Relationship between Serum Lactate Dehydrogenase and the Pattern of Food Intakes in Japanese

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I Introduction

It was of interest to investigate the effects of nutrient intake levels upon values of serum lactate dehydrogenase (LDH). As described in a previous paper (Imake et al, 1984; Yoshimura et al, 1985), significant correlations were found between the percentages of LDH-4 and LDH-5 and protein and vitamin C intakes.

In this study, applying the statistical technique of multivariate analysis which is widely used in various fields such as public health or nutritional science, we examined the relation between LDH activity and LDH isozyme pattern and the pattern of food intake in healthy young Japanese men.

II Materials and Methods

1 Subjects

The subjects examined were 257 healthy Japanese male volunteers aged 21 to 24 years. They consented to participate after being fully informed of the purpose of the experiment, and were all healthy as judged by their detailed medical histories, physical examinations, urinalyses and hematological and serum biochemical analyses. The physical characteristics of the subjects are given in Table 1.

Table 1 Characteristics of subjects

Items	Mean	S.D.	Max.	Min.
Height (cm)	170.7	5.4	190.0	153.0
Weight (kg)	63.0	8.0	85.0	49.0
Broca index	89.2	9.9	118.2	68.3

Number of subjects : 257 men

Broca index : $(\text{weight}/(\text{height} - 100)) \times 100$

2 Nutrition survey

The subjects recored their food intakes after each meal and snack. All food eaten by the subjects in a 2-day period before the test was weight and the intakes of 15 food groups calculated from satandard tables food composition in Japan (4th revised edition, 1976).

3 Blood samples

Venous blood samples were usually drawn from subjects after they had fasted overnight for at least 12 hr.. The serum sepatated and stored at 4°C for analysis. Serum LDH activity and the percentage of LDH isozymes were measured on the day that blood was taken. Serum LDH activity was determined by a UV method (Worblewski, F. et al, 1955) with a LDH-UV Test kit (Wako pure Chemical Industry). Serum LDH isozymes were separated by electrophoresis on agarose film, and the percentage of LDH isozymes were measured by dye scanning (Opher, A., 1966). Pooled serum prepared in our department was used as the control serum.

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4 Data analyses

Data were processed in a NEC PC9800 computer. Factor analysis (Yamagami et al, 1979), a multivariate analysis was applied to intakes of 15 groups of foods in all subjects. The 15 groups of foods examined are listed in Table 2. Factor scores were calculated for the

4855 (257×15) data with factor loadings as weights.

III Results

1 Distributions of serum LDH activity and serum LDH isozyme pattern

Fig. 1 shows the distribution of serum LDH activity in the 257 subjects. Their values showed an approximately normal distribution with a peak at 200 Wroblewski units. The mean serum LDH activity was 245 ± 47 Wroblewski units (range 50—399 Wroblewski units). The distribution of percentage of serum LDH isozyme in the 257 subjects is shown in Fig. 2. Values for the percentages of the five fractions showed approximately normal distribution.

2 Food intake of subjects

The means, standard deviations, and coefficient of variation of the food intakes in the subjects are shown in Table 2. All the subjects were well nourished and apparently in

Table 2 Food intakes of subjects

Items	Mean	S.D.	C.V.(%)
1. Rice	253.2	79.4	31.4
2. Wheat	107.2	64.9	60.5
3. Potatoes	45.0	46.8	104.0
4. Sugar	8.4	9.8	116.7
5. Nuts and Seeds	1.8	10.5	583.3
6. Fats and Oils	23.5	13.4	57.0
7. Pulses	72.3	84.1	116.3
8. Fish	62.2	59.6	95.8
9. Meats	128.5	75.4	58.7
10. Eggs	62.8	52.8	84.0
11. Milks	156.1	147.3	94.3
12. Vegetables	211.1	108.5	51.3
13. Fruit	60.8	94.5	155.4
14. Seaweed	2.3	7.0	304.3
15. Confectionaries	27.4	45.5	166.1

Fig. 1 Distribution of serum LDH activity in subjects

Fig. 2 Distribution of serum LDH isoenzyme fractions in subjects

good health.

3 Statistical analysis (Factor analysis)

Applying the technique of factor analysis to the food intake data, we extracted three factors. The factor loadings of 15 food groups are shown in Table 3. The contribution ratios

of the first-third factors were 44.7%, 22.5% and 14.2%, respectively. The first factor (F1): meat, eggs and vegetables had highly positive factor loadings. The second factor (F2): wheat had a highly positive factor loading, while rice has a highly negative factor loading. This

Table 3 Factor loadings

Item	Factor loadings			Communality
	F1	F2	F3	
1. Rice	-0.062	-0.770	0.264	0.528
2. Wheat	0.057	0.808	0.083	0.527
3. Potatoes	-0.066	-0.101	0.406	0.191
4. Sugar	-0.047	0.064	0.312	0.104
5. Nuts and Seeds	-0.054	-0.051	0.080	0.065
6. Fats and Oils	0.191	-0.038	0.282	0.130
7. Pulses	-0.172	-0.313	0.235	0.213
8. Fish	0.225	-0.028	-0.143	0.357
9. Meats	0.753	0.093	-0.106	0.591
10. Eggs	0.711	0.155	-0.103	0.603
11. Milks	0.247	0.679	-0.045	0.582
12. Vegetables	0.741	-0.049	0.079	0.425
13. Fruit	-0.083	0.178	0.111	0.121
14. Seaweed	0.283	0.046	0.018	0.084
15. Confectionaries	0.047	-0.130	0.303	0.282
Eigenvalue	2.40	1.21	0.76	
Proportion (%)	44.7	22.5	14.2	

F1: Factor 1, F2: Factor 2, F3: Factor 3

Table 4 The correlation coefficient between serum LDH activity, percentage of LDH isozyme fraction and factor scores

Item	F1	F2	F3
LDH(T)	0.119	0.098	0.054
LDH-1	0.121	0.114	0.122
LDH-2	0.111	-0.010	0.036
LDH-3	-0.093	-0.049	0.030
LDH-4	-0.304**	-0.143*	0.104
LDH-5	-0.505**	-0.194**	0.136

* : $p < 0.05$ ** : $p < 0.01$

LDH(T) : serum total LDH activity

LDH-1 : percentage of LDH-1 isozyme fraction

factor was considered to be a "wheat versus noodles factor". The third factor (F3) could not be explained simply in terms of their factor. The scores of three factors for the 257 subjects were calculated. Table 4 shows the correlation coefficient between serum LDH activity, percentages of LDH isozyme fractions and factor scores. Significantly negative correlations were observed between the percentage of LDH-5 and factor scores of F1 ($r = -0.505$ $p < 0.01$), between the percentage of LDH-5 and factor scores of F2 ($r = -0.194$ $p < 0.01$), between the percentage of LDH-4 and factor scores of F1 ($r = -0.304$ $p < 0.01$), between the percentage of LDH-4 and factor scores of F2 ($r = -0.143$ $p < 0.05$). The serum total LDH activity and the percentage of other isozymes were not correlated with factor scores.

IV Discussion

There have been few reports on relations of its activity and isozyme pattern and the intake of nutrients in normal people. Therefore, we studied the relations between the activity and isozyme pattern of serum LDH and the dietary intakes of nutrients.

In the present study, we investigated the effects of the pattern of food intake on serum LDH activity and serum LDH isozyme pattern in healthy young men. When diets of groups are examined, the intakes of individual food items or nutrient intakes are not independent of each other but show synergistic or antagonistic relations with other food items or nutrient intakes. Thus the relation constitutes what is generally called a pattern of food intake (Toyokawa, 1981).

We used multivariate analysis (factor analysis) to analyze the data on food intakes of the subjects: this method allowed analysis of the pattern of food intake in the subjects. The results obtained showed that the first factor determining the relative degree of importance of meats, eggs and vegetables in the diets. In this study, significantly negative correlations were observed between the percentages of LDH-4 and LDH-5 and factor score of F1. In other words, although the percentages of LDH-4 and LDH-5 remained within normal limits, they tended to increase with a decrease intake of meats, egg and vegetables.

The second factor is supposed to be a factor indicating the degree of importance of wheat and rice. That is, a factor related to the nature of the food's main constituent. A significantly negative correlation was observed between the percentages of LDH-4 and LDH-5 and the factor score of F2. The percentage of LDH-4 and LDH-5 tended to increase with a decrease in wheat intake and increase in rice as the main constituent.

We observed that the percentage of LDH-4 and LDH-5 increased significantly in eight healthy young volunteers who low protein diets for 21 days (Imaki, et al. 1984). We also observed that after 10 days of oral adminis-

tration with 1 and 10 g/day of vitamin C six normal subjects, their percentage of LDH-4 and LDH-5 were lower than that before administration (Yoshimura, et al. 1985).

The mechanism of increase in these isozyme percentage in the serum is unknown. However, Koike, et al. (1973) reported that a low protein intake, low vitamin C intake and unbalanced diets caused metabolic stress. The data in these paper also suggested that the percentage of LDH-4 and LDH-5 increased in certain individuals in response to the metabolic stress induced by unbalanced pattern of food intake, and that these isozyme passed from the liver into the blood stream due to a slight fatty degeneration of the liver. The present study indicated that the liver tended to increase on high intakes of meats, eggs and vegetables and that on intakes of modern food habit with wheat as main constituent the levels of the percentages of LDH-4 and LDH-5 were low.

With respect to the relation of the serum LDH activity and nutrient intake, Metwalli, et al. (1977) reported that in patients with malnutrition the serum LDH activity was significantly higher than in normal subjects, and that the level was normalized on improvement of the nutritional state. Marshall, et al. (1976) reported that the serum total LDH activity in healthy persons scarcely changed during starvation, and was similar before and after meals. In the present study, we found that the pattern of food intake did not affect serum LDH activity, but affect the percentages of LDH-4 and LDH-5. This affect was probably because these two isozyme are mainly derived from liver where the enzyme is involved in nutritive metabolism and so be influenced by the pattern of food intake, but

dose not appreciably influence total activity because the percentages of these two isozymes are much low than those the other isozymes.

In general, the nutritional status of a subjects depends on his social, economic, personal and family backgrounds. Our results suggested that the LDH isozyme pattern, an index that has been widely used as a liver function test, is influenced by the pattern of food intake of each subject.

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〔和文抄録〕

血清 Lactate dehydrogenase 活性と食物摂取パターンとの関連性について

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血清 Lactate dehydrogenase 活性と食物摂取パターンとの関連性について、健康な日本人被験者257人を以下の疫学調査を実施した。対象者の食物摂取データについて、因子分析法を用いて、3つの因子を抽出した。第1因子は、肉類、卵類、野菜類に正の高い因子負荷量があり、第2因子については、小麦類が正の高い因子負荷量、米類が負の高い因子負荷量を示した。第3因子は、十分に説明できなかった。

統計的に有意な負の相関がLDH-5分画比と第

1因子 ($p < 0.01$)、第2因子 ($p < 0.01$) の間に認められた。さらに、統計的に有意な負の相関がLDH-4分画比と第1因子 ($p < 0.01$)、第2因子 ($p < 0.05$)の間に認められた。血清総LDH活性値と他の分画比については、食物摂取因子とは、統計的に有意な関係は認められなかった。

以上の結果から、LDH-4、5分画比は、摂取食物パターンの影響を受けていることが疫学的調査によって認められた。

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