

## 4-4. A STUDY OF THE INFLUENCE OF JUVENESCENT JUDO PRACTICE ON THEIR BODIES

### Report 3. The Change of Blood Substance before and after the Judo Workout of Body Judoists

Masayuki WATANABE, Mitsutsugu ONO, Teruo KAISE (Tokyo Gakugei University), Tetsuo ASANO (Kamishakujii Junior High School), Tetsuo HISANAGA (Tama High School), Heiji NAGATSU (Kodaira-Nishi High School), Masaaki SUGAWARA (Kodokan)

In this series of study the characteristics of boy Judoists' physique and motor ability was discussed in Report I, in comparison with boy soccer and baseball players. In Report II in order to find the percentage of individual oxygen intake ability at boy-Judoist workout, a relative exercise intensity was measured by inserting heart rate at Judo workout into the formulas of oxygen intake and heart rate taken from the maximum-work test. As a result the following facts were found; the physique of the subjects in this study as boy Judoists was larger than other boys, their motor abilities were also superior because of large physique, and Judo workout intensity was 83% of maximum oxygen intake in average value, which was quite high.

In this study the focus was set on the body at Judo workout of high intensity. Concerning the children's bodies developing period, the influence of various troubles to their bodies can be considered under the intensive Judo workout. It is important to analyze whether the trouble is temporary or lasting. The juvenescent sports troubles in recent years<sup>1,2,7,14,15)</sup> are considered to be lasting. Even though the single stimulation is not excessive, conscious symptom appears all of sudden as the result of accumulation. It is very difficult to find out the lasting factor beforehand.

On the contrary, it is very important to study the temporary response against stimulation in order to find out the propriety of the stimulation at the moment. The various substances in blood are often made use of as clues to its judgement.<sup>8,9,10,11)</sup>

Various enzymes in blood function as the catalyzer to various responses for the respiration in the cell, and blood is not the place where enzymes usually exist. When a trouble occurred in a certain organ, the activity of enzymes in blood system of the organ often increases.<sup>5)</sup>

The purpose of enzyme activity measurement is to judge the diagnosis of various diseases and prognosis from the change of enzyme activities in blood. However, regarding the change of enzyme activity in blood before and after exercise load, it is not possible to treat this in the same way as in clinical cases. For instance, it is often seen that the active value right after exercise (such as running) rises far beyond the normal value. However, it approximately returns to rest value after an hour. Therefore, it is impossible to explain that the malfunction is only due to the rise of active value right after exercise.

Regarding the change of enzyme activity in blood at exercise, it is considered that there must be some other factors than simple malfunction of organs.

In order to analyze the change of enzymes in blood before and after the workout of boy Judoists, we made a survey of various kinds of load imposed on boy Judoists at work with the consideration of the change of various substances in blood.

## I. METHOD

### A) Subjects

The subjects were chosen under the same conditions as Report I and II; 5 members of 5th grade, 7 of 6th grade, 6 of 7th grade, and 6 of 8th grade, 24 members in total. The comparison of their height and body weights is shown in table 1.

**Table 1** Physical Characteristics of Subjects.

|                                | Height(cm)    | Weight(kg)   |
|--------------------------------|---------------|--------------|
| Elementary School Boy<br>N=12  | 144.9 ± 7.29  | 42.6 ± 19.37 |
| Junior High School Boy<br>N=12 | 163.3 ± 10.13 | 59.3 ± 15.18 |

### B) Procedure

Like Report II, there are four items of Judo workout; *ukemi*, *uchikomi*, *randori* (*tachiwaza*, *newaza*), *kakari-geiko*. They had no break particularly during one-hour workout. Blood pressure and heart rate were measured every minute before and after workout for 10 minutes and the same measurement was done after 30 minutes. Blood-collecting was done 3 times; immediately before and after the workout and 30 minutes later. The blood was collected 4 cc each time from the median cubital vein.

The subjects participated in this experiment without taking any food and drink after dinner the night before, and any breakfast on the following day.

### C) Items of Measurement and Method

Riva-Rocci's tonometer was used to measure blood pressure, and it was done by palpation. Heart rate was measured for 30 seconds by palpation from the radial artery, and doubled to make it one-minute value. The values of the following substances in blood were measured by Enzymic Assay Method; blood sugar, serum triglyceride (TG), total cholesterol (T. Chol.), serum urea N (BUN), uric acid (UA), creatine. The values of the following substances in blood were measured by Ultra-Violet Method; serum glutamic oxaloacetic transaminase (GOT), glutamic pyruvic acid transaminase (GPT), lactate dehydrogenase (LDH), creatine phosphokinase (CPK),  $\alpha$ -hydroxybutyric acid dehydrogenase ( $\alpha$ -HBDH),  $\gamma$ -glutamyl transpeptidase, alkaline phosphatase.

## II. RESULT

The heart rate of elementary school boys before the workout was  $79.0 \pm 8.50$  beats/min. in average, and that of junior high school boys was  $78.5 \pm 11.50$  beats/min. There was practically no difference between two groups. However, the heart rate of junior high school boys after the workout was  $134.4 \pm 18.96$  beats/min., showing a conspicuous difference from elementary school boys' rate of  $110.4 \pm 21.90$  beats/min. The both groups showed gradually a decreasing tendency in their recovery process after the workout. These results are shown in Fig. 1.

The change of blood pressure is shown in Fig. 2. Elementary school boys' maximum blood pressure increased about 15.5 mmHg after the workout from  $113.2 \pm 20.44$  mmHg to  $128.7 \pm 19.39$  mmHg. In the case of junior high school boys, it increased 23.5 mmHg from  $120.2 \pm 18.50$  mmHg to  $143.5 \pm 10.41$  mmHg. The increasing rate was greater in junior high school boys. In both groups the blood pressure decreased gradually for 6 minutes after the workout and then reached a plateau. The value checked after 30 minutes later was the same. At least the average value of the minimum blood pressure of elementary school boys showed no change. However, that of junior high school boys decreased

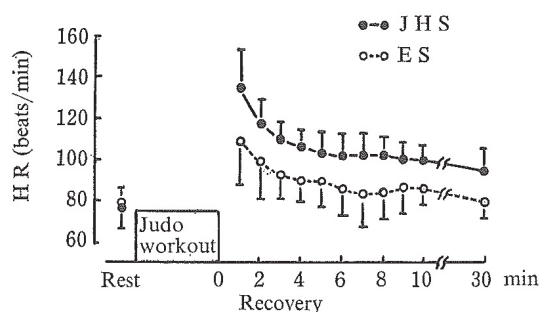


Fig 1. Physical Characteristics.

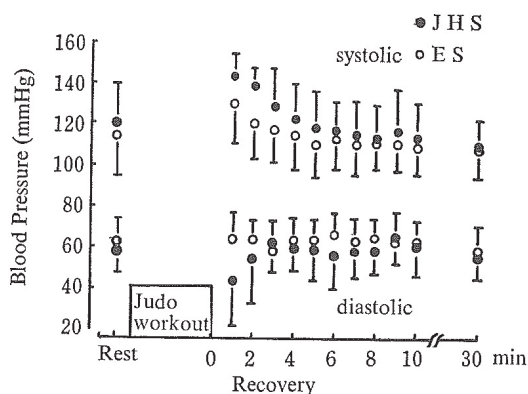


Fig 2. Changes in blood pressure and after Judo workout.

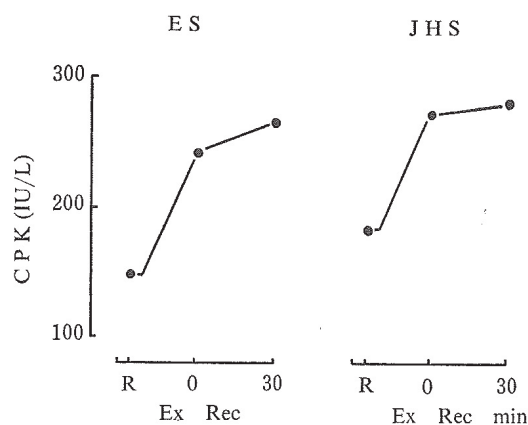
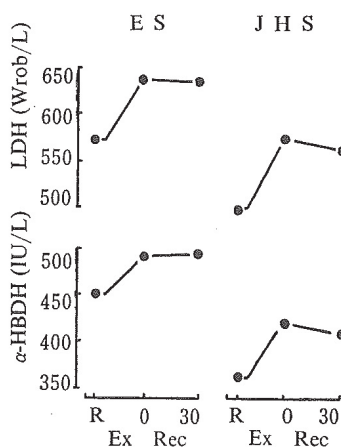


Fig 3. Changes in serum creatine phosphokinase activities.

Fig 4. Changes in serum lactatedehydrogenase and  $\alpha$ -hydroxybutyrate dehydrogenase activities.

13.4 mmHg after the workout from  $57.7 \pm 11.90$  mmHg to  $44.3 \pm 22.56$  mmHg. Three minutes later it reached a plateau, and there was no difference from elementary school boys.

The substances in blood showed large value in the change of serum enzyme were CPK in Fig. 3, LDH and  $\alpha$ -HBDH in Fig. 4. CPK increased largely in both groups before and after the workout and continued increasing slightly even after 30 minutes. The values checked 30 minutes later were  $264 \pm 74.2$  IU/L for elementary school boys, and  $287 \pm 137.9$  IU/L for junior high school boys. Except the high value of LDH and  $\alpha$ -HBDH in elementary school boys even before the workout, the pattern of change was the same; the values of both groups increased immediately before and after the workout, and decreased slightly 30 minutes later. The average value and standard deviation of both groups concerning GOT, GPT,  $\gamma$ -GTP, and ALP are shown in Table 2. No large change can be recognized, and the values were all within the normal value.

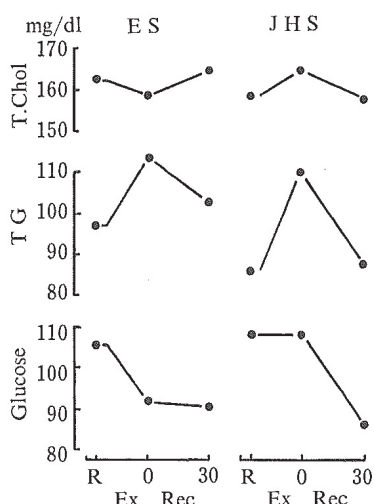
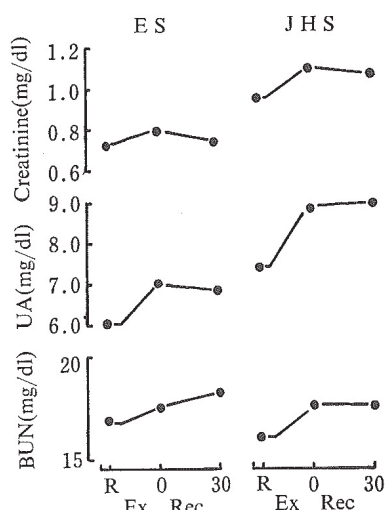
The average value and standard deviation of stroma in blood are shown in Table 3, and diagramed in Fig. 5. No great change in total cholesterol was recognized in both groups before and after the

**Table 2** Changes in serum glutaminoxaloacetictransaminase, glutamicpyruvictransaminase,  $\gamma$ -glutamyl transpeptidase, and Alklinephosphatase activities.

| IU/L  |            | Rest               | Immediately after exercise | 30 min after exercise |
|-------|------------|--------------------|----------------------------|-----------------------|
| GOT   | Pri. Sch.  | 11.7 $\pm$ 2.37    | 13.2 $\pm$ 2.09            | 13.3 $\pm$ 2.45       |
|       | J. H. Sch. | 11.6 $\pm$ 4.08    | 13.5 $\pm$ 4.57            | 12.7 $\pm$ 4.61       |
| GPT   | Pri. Sch.  | 5.5 $\pm$ 1.13     | 5.1 $\pm$ 1.64             | 5.9 $\pm$ 1.66        |
|       | J. H. Sch. | 9.8 $\pm$ 7.52     | 9.7 $\pm$ 8.09             | 10.0 $\pm$ 7.70       |
| S-GTP | Pri. Sch.  | 13.3 $\pm$ 3.66    | 12.9 $\pm$ 3.24            | 12.5 $\pm$ 3.98       |
|       | J. H. Sch. | 17.7 $\pm$ 10.87   | 19.2 $\pm$ 10.78           | 18.0 $\pm$ 10.32      |
| ALP   | Pri. Sch.  | 370.4 $\pm$ 116.81 | 366.8 $\pm$ 114.89         | 396.5 $\pm$ 109.75    |
|       | J. H. Sch. | 349.2 $\pm$ 150.51 | 358.1 $\pm$ 156.00         | 343.9 $\pm$ 161.58    |

**Table 3** Changes in blood sugar, serum triglyceride, and total cholesterol values.

| mg/dl             |            | Rest              | Immediately after exercise | 30 min after exercise |
|-------------------|------------|-------------------|----------------------------|-----------------------|
| Glucose           | Pri. Sch.  | 105.3 $\pm$ 4.73  | 91.3 $\pm$ 7.95            | 90.5 $\pm$ 7.47       |
|                   | J. H. Sch. | 108.1 $\pm$ 7.99  | 108.1 $\pm$ 24.14          | 86.5 $\pm$ 7.65       |
| Triglyceride      | Pri. Sch.  | 96.7 $\pm$ 40.07  | 113.5 $\pm$ 39.54          | 102.8 $\pm$ 38.26     |
|                   | J. H. Sch. | 85.8 $\pm$ 45.37  | 110.1 $\pm$ 48.88          | 88.0 $\pm$ 38.71      |
| Total cholesterol | Pri. Sch.  | 162.4 $\pm$ 38.72 | 158.5 $\pm$ 32.32          | 164.3 $\pm$ 33.43     |
|                   | J. H. Sch. | 158.5 $\pm$ 25.64 | 164.5 $\pm$ 33.95          | 157.5 $\pm$ 27.88     |

**Fig5.** Changes in glucose, serum triglyceride, and total cholesterol values.**Fig6.** Changes in serum urea nitrogen, uric acid, and creatinine values.

workout. No difference of TG was recognized in both groups. Concerning blood sugar, no change was observed in the average value before and after the workout in junior high school boys, and decreased 30 minutes later. In the case of elementary school boys, the value decreased greatly right

after the workout, and kept decreasing even after 30 minutes. Since the subjects of both groups participated in the experiment on an empty stomach, there should be no change of blood sugar value at least because of the external cause. This must be noticed as the difference of sugar metabolism between elementary school and junior high school boys.

The change of BUN, UA, and creatine are shown in Fig. 6. The value of change was smaller in elementary school boys than junior high school boys, and no recoveries were shown in BUN and UA even after the workout. On the contrary, in the case of junior high school boys the change of UA was especially great and showed definitely abnormal value after workout.

### III. DISCUSSION

Even though the subjects in this study were chosen under the same condition as Report I and II, their height and weight were below those of Report I and II. Especially, it was shown clearly in junior high school boys. It cannot be considered that the difference of physique has influence on the heart rate response at Judo workout. Comparing the heart rate of recovery process after Judo workout (Fig. 1) with that of recovery process obtained from the heart rate response during Judo workout of Report II, the heart rate after Judo workout of this study is considered to be very low. The result indicates that the intensity of Judo workout in this study was not as high as Report II. It is also estimated from the response of blood pressure shown in Fig. 2. The contents of Judo workout were the same, but the subjects, the level of skill of workout opponents and the experimental condition (empty stomach) were not the same as the former reports and they might be the causes that the Judo workout intensity from heart rate response in this study was below that of Report II. It is not proper to judge that all the results of this experiment are meaningless because of the low workout intensity.

In order to consider the load on the Judoists' bodies at work from the standpoint of the change of enzymes in blood before and after Judo workout, an analysis must be made from which organ enzymes in blood flow out. It seems to be an interpretation based on the mechanism of enzymes' flow into blood because of cell demolitic and cell wall permeability, to think simply that load on the subjects' bodies is heavy because of the increase of enzyme level in blood. This does not seem to be satisfactory explanation for these complicated phenomena. Therefore, it is necessary to provide with some different explanations from a clinical viewpoint.

Regarding the result of this study, a comparison was made on the increasing rate of CPK (shown in Fig. 3) in Fig. 7. The increasing rate of elementary school boys right after the workout was 1.76

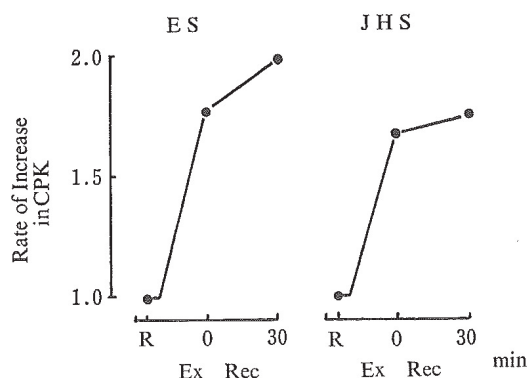


Fig 7. Comparison of rate of increase in serum creatine phosphokinase activities.

times in average and 30 minutes later, it increased to 1.98 times, and that of junior high school boys was 1.67 times (right after workout) and 1.74 times (30 min. later). The distribution of CPK in organs was converged into skeletal muscle, heart muscle, unstriated muscle, and brain.<sup>13)</sup> From the result it can be considered that CPK from skeletal muscle had much to do with the increase of CPK. Since the value did not decrease even 30 minutes after the workout, it indicates that Judo workout is very hard. Regarding the high value mechanism at the recovery period, it was rather a new mechanism of active discharge of over-produced CPK in muscle cells into the outside of cells than the destruction of muscle cells. It is not proper to say that the hard workout is not suitable to boy Judoists simply because of the high intensity of workout. Then, how much increase is proper against the increase of CPK? Regarding the supremum increase, further studies are to be required.

In LDH, the value before the workout of elementary school boys was  $572.7 \pm 100.01$  Wrob. U/L and that of junior high school boys was  $497.5 \pm 95.54$  Wrob. U/L. The former showed a higher value than the latter. Since LDH shows the highest value right after birth and decreases until they become adults,<sup>3)</sup> it is reasonable that elementary school boys showed higher values. Therefore, it is not proper to judge this high value as an abnormal value.

The changing pattern of LDH is the same as CPK (shown in Fig. 4). Then, what is the cause of increase of enzyme level in blood? LDH is a tetramer consisting of H-subunit and M-subunit. The organs containing lots of H-subunit are the heart, the kidney, and the erythrocyte. The organs containing lots of M-subunit are the skeletal muscle and the liver. In order to study the movement of LDH mainly consisting of H-subunit,  $\alpha$ -HBDH was measured. There are clinical report,<sup>4,12)</sup> describing that  $\alpha$ -HBDH accords with the change of LDH consisting of H-subunit. The value of  $\alpha$ -HBDH shown on lower row of Fig. 4, indicates almost the same change as LDH. It cannot be asserted positively that the influence was only given to the heart and the kidney when the increase of  $\alpha$ -HBDH was observed through Judo workout. It was because the total level increased because the ratio of  $\alpha$ -HBDH against LDH showed very little change and no peculiarity was recognized in the heart and the kidney.

Since LDH showed high value before the workout, it indicates that the metabolism in cells is very active. It was impossible to conclude the propriety of Judo workout from the result of this study, however, there seems to be no problem concerning LDH and  $\alpha$ -HBDH.

In comparison with the increase of CPK, LDH, and  $\alpha$ -HBDH, GOT, GPT,  $\gamma$ -GTP, and ALP (Table 2) showed very little change. GOT is distributed over the heart and the liver, GPT is distributed over the liver and the kidney,  $\gamma$ -GTP is distributed over the kidney and the pancreas, and ALP is distributed over the liver, the bones, and the small intestine. Supposing the mechanism of cell demolition and cell wall permeability brought about the increase of enzyme level in blood, the values of the above would have also increased paralleled to the increase of  $\alpha$ -HBDH. The dynamic balanced state of metabolism would be one of the contributing factors to the fact that there was little change in these values obtained during the Judo workout.

The most important difference between elementary and junior high school boys was the blood sugar value shown in Fig. 5. In junior high school boys the value before the workout was  $108.1 \pm 7.99$  mg/dl., and that of right after workout was  $108.1 \pm 24.14$  mg/dl. The value decreased 30 minutes later to  $86.5 \pm 7.65$  mg/dl. However, at least it did not decrease right after the workout. On the contrary, the value of elementary school boys decreased from  $105.3 \pm 4.73$  mg/dl. (before the workout) to  $91.3 \pm 7.95$  mg/dl. (right after workout). Even 30 minutes later the value stayed as low as  $90.5 \pm 7.47$  mg/dl. Since the subjects participated in this experiment on an empty stomach, they must have been hungry. The junior high school boys were able to keep the blood sugar value normally till after the workout. However, in the case of elementary school boys, the control system of blood sugar value was fixed in a low level because of sugar metabolism. In the case of a longer period of the workout, further decrease of blood sugar value can be anticipated. Therefore, it is dangerous for elementary

school boys to practice Judo on an empty stomach.

As the result of lipid metabolism, it seems that TG discharges its duty as an energy source, judging from the fact that TG increased right after the workout and decreased to the resting value before the workout. There was no change in the total cholesterol.<sup>16)</sup>

Since the value of creatine increases by aging,<sup>6)</sup> the difference of the value between elementary and junior high school boys can be explained. However, because of a very small change before and after the workout, it was impossible to judge whether creatine from the skeletal muscles was too little or the excretion into urine increased.

It should be more important that the value of UA of junior high school boys greatly increased after the workout. The mechanism of this increase is not clear. The problem itself exists in the high value of UA. Also, if it indicates the secondary high value, such as the excretion disturbance, it will be another problem. In all cases the further studies are required on the movement of UA of junior high school boys before and after the workout especially in relation to the kidney disturbance.

#### IV. SUMMARY

In order to analyze the load on Judoists' bodies at the workout of boy Judoists, this study was made on the change of various substances in blood. The following results were obtained;

- 1) The active value of serum creatine phosphokinase (CPK) increased 1.67–1.98 times in elementary and junior high school boys after Judo workout.
- 2) The change of serum lactate dehydrogenase and  $\alpha$ -hydroxybutyric acid dehydrogenase was similar to that of CPK.
- 3) The change in serum glutamic oxaloacetic transaminase was hardly recognized.
- 4) In blood sugar value, there was no difference in junior high school boys before and after the workout. However, the value of elementary school boys dropped sharply right after the workout.
- 5) Serum uric acid value was high in junior high school boys and it even increased after the workout.
- 6) In the case of elementary school boys, the load on circulatory system during Judo workout was smaller than junior high school boys, however, the increasing rate of CPK was slightly larger.
- 7) It seems to be dangerous for elementary school boys to exercise on an empty stomach.

#### REFERENCES

- 1) Adams, J. E.: *Bone Injuries in the Very Young Athlete* Clin. Orthop. **58**: 129, 1968.
- 2) Akimoto, T.: *Juvenescent Sports Activities and Spondylolysis*, Orthopedic Surgery **30**(6): 638–646, 1979.
- 3) Aoki, R.: *LDH and the Iso-enzyme*, Japan Clinic **38**: 1269–1278, 1980.
- 4) Elliott, B. A. and J. H. Wilkinson:  *$\alpha$ -Hydroxybutyric Dehydrogenase in Myocardial Infarction and in Liver Disease* Lancet 698–699, 1961.
- 5) Genban, A.: *Clinical Pathology of Enzyme*, Chugai Iyaku-sha, Tokyo, 1974.
- 6) Furukawa, T.: *Creatine, Creatinine*, Japan Clinic **38**: 1320–1331, 1980.
- 7) Kashiwagi, D.: *Elbow Joint Disturbance by Playing Baseball—Especially on the Transformation of Elbow among Boy Baseball Players*, Orthopedic Surgery **30**(6): 611–621, 1979.
- 8) Ono, M.: *The Influence to Taulin's Metabolism at Exercise, Part I*, Physical Science **29**(4): 191–204, 1980.
- 9) Ono, M., et al.: *The Basic Survey to Establish Optimum Prescription of Long Distance Walk, Part I*, Physical Science **30**(4): 193–205, 1981.
- 10) Ono, M., et al.: *The Survey of Middle Age Physical Strength in Endurance Running Training*, Physical Science **22**(2): 63–70, 1973.
- 11) Ono, M., et al.: *The Conditions to apply Middle Long Distance Running to Non-Training Adults*,

- Physical Science **22**(4): 161–172, 1973.
- 12) Rosalki, S. B.: *Serum  $\alpha$ -Hydroxybutyrate Dehydrogenase A New Test for Myocardial Infarction*, Brit. Heart J. **25**: 795–802, 1963.
  - 13) Shoji, S.: *Creatine Phosphokinase (CPK) and the Isoenzyme*, Japan Clinic **38**: 1320–1331, 1980.
  - 14) Takatsuki, S.: *Elbow Joint Disturbance of Elementary School Children by Playing Baseball*, Accident Medicine **21**: 557, 1978.
  - 15) Takatsuki, S.: *Elbow Joint Disturbance of Junior High School Baseball Club Members*, Clinical Orthopidic Surgery **30**(6): 638–646, 1979.
  - 16) Watanabe, M., et al.: *Sugar and Lipid Metabolism during Exercise of Medium Intensity*, Descent Sports Science **3**: 190–195, 1982.