6–1. A STUDY ON WOMEN JUDO PRACTICE FROM THE VIEWPOINT OF BIOCHEMISTRY

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Women Judo has been devised by Prof. Jigoro Kano in order to make the best of physical efficiency and also originality and ingenuity have been taken into consideration in order to heighten the safety further than that of men's Judo. Recently, women Judo matches in *randori* practice has been efficially approved, and the activities have been further qualified.

The studies have been made between the Judoists of black belt holders and the Judoists of no belt holders on aerobic work capacity of women Judoists (1978, Haga and others).[5] Also the study has been made on the oxygen intake and the heart rate in order to survey the degree of physiological load of Judo practice on women (1975, Haga and others).[6] As a result, the exercise intensity was 80% of aerobic work capacity and the heart rate was 170 beats/min., which was closer to the maximum work. The purpose of this study is to make a biochemical study of the properties of blood and hormones system in order to *pinpoint* the influence of Judo practice on women Judoists.

I. Method

1. Subjects

The subjects are eight reinforced players for international Judo Championship. Their physical characteristics were shown in Table 1. Most of the subjects were ages between 17 and 28. One of them was a woman of 42 years of age. The average age was 25.6. The average height was 162.4 cm and the average weight was 61.2 kg. All the subjects lived in Tokyo and its vicinities.

2. Procedure

The subjects stayed at the Kodokan from the night before the experiment day. The measure-

Table 1 Physical Characteristics of Women Judoists

Subj.	Age	Height	Weight
H.S.	22	172	71.5
H.F.	26	169	67.0
M.S.	24	165	63.5
H.K.	17	157	64.5
T.N.	25	160	58.5
T.T.	23	160	57.5
K.I.	42	156	58.0
M.T.	28	160	49.0
$\overline{M}$	25.6	162.4	61.2
(SD)	(6.8)	(5.3)	(6.6)

Table 2 Measurement Order

6:30	Lying down at rest	
7:00	Getting up	(Measurement) 1
7:30	Breakfast	
9:00	Measurement before workout	(Measurement) 2
9:30	Workout start	
11:30	Workout finish	(Measurement) 3
12:00	Lunch	
13:30	Measurement before workout	(Measurement) 4
14:00	Workout start	
16:00	Workout finish	(Measurement) 5

ments were taken 5 items as shown in Table 2.

Measurement 1: Getting up at 7 a.m., the subjects were kept in a rest state and their specimen venous blood was drawn after urination. At the same time the blood pressure, heart rate, height, and weight were also measured.

Measurement 2: At 7:30 a.m. breakfast (2 slices of toast and coffee) was taken. After that, between 9 and 9:30 a.m. the same measurements as above were repeated.

Measurement 3: The measurements were made right after the practice.

Measurement 4: Lunch was taken between noon and 12:30 p.m. The measurements were taken between 13:30–14:00.

Measurement 5: The measurements were taken right after the practice.

3. Practice

The practice for two hours in the morning and two hours in the afternoon is shown in Table 3. The practice was done under the guidance of 3 women instructors.

Table 3 Contents of Practice of Women Judo

(1)	Morning practice (*katamewaza*)	
	Warming up	about 10 minutes
	Reinforcement *katamewaza*	about 15 minutes
	Practice of *katamewaza*: 30 seconds *osaekomi* practice attack practice	
	katamewaza-randori	4 min. × 10 times
		about 50 min.
	Kakari practice	20 times × 5
(2)	Afternoon practice (*nagewaza*)	
	Preparatory exercise	
	Kakari practice	20 times × 5
	Moving *uchikomi*	
	Yakusoku-renshu	15 min.
	Randori	5 min. × 10
	Cleaning down exercise	

II. Results

The transition of weight by each measurement is shown in Table 4. From the average values, 1.2 kg decreased in the morning practice from 61.8 kg (before the practice) to 60.6 kg (after the practice). In the afternoon practice 0.8 kg decreased from 61.5 kg (before the workout) to 60.7 kg (after the practice).

The result of the blood pressure measurement is shown in Fig. 1. The sistolic blood pressure was approximately 120 mmHg immediately after getting up, at the rest periods after breakfast and lunch. However, it increased to 160 mmHg immediately after the practice in the morning and in the afternoon. The diastolic blood pressure showed almost no change, approximately 70 mmHg both at the rest period and immediately after the practice in the morning and afternoon.

Table 4 The Change of Body Weight at Each Measurement

G—Get up
B—Before
A—After

Subj.	Weight				
	1 (G)	2 (B)	3 (A)	4 (B)	5 (A)
H.S.	71.5	72.5	71.0	72.2	71.0
H.F.	67.0	67.3	66.0	67.0	66.0
M.S.	63.5	64.0	62.3	63.0	61.5
H.K.	64.5	65.0	63.2	65.0	65.0
T.N.	58.5	59.0	58.5	59.0	58.0
T.T.	57.5	59.0	58.0	58.5	58.0
K.I.	58.0	58.5	57.4	58.4	58.0
M.T.	49.0	49.0	48.5	48.5	48.0
$\overline{M}$	61.2	61.8	60.6	61.5	60.7
(SD)	(6.6)	(6.6)	(6.3)	(6.6)	(6.5)

From the analysis of properties of blood, the protein taken from food is composed into albumin in the liver and it maintains plasma osmotic pressure and keeps the balance of water in. A part of albumin becomes amino-acid and enters into the urea cycle (Krebs-Henselei Cycle) and produces urea through the function of various enzymes. Urea is one of the indexes to examine the kidney function. At the measurements albumin was 3.8–4.0 mg/dl each time. The value did not change at the rest period, after meals, and after the practice. It was always within the normal range. Also urea showed the same tendency. It was between 11.4–14.1 mg/dl. Serum creatine is also considered to be a positive index of the kidney disturbance when it increases. At getting-up time it was 3.8 g/dl and it was also 3.8 g/dl after the practice, which showed no difference. The normal value of uric acid of healthy women is 2.6–6.0 mg/dl. In this study, after each practice it showed 2.4–3.6 mg/dl. There was no remarkable change from after the rest period. The change of value through a day was 1.2 mg/dl on and average and there was no influence observed from the practice.

The blood lipid includes triglyceride, phospholipid, and the free fat acid as the neutral fat, and cholesterol as the inducing lipid. The fat taken from meal is mainly triglyceride and it goes into blood and becomes chylomicrone. The change of triglyceride is shown in Fig. 2. The value immediately after getting up is 73 mg/dl, which is rather low. After breakfast the value increases to 90 mg/dl, and one hour after lunch it increased further to 127 mg/dl. After the practice the value was 90 mg/dl. No influence of the practice was observed.

In the case of increased demand of body energy, the total cholesterol is resolved into free fat acid of hydrolysis lipase, and helps to produce adenosine triphosphate (ATP). Even though the value is rather low immediately after getting up, there is no change after the Judo practice (Fig. 2). The average value of high density lipoprotein (HDL Cholesterol) in lipoprotein to which special attention has recently been paid as a preventive factor of arteriosclerosis was 64 mg/dl. There were no remarkable change observed at the rest period, after the meals, and after the practice, which showed approximately the same tendency as in the case of total cholesterol (Fig. 3).

Generally, in the case of muscle movement, creatine phosphokinase (CPK) is an important enzyme, which plays the role of acting on creatine phosphate in the Lohmann Response created during the muscular contraction, which separates active phosphoric acid, and combines it with adenosine diphosphate (ADP) synthesizing ATP. The result is shown in Fig. 4. The value increased

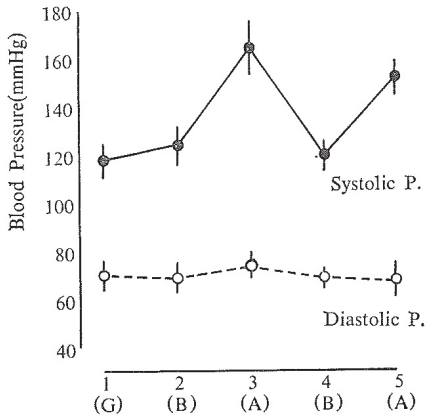

Fig. 1 The Change of Blood Pressure at Each Measurement

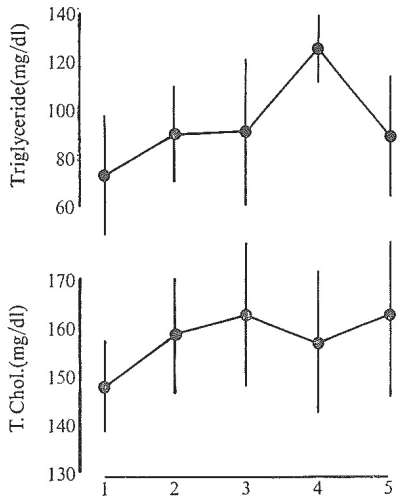

Fig. 2 The Change of Triglyceride and Total Cholesterol at Each Measurement

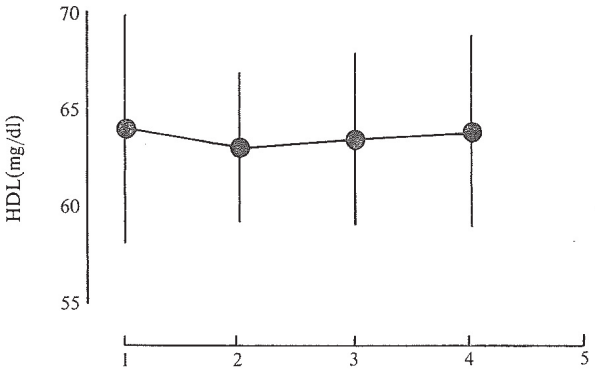

Fig. 3 The Change of HDL Cholesterol at Each Measurement

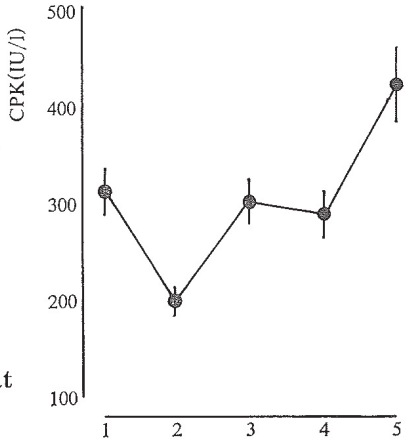

Fig. 4 The Change of Cleatine Phosphokinase at Each Measurement

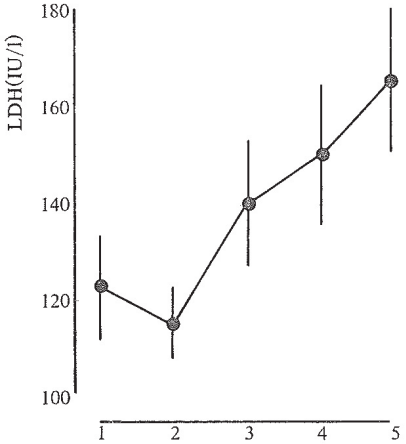

Fig. 5 The Change of Lactate Dehydrogenase at Each Measurement

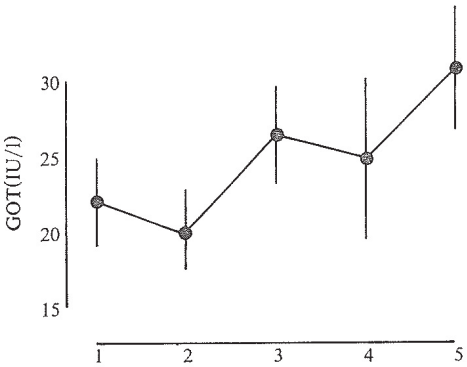

Fig. 6 The Change of Glutamic Oxalacetic Transaminase at Each Measurement

from 195 IU/l at the rest period after breakfast to 297 IU/l after the morning practice. Though it decreases slightly after lunch to 287 IU/l, the value increased remarkably after the afternoon practice to 421 IU/l.

Lactate Dehydrogenase (LDH) is the enzyme to catalyze mutual conversion of lactic acid and pyruvic acid in conjugation of coenzyme NAD. The increase of LDH value during the practice throughout the day is shown in Fig. 5 as follows: 122.5 IU/l immediately after getting up, 114.8 IU/l after breakfast, 140.0 IU/l after the morning practice, 149.3 IU/l after lunch, and 165.5 IU/l after the afternoon practice.

Glutamic Oxalacetic Transaminase (GOT) is an enzyme contained in the heart muscles and transfers amino. It changes slightly by the movement. The result of the measurement is shown in Fig. 6. The value increased after the practice showing a higher value in the afternoon practice than in the morning. There was almost no change observed in blood triiodo thyronine (T3), blood thyroxine (T4), and blood tyroid stimulating hormone (TSH).

III. Discussion

There were no particular changes observed in the values of albumine, urea, serum creatine, uric acid, triglyceride, total cholesterol, and HDL cholesterol. The values were all within the normal domain. The examination of the substances which showed some change revealed that the individual difference of serum CPK active value was large. It was impossible to discuss the difference unconditionally. In general, it is known that the value is high among the people who are training jogging every day (107.4 ± 39.6 IU/ml, $n=37$), and it is low among the people who are engaged in sedentary work with less physical exercise (84.3 ± 45.8 IU/ml, $n=38$).[8] Accordingly, the CPK active value increases by exercise. In the previous reports it has been known that in the training camp of women's college athletic club the value of before the training camp was approximately 50 IU/ml and it increased to 400 IU/ml on the last day of the trainig.[7] There were some individuals whose values reached 600 IU/ml. From these facts, we could conclude that the value would not go over the supremum in women's Judo pcratice.

It is desirable to observe muscle LDH active value of biopsy for the value of LDH. However, in general, the enzyme deviated from serum is measured in order to conjecture the mechanism created in the muscles. There is a report[9] among many others that the change of serum LDH isoenzyme after taking some exercise differs according to the intensity of exercise, duration, and frequency. Also there is another report[10] that the influence of exercise intensity is especially great and it shows remarkable increase under the load of 80% and 90% of VO_2 max.

It seems to be difficult to judge the quantity of exercise from the size of serum LDH isoenzyme produced during the practice. Namely, it is not proper yet to dicuss from serum LDH the series of relations between exercise intensity and the duration. Blood GOT is reported to increase by exercise intensity.[3] The GOT during the exercise was considered to come from the heart muscles and it increased during *tachiwaza* practice by women in the afternoon. The heart rate during the practice in women's Judo was 160–170 beats/min. at *kakari* practice and 170–180 beats/min. at *randori* practice. It is reported that the load influencing circulatory system becomes extremely great.[5] However, the influence on GOT is within the normal range. The up-and-down change of GOT does not appear only immediately after the practice. The observation of the influence should be kept even several hours to several days after the practice. Also the relation to the period of practice must be taken into the consideration.

This investigation revealed that the change of each item by blood biochemical examination generally stayed within the physiologically normal range and that the Judo practice was not physiologically normal range and that the Judo practice was not physically too much at all for women. However, the further studies should be required in comparison with the results of other sports for

women and the case of long-period training camp.

One of the subjects in this study was a woman aged 42, whose values immediately after getting up and during the rest period were as follows: 16 ml/dl urea N, 4.0 mg/dl uric acid, 57 mg/dl -tri glyceride, 145 mg/dl total cholesterol, 61 mg/dl HDL Cholesterol, 87 IU/l CPK, and 85 IU/l LDH. The systolic blood pressure was 112 mmHg and the diastolic blood pressure was 74 mmHg. These values are almost equal to those who are in their 10's and 20's, and it was impossible to find the influence of aging. From these facts it seems to be effective for women to continue practice for a long period of time for the maintenance and promotion of physical fitness. It is also desirable to keep good health for the improvement of physical fitness as well as staying young.

IV. Conclusion

1. Blood biochemical examination was done on the 8 members (of All-Japan reinforced women Judoists for international tournaments) in order to analyze the influence of Judo practice on their organism.

2. Blood collecting was made 5 times—immediately after getting up, after breakfast, immediately after the morning practice (*newaza*), after lunch, and immediately after the afternoon practice (*tachiwaza*).

3. The values of albumin, urine, serum creatine, and uric acid were kept within the normal range without any change between the rest period and immediately after the practice.

4. Concerning the blood lipid, the triglyceride, the total cholesterol, and the HDL cholesterol showed normal values, and there was no change observed between before and after the practice.

5. The values of CPK, LDH, and GOT increased after the exercise. Especially the values examined immediately after the afternoon practice (*tachiwaza*) increased higher than immediately after the morning practice (*newaza*).

6. Concerning hormones, such as T3, T4 and thyroid stimulating hormone, there were no recognizable changes at the both periods of the rests and workouts.

7. In the case of a woman subject who has practiced Judo for many years, the values of uric acid, triglyceride, CPK, LDH, sistolic blood pressure, and diastolic blood pressure showed the values of the women in their twenties. It is desirable for women of middle- and-old-aged to practice Judo in order to keep good health and to keep physical fitness.

8. From the above results, it can be suggested that Judo practice is not a severe exercise for women, but effective as an exercise of the middle-aged and elderly women.

REFERENCES

1) Bass, A., Vondra, K., Rath, R., Vitek, V., Teisinger, J. and Mackova, E.: *Enzyme Activity Patterns of Energy Sypplying Metabolism in the Quadriceps Femoris Muscle* (vastus lateralis). Pflügers Arch., **361**: 169–173, 1976.

2) Block, P., Rijmenant, M. U., Badjou, R., Melsem, A. Y. U. and Vogeleer, R.: *The Effects of Exhaustive Effort on Serum Enzymes in Man.* In Poortmans, J. R. Ed. Biochemistry of Exercise. Medicine and Sport, **3**: 259–267, Karger: New York, 1962.

3) Fowler, W. M. Jr., Gavner, G. W., Kazurunian, H. H. and Lanvstad, W. A.: *The Effect of Exercise on Serum Enzyme*, Arch. Physiol. Med. Rehabil. **49**: 554–565, 1968.

4) Haga, S., Asami, T., Onozawa, K.: *The Change of Oxygen Intake and Heart Rate During* practice *in Women Judo.* Budo Kenkyu Vol. **7**(2): 27–33, 1975.

5) Haga, S., Mizuta, T., Kaise, T., Kudo, T.: *Aerobic Work Capacity of Women Judoists*, Budo Kenkyu, Vol. **10**(3): 42–49, 1978.

6) Igawa, Y., et al.: *Exercise and Serum Enzyme*, Nihon Ishikai Zasshi **71**(5): 659–705.

7) Igawa, Y.: *Exercise Therapy* (edited by M. Abe and M. Ono), 30–35, Asakura Shoten, Tokyo,

1978.

8) Igawa, Y., Suzuki, M. and Nakajima, T.: *The Properties of Blood, Physical Fitness, Exercise, Health, and Consciousness of the Instructors of Drivers School and Middle-aged Athletic Club Members*, J.J. Physical Fitness and Sports Science, Vol. 7: 179–188, 1979.

9) Schwartz, P. L., Carroll, H. W. and Douglas, J. S., Jr.: *Exercise Induced Changes in Serum Enzyme Activities and Their Relationship to Max. VO_2.*, Int. Z. Angew Physiol. **30**: 20–33, 1971.

10) Suzuki, T., Ishiko, T., and Aoki, J.: *Workout Intensity and the Change of Serum LDH and LDH Isoenzyme by the Passage of Time*, J. Physiol. Society of Japan, **38**: 198, 1976.