rats. J Nutr Sci Vitaminol 1988; **34**: 117-29.
12) Lopes SW, Trimbo SL, Mascioli EA, Blacburn GL. Human plasma fatty acid variations and how they are related to dietary intake. Am J Clin Nutr 1991; **53**: 628-37.
13) Chan JK, Bruce VM, McDonald BE. Dietary α-linolenic acid is as effective as oleic acid and linoleic acid in lowering blood cholesterol in normolipidemic men. Am J Clin Nutr 1991; **53**: 1230-4.
14) Sugano M. Nuritional studies on the regulation of cholesterol metabolism: The effects of dietary protein. J Jpn Soc Nutr Food Sci 1987; **40**: 93-102.
15) Maruyama C, Ezawa I. The effect of milk and skim milk intake on serum lipids and apoproteins in young females. J Nutr Sci Vitaminol 1991; **37**: 53-62.
16) Kromhout D. Body weight, diet, and serum cholesterol in 871 middle-aged men during 10 years of follow-up (the Zutphen study). Am J Clin Nutr 1983; **38**: 591-3.
17) Azuma T et al. A survey on the relation of obesity with blood levels among the employees in a section of government office. Jpn J Nutr 1986; **44**: 343-7.
18) Aubert R, Camus MC, Bourgeois F, Herzog J, Lemonnier D. Serum lipoproein profiles in mice: Effects of early over-and undernutrition. J Nutr 1988; **118**: 1190-6.
19) Kuzuya F. Epidemiological study of hyperlipidemia in Japanese. Jpn J Clin Nutr 1981; **58**: 569-79.
20) Azami S, Hiratsuka S, Kitano T, Esashi T. Effects of dietary casein and soy protein isolate on calcium, phosphorus and magnesium balance in female rats. Jpn J Nutr 1989; **47**: 103-12.
21) Weaver CM. Assessing calcium status and metabolism. J Nutr 1990; **120**: 1470-3.
22) Heaney RP, Weaver CM, Fitzsimmons ML. Soybean phytate content: Effect on calcium absorption. Am J Clin Nutr 1991; **53**: 745-7.
23) Kaneko K et al. Urinary calcium and calcium balance in young women affected by high protein diet of soy protein isolate and adding sulfur-containing amino aids and/or potassium. J Nutr Sci Vitaminol 1990; **36**: 105-16.
24) Hoek AC, Lemmens AG, Mullink JWMA, Beynen AC. Influence of dietary calcium: Phosphorus ratio on mineral excretion and nephrocalcinosis in female rats. J Nutr 1988; **118**: 1210-6.
25) Akimoto M, Suzuki K, Endo Y, Goto S. Effect of excess phosphorus diet of calcium, phosphorus and magnesium metabolism in rats. Jpn J Nutr 1986; **44**: 79-86.

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