

Correlation of Diet and Serum Cholesterol Level with Serum Lipid Fatty Acid Composition.* (27306)

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A number of studies(1-4) have shown that the serum lipid fatty acid spectrum and blood cholesterol level are altered by feeding carefully controlled diets rich in polyunsaturated fatty acids. Such diets produce an increase in the percentage of those acids in the serum lipid fractions and a lowering of blood cholesterol level. Also, a decrease in percentage of linoleic acid in the serum lipid fraction with advancing age, hypercholesterolemia and hyperlipemia has been reported(5, 6). The findings suggest that there is a relationship between level of linoleic acid in serum lipid fractions and blood cholesterol level. The investigation reported here was concerned with the effect of family diet patterns, high and low in linoleic acid, on fatty acid composition of the serum lipid fractions of clinically healthy subjects with normal and elevated serum cholesterol levels. Such practical and relatively non-restrictive diets have previously been shown to be effective in lowering and elevating the serum cholesterol level(7) of normal subjects.

Methods and materials. There were 2 groups of subjects. Group I consisted of 10 healthy individuals (average age 34 years) with serum cholesterol levels in the approximate range of 150-250 mg%. Fasting blood samples were obtained from each for 5 weekly intervals while on their usual diet; then the whole household in which each subject resided was placed on a dietary pattern rich in linoleic acid(7). Blood samples were obtained at the end of 10 weeks. The diet was then changed to one low in linoleic acid (7), and blood samples obtained at the end of 10 weeks. The second group (Group II) (average age 43 years) consisted of 16 clinically healthy subjects and one with known ischemic heart disease, all with elevated serum cholesterol levels in the approximate

range of 250-400 mg%. Blood samples were obtained for 4 weekly intervals prior to placing the individuals on the high linoleic acid diet, and at the end of 10 weeks thereafter. Average fat intake of the subjects of both groups while on those diets was estimated at 100-125 g per day; the changes introduced into the diet did not affect total fat intake, but the ratio of saturated and monounsaturated fatty acids to linoleic acid. The normal diet (before any diet change) had approximately 9-11% of its fat calories as linoleic acid; the diet rich in linoleic acid 20-25%; the diet low in linoleic acid had 4-6%.

Total serum cholesterol level was determined by the method of Sperry and Webb (8). The serum lipid fractions (cholesterol esters, triglycerides and phospholipids) were separated on silicic acid and their fatty acid composition determined by gas-liquid chromatography as previously described(9). Statistical analyses were carried out by the "t" test. $P < .05$ was considered to be significant and $P < .01$ highly significant.

Results. Cholesterol esters (Table I). The high linoleic acid diet produced a slight elevation in percentage of linoleic acid in the cholesterol ester fraction of Group I; this was found to be not significant. However, there was a significant decrease in serum cholesterol level from 212 mg% to 186 mg%. When those subjects (Group I) were transferred to the low linoleic acid regimen there were highly significant decreases in percentages of linoleic and arachidonic acids, and proportionate increases in percentages of the saturated and monounsaturated fatty acids. The low linoleic acid regimen increased the serum cholesterol level significantly above the high linoleic acid dietary period. In Group II subjects the high linoleic acid regimen produced a highly significant increase in percentage of linoleic acid with a concomitant decrease in percentage of oleic acid. The se-

* This work was supported in part by U. S. Public Health Service Grant.

TABLE I. Effect of Dietary Regimens on Serum Cholesterol Ester Fatty Acid Composition.

Fatty acid*		Group I†			Group II‡	
Chain length carbons	No. double bonds	Before dietary change	10 wk high linoleic	10 wk low linoleic	Before dietary change	10 wk high linoleic
% TOTAL FATTY ACIDS						
6 to 14		1.7 ± .6§	1.6 ± .5	2.7 ± .7	2.2 ± .6	2.2 ± .5
16	0	15.6 ±1.6	17.0 ±2.5	17.7 ±1.4	17.4 ±3.1	17.3 ±1.8
16	1	3.7 ±1.6	2.9 ± .7	4.4 ±1.1	4.2 ±1.4	3.1 ± .8
16	2	.2 ± .1	.3 ± .1	.3 ± .1	.3 ± .1	.3 ± .1
18	0	2.4 ± .5	2.6 ±1.1	3.9 ± .9	3.5 ± .8	2.7 ± .6
18	1	21.8 ±3.1	19.4 ±2.4	25.1 ±2.5	24.5 ±3.0	19.3 ±2.5
18	2	47.5 ±5.4	49.6 ±5.4	40.2 ±3.9	41.9 ±6.0	48.6 ±4.1
18	3	.5 ± .2	.6 ± .2	.8 ± .3	.8 ± .2	.7 ± .4
20	0	.3 ± .1	.4 ± .2	.5 ± .2	.6 ± .2	.5 ± .3
20	3	.4 ± .1	.3 ± .1	.3 ± .1	.4 ± .1	.4 ± .1
20	4	5.9 ±1.4	5.3 ± .6	4.1 ± .5	4.2 ± .8	4.9 ± .9
Serum cholesterol, mg%		212 ± 29	186 ± 26	236 ± 43	293 ± 43	231 ± 35

* Represents major fatty acids determined; small amounts of others were also detected.

† Values represent average of 10 subjects with initial serum cholesterol level of 150-250 mg%.

‡ Values represent average of 17 subjects with initial serum cholesterol level of 250-400 mg%.

§ Standard deviation.

rum cholesterol level of that group decreased significantly from 293 mg% to 231 mg% during that dietary period. Comparison of the cholesterol ester fatty acid spectrum of Group I and II subjects while on their control diets indicated that Group II subjects had significantly less linoleic and more oleic acid than Group I subjects. Also, at the end of 10 weeks on the high linoleic acid regimen both groups had virtually the same cholesterol ester fatty acid spectrum.

Triglycerides (Table II). The principal changes in the serum triglyceride fatty acids of both groups were in percentages of oleic and linoleic acids. While on the high linoleic acid regimen, Group II subjects showed a highly significant increase in level of linoleic acid with proportionate decreases in percentages of oleic and saturated fatty acids. The slight increase in percentage of linoleic acid in the serum triglyceride fraction of

Group I subjects while on the high linoleic acid diet was found not to be significant, but there was a significant decrease in the proportion of oleic acid. The low linoleic acid regimen produced a highly significant reduction in percentage of linoleic acid with proportionate increases in saturated and monounsaturated fatty acids of Group I subjects.

Phospholipids (Table III). In both groups the serum phospholipid fatty acids exhibited the least change of serum lipid fractions as a result of the dietary regimens. The low linoleic acid diet produced a significant reduction in percentage of linoleic acid in the serum phospholipid fatty acid fraction of Group I subjects.

Discussion. While these data are in general agreement with observations made in earlier studies(1-4), our results suggest that a number of independently operating factors may be involved in determining both the pro-

portion of polyunsaturated fatty acids in serum lipid fractions and serum cholesterol level. One factor is the diet; however, the response was not uniform. When the subjects with elevated serum cholesterol levels were placed on a diet high in linoleic acid

TABLE II. Effect of Dietary Regimens on Serum Triglyceride Fatty Acid Composition.*

Fatty acid*		Group I†			Group II‡	
Chain length carbons	No. double bonds	Before dietary change	10 wk high linoleic	10 wk low linoleic	Before dietary change	10 wk high linoleic
% TOTAL FATTY ACIDS						
6 to 14		3.6 ±1.2	2.6 ±1.0	4.8 ±1.4	4.3 ±1.1	3.4 ±1.0
16	0	31.2 ±3.9	35.5 ±3.8	33.3 ±3.6	33.6 ±3.2	33.8 ±6.8
16	1	3.1 ±1.3	3.5 ±.9	3.9 ±1.5	3.6 ±.7	3.2 ±1.2
18	0	6.8 ±1.8	6.3 ±1.2	6.7 ±1.5	6.1 ±1.0	5.1 ±.9
18	1	41.1 ±4.8	35.3 ±3.6	41.1 ±2.7	40.0 ±2.7	36.6 ±4.1
18	2	13.0 ±3.4	15.4 ±4.4	8.8 ±2.9	10.9 ±2.3	16.7 ±6.5
18	3	.4 ±.2	.7 ±.3	.8 ±.3	.8 ±.3	.5 ±.3
20	4	.8 ±.3	.7 ±.2	.6 ±.3	.7 ±.2	.7 ±.2

* See footnotes to Table I.

TABLE III. Effect of Dietary Regimens on Serum Phospholipid Fatty Acid Composition.*

Fatty acid*		Group I†			Group II‡	
Chain length carbons	No. double bonds	Before dietary change	10 wk high linoleic	10 wk low linoleic	Before dietary change	10 wk high linoleic
% TOTAL FATTY ACIDS						
6 to 14		2.3 ±.9	1.6 ±.6	1.9 ±.6	1.5 ±.4	1.4 ±.5
16	0	32.6 ±3.4	33.4 ±4.4	34.0 ±3.0	32.9 ±2.7	32.8 ±3.3
16	1	2.0 ±.8	1.5 ±.3	1.8 ±.3	1.3 ±.6	1.1 ±.2
17	0	.6 ±.1	.7 ±.3	.8 ±.3	.6 ±.2	.4 ±.2
18	0	13.5 ±2.7	12.9 ±1.6	14.3 ±1.5	14.3 ±1.7	14.8 ±1.4
18	1	17.8 ±2.3	16.4 ±1.4	18.4 ±2.0	17.3 ±2.4	16.3 ±3.1
18	2	18.2 ±4.9	20.0 ±2.4	16.3 ±2.2	18.7 ±3.0	20.2 ±3.3
18	3	.3 ±.1	.4 ±.1	.4 ±.1	.4 ±.1	.5 ±.1
20	0	.5 ±.1	.4 ±.1	.5 ±.1	.5 ±.1	.5 ±.1
20	3	1.1 ±.4	.8 ±.4	1.1 ±.4	2.0 ±.6	1.2 ±.8
20	4	6.6 ±1.8	6.9 ±1.1	6.0 ±1.0	5.7 ±2.0	5.9 ±1.6
22 to 24		4.5 ±1.0	5.0 ±1.2	4.5 ±1.3	4.8 ±1.5	4.9 ±1.2

* See footnotes to Table I.

there was a significant increase in percentage of polyunsaturated fatty acids in the serum cholesterol ester and triglyceride fractions and the serum cholesterol level was significantly lowered. However, the same shift in dietary regimens did not alter the serum lipid fatty acid spectrum of subjects with initially normal blood cholesterol levels, but produced a significant reduction in serum cholesterol level. When the latter group of subjects was transferred from the high linoleic acid diet to a diet low in that acid there was a significant decrease in percentage of linoleic acid in the serum cholesterol ester and triglyceride fractions, and a significant elevation of the blood cholesterol level. Other factors could account for the difference in varying response to the dietary regimens. One factor could be the difference in the ages of the subjects. The data also suggest that linoleic acid affects the serum cholesterol level independently of its effect on the serum lipid fatty acid spectrum, e.g., when serum cholesterol levels of both groups were the same, the percentage of linoleic acid in the serum cholesterol esters of Group I subjects was lower than in Group II subjects. These findings stress the need for further investigation of the role of essential

fatty acids in cholesterol ester transport and metabolism.

Summary. The findings suggest that the level of linoleic acid in the diet, age, and possibly other factors may influence the serum cholesterol level and fatty acid composition of the serum lipid fractions. The significance of these findings is discussed.

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Received December 27, 1961. P.S.E.B.M., 1962, v109.

Reaction of Polyoma and Influenza Viruses with Receptors of Erythrocytes and Host-Cells.* (27307)

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Recently, polyoma virus was found to agglutinate RBC (red blood cells) as do the myxoviruses through interaction with mucoprotein receptors. RBC treated with RDE

(receptor destroying enzyme) or influenza virus were inagglutinable by polyoma virus. However, the latter was devoid of neuraminidase(1). The present report concerns the relationships between RBC receptors for polyoma and influenza viruses, and since the primary interaction of myxoviruses with RBC has proved to be a useful model of the virus host-cell reaction, experiments were designed to test whether receptors of the mucoprotein type also function in the initiation of infection of host-cells by polyoma virus.

Materials and methods. Viruses. The SE

* Aided by a grant from The National Foundation.

[†]From School of Medicine, Kyushu Univ., Japan, Fellow of the Rockefeller Foundation, 1960-1961.

[‡]Trainee under a training grant for microbiologists supported by Nat. Inst. of Allergy and Infect. Dis. Condensed in part from a dissertation submitted by Mr. Schieble to the Graduate School, Univ. of Michigan, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.