

## PHYSICAL FITNESS OF THE TOP JUDOISTS IN JAPAN

( 1961 )

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The general tendency of the sports world, recently, is to adopt a rational and efficient hard training method based on the principles of anatomy, physiology, psychology, dynamics and other sciences, instead of the old and irrational empirical method. On the request of the late Jigoro Kano, founder of the Kodokan, Prof. Seizaburo Uramoto, in 1930, undertook to make a scientific study of "Shizentai" (Natural posture) and "Jigotai" (Defensive Posture). This was the first of a series of scientific studies on physical fitness in relation to Judo.

With the next Olympic Games near at hand, it is only natural that various sports organizations are frantically training their athletes. The Judo circle is no exception, and in August 1961, the Judo Federation sponsored a one week training camp at the Kodokan. Availing of this opportunity, the Association for the Scientific Studies in Judo conducted a research on the various aspects of physical fitness of expert Judoists with the view of obtaining a proper understanding of their physical capabilities.

From among the items of measurement selected by the Committee of Sports Science in the Japan Amateur Athletic Association those that meet with the requirements of Judo were selected for the present study (Table 1)

Since mental and physical capabilities which are the bases of human activities form what is called "physical fitness", a co-ordinated analysis from various angles is necessary. However, due to restrictions in the number of investigators, experimental subjects, and apparatuses, studies were limited to measurements of the morphological features, muscular strength, agility, flexibility, and respiratory and circulatory functions. Thus, more importance was laid in obtaining a proper understanding of actual conditions of physical fitness rather than on health supervision. However, health supervision was not altogether disregarded, and medical examination of the athletes was also conducted.

Measurements were made in accordance with the physical Measurement Guide planned by the Sports Science Committee. The Judoists used as experimental subjects were composed of champions recommended by ten districts of the All Japan Judo Federation, and those recommended by such organizations as universities, police force, industrial companies, and high schools;

Table 1

Name	Age		Date of birth			
Dan	Affiliation	Started Judo at age,				
Morphological Features	Items for measurement		Items for measurement			
	Body weight	kg.	Muscle strength	Back strength	kg.	
	Height	cm.		Grip strength	r   l	
	Sitting height	cm.		Arm strength	r   l	
		r	l	Agility	Reaction time	
	Length of arm	cm.			Stepping	
	Length of leg	cm.		Flexibility	Forward flexion	
	Chest circumference	cm.				
	Arm circumference, exten.	cm.			Vital capacity	cc.
	Arm circumference, flex.	cm.		Respiration	Holding breath	At rest
	Forearm circumference	cm.				After exercise
	Wrist circumference	cm.		Circul. system	Pulse	
	Thigh circumference	cm.			Blood pressure	
	Lower leg circumference	cm.				
	Ankle circumference	cm.				
	Footprint					
	Hip circumference	cm.				
	Comparat. body weight					
	Comparat. chest circum.					
	Comparat. lower leg length					
Span of finger reach						

to these were added free participants making a total of 101 athletes. In accordance with the decision reached at the meeting of the International Judo Federation held in December, 1961, these athletes were divided into heavyweight (over 80 kg., 43 individuals), middleweight (68 kg.-80 kg., 43 individuals) and lightweight (below 68 kg., 15 individuals) classes. The ages ranged between 17 years and 30 years, with an average of 21 years.

## RESULTS OF MEASUREMENTS AND DISCUSSION

Table 2 shows the average measurements of each class together with the average of the total (101 subjects). Average measurements of the candidates for the coming Olympic track and field (30 athletes) and wrestling (28 athletes) are also given.

Table 2. Results of measurements (Average)

Items for measurement		heavy wgt. (43)	middle wgt. (43)	Light wgt. (15)	Average (101)	Track and Field (60)	Wrest- ling (28)
Body weight	kg.	89.7	74.9	63.7	79.5	67.0	68.1
Height	cm.	174.4	172.5	162.3	171.8	171.9	165.8
Sitting height	cm.	95.4	94.3	89.8	94.1	93.0	91.5
Leg length	cm.	95.0	78.3	72.8	77.8	96.7	74.3
Chest circumference	cm.	105.8	97.9	93.4	100.6	92.8	96.3
Upper arm circum., extension	{r. cm. l. cm.	32.9 32.9	29.9 29.5	28.2 28.3	30.9 30.8	27.2 26.5	29.8
Upper arm circum., flexion	{r. cm. l. cm.	36.7 36.5	33.6 33.1	31.7 31.2	34.6 34.3	30.0 29.1	34.3
Forearm circumference	{r. cm. l. cm.	29.2 29.1	27.3 26.9	25.7 25.2	27.9 27.6	25.7 25.1	27.3
Wrist circumference	{r. cm. l. cm.	18.9 18.7	17.8 17.7	16.2 16.6	18.1 17.9	16.4 16.2	
Lower leg circumference	{r. cm. l. cm.	40.9 40.8	37.8 37.7	35.7 35.7	38.8 38.7	37.2 36.9	36.9
Ankle circumference	{r. cm. l. cm.	24.7 24.7	23.3 23.3	21.9 22.1	23.7 23.7	21.6 21.6	
Hip circumference	cm.	95.5	87.0	80.8	89.7		
Span of finger reach	cm.	178.6	176.0	164.8	175.4	174.7	
Back strength	kg.	148.6	142.3	123.4	142.2	179.5	172.9
Grip strength	{r. kg. l. kg.	56.9 52.9	52.2 49.8	46.9 42.8	53.4 50.1	54.5 48.2	51.1 49.0
Arm strength	{r. kg. l. kg.	32.7 33.5	29.7 29.1	24.4 24.2	30.2 30.2	25.5 24.3	39.6 39.8
Forward flexion	cm.	12.0	15.2	17.5	14.2	11.7	16.0
Vital capacity	cc.	4,977.4	5,058.1	4,228.0	4,900.5	4,692.0	4,619.6
Holding breath	{at rest sec. after exercise sec.	52.8 20.1	66.8 26.4	63.2 25.8	60.3 43.6	62.0 15.0	65.3
Subcutaneous fat	mm.	15.6	6.3	4.1	10.0	2.1	4.4
Blood pressure	{systolic mm. Hg diastolic mm. Hg	127.8 72.6	123.7 67.5	123.7 75.0	125.5 70.0		114.4 70.1
Body reaction time	{sound sec. light sec.	0.386 0.397	0.375 0.389	0.349 0.372	0.375 0.385	0.324 0.321	
Muscle contraction time	{sound sec. light sec.	0.181 0.177	0.174 0.165	0.163 0.160	0.175 0.169	0.125 0.125	
Inception of reaction	{sound sec. light sec.	0.205 0.220	0.201 0.213	0.186 0.211	0.200 0.216	0.199 0.196	
Stepping	times	93	94	97	94	112	

1. Morphological Features. Martin's method of body measurement was adopted in the present study, and for the sake of accuracy, measurements were made under the direction of Prof. Morita of the Department of Anatomy, Tokyo University of Education.

As shown in Fig. 1, the average body weight of the Judoists was 79.5 kg., and comparatively heavy. The average body weight of the track and field athletes was only 67.0 kg. and corresponded to the average of the lightweight class of the Judoists. The average body weight of the heavyweight class was 89.7 kg., and if the body weight limit of the heavyweight class were to be raised to over 87.0 kg., the average would be 94.9 kg. making the average body weight of the Judoists when compared to that of the athletes of other sports (excluding professional wrestling) considerably heavier. Thus, by designating the upper weight limit of the heavyweight class as 80 kg. the average weight of the heavyweight class was reduced by 5.2 kg., and that of the middleweight class by 2.8 kg. The difference between the average weight of the heavyweight and that of the middleweight was 14.8 kg.; the difference between the average weight of the middleweight and that of the lightweight was 11.2 kg.,

As regards height, the average of the three classes of Judoists was 171.8 cm., and nearly the same as that of the track and field athletes. The difference between the averages of the height of the heavyweight and the middleweight was 1.9 cm.; and that between the middleweight and the lightweight was 10.2 cm. showing considerable difference, and indicating a great handicap in height of the lightweight athletes.

The average of the sitting height of the three classes was 94.1 cm., and did not differ significantly from that of the track and field athletes or the wrestlers.

The average length of the lower extremity (measured from the spina iliaca anterior superior) of the track and field athletes was 96.7 cm. and considerably longer than that of the Judoists or wrestlers bespeaking the fact that a pair of long legs is an absolute necessity for track and field athletes. In the case of Judoists and wrestlers, short legs are advantageous, because by lowering the center of gravity the stability of the athletes is increased.

Fig. 2 shows circumference of the upper arm during flexion and extension. Upper arm circumference during flexion was measured at the biggest bulge with the arm forcefully and fully flexed, and with the fist clenched. The Judoists had the largest averages of the upper arm circumference during flexion and extension. However, the wrestlers showed the biggest difference between the averages of the upper arm circumference during flexion and extension (wrestlers: 4.5 cm., Judoists: 3.7 cm., track and field athletes: 2.8 cm.).

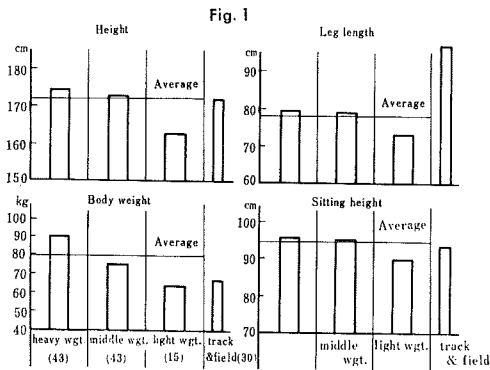
Fig. 3 shows averages of circumference of the forearm and wrist. The differences in these circumferences between the weight classes were as follows:

- R. forearm circumference: heavyweight-middleweight—1.9 cm.  
middleweight-lightweight—1.6 cm.
- L. forearm circumference: heavyweight-middleweight—2.2 cm.  
middleweight-lightweight—1.7 cm.
- R. wrist circumference: heavyweight-middleweight—1.1 cm.  
middleweight-lightweight—1.1 cm.
- L. wrist circumference: heavyweight-middleweight—1.0 cm.  
middleweight-lightweight—1.1 cm.

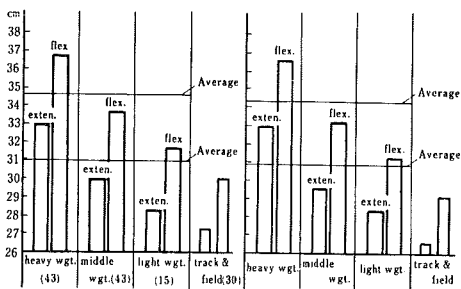
The circumference of the forearm was 3.0 cm. less than that of the upper arm, and that of the wrist was 9.8 cm. less than that of the forearm.

Fig. 4 shows the average circumference of the lower leg and the ankle. The averages of the circumference of the lower legs were 38.8 cm. and 38.7 cm. for the right and left legs, respectively. These values were not very much in excess to those of the wrestlers or the track and field champions, however, the average circumference of the ankle of the Judoists was 23.7 cm. and that of the track and field athletes 21.6 cm., indicating that the Judoist have thick legs.

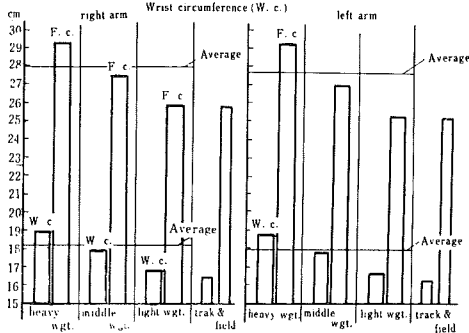
Fig. 5 shows average circumference of the chest. It will be seen that the Judoists have the largest chest measurement: Judoists, 100 cm., wrestlers 96.3 cm., and track and field athletes 92.8 cm. The average of the heavyweight Judoists was 105.8 cm., indicating a very large chest. The difference between the averages of the heavyweight class and the lightweight class was quite pronounced.



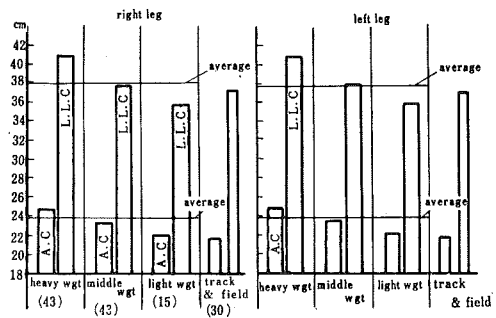
**Fig. 2**  
Upper arm circumference



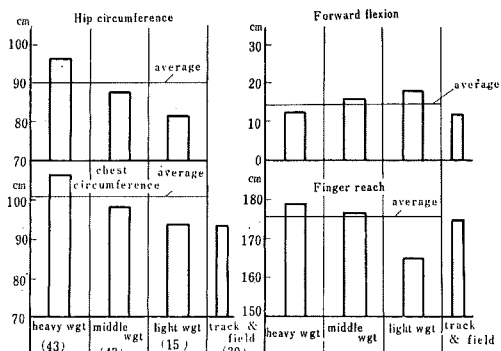
**Fig 3**  
Forearm circumference (F c.)



**Fig 4**  
Lower leg circumference (L.L.C)  
Ankle circumference (A.C)



**Fig. 5**



The hip measurements taken at the maximum bulge showed an average of 89.7 cm.—10% less than that of the chest. (Fig. 5)

Span of finger reach was measured with the arms outspread horizontally. The average length was found to be 3.6 cm. longer than the average of the height. The difference between the average of the heavyweight class and that of the middleweight class was only 2.6 cm., however, the difference between that of the middleweight and the lightweight classes was 11.2 cm. showing a considerable difference, and is thought to present quite a handicap from the point of view of "reach". (Fig. 5)

From the foregoing results of measurements of the morphological features, it is expected that the Judoists have a greater capacity of physical strength than the wrestlers or the track and field athletes. In length measurements, such as height and sitting height, considerable differences were seen between the averages of middleweight and lightweight classes. In circumferential measurements, such as chest circumference and upper arm circumference, considerable differences were seen between the averages of the heavyweight and the middleweight classes.

2. Flexibility. The only method of measuring body flexibility is by flexing the body anteriorly. The Judoists showed more flexibility (average 14.2 cm.) than the track and field athletes, but less than the wrestlers. The flexibility of the wrestlers did not vary with different body weight, however, among the Judoists the heavyweights had the least flexibility. This is thought to be due to the fact that the heavyweight Judoists had more subcutaneous fat in the abdominal region than the middleweight or the lightweight Judoists. (Fig. 5)

3. Muscle Strength. Back strength, grip strength, and arm flexion strength were measured (Fig. 6). Back strength was measured in an anteriorly flexed ( $30^\circ$ ) posture, and by the use of a KYS dynamometer. Grip strength was measured by a Smedley squeeze dynamometer. Arm flexion strength was measured by using a tensiometer after fixing the upper part of the body and shoulders firmly and with the arm flexed at an angle of  $90^\circ$ .

As shown in Fig. 6, the average back strength of the Judoists was 142.2 kg., and compared to those of the wrestlers (172.9 kg.) and track and field athletes (179.5 kg.) was remarkably low. The difference between the averages of the dorsal muscle strength of the heavyweight Judoists and the middleweight Judoists was 6.3 kg., however, the difference between the averages of the middleweight Judoists and the lightweight Judoists was 18.9 kg., indicating a considerable drop in back strength. This comparatively low muscle strength is approximately the same as that of the ordinary layman.

The averages of grip strength were 53.4 kg. for the right hand, and 50.1 kg. for the left hand, and did not differ significantly from those of the wrestlers (right 51.1 kg., left 49.0 kg.) and track and field athletes (right 54.4 kg., left 48.2 kg.) From the characteristics of Judo techniques higher values were expected of the Judoist, however, the results were quite unanticipated.

The average of right and left arm flexion strength was 30.2 kg., and although higher than the average value of the track and field athletes it was considerably lower than those of the wrestlers (right 39.9 kg., left 39.8 kg.). From the characteristics of Judo techniques the development of arm flexion strength is of great importance, and this result indicates that there is much room for further training in this respect. (Fig. 6)

The differences in the averages of grip strength and arm flexion strength between the middleweight and lightweight Judoists were greater than those between the heavyweight and the middleweight Judoists. Consequently, when two individuals were picked at random for a

tournament there is a greater handicap when a lightweight Judoist is matched against a middleweight Judoist than when a middleweight Judoist is matched against a heavyweight Judoist. The percentage ratio of muscle strength to body weight is given below.

	$\frac{\text{back. str.}}{\text{body weight}} \times 100$	$\frac{\text{r. grip str.}}{\text{body weight}} \times 100$	$\frac{\text{r. arm str.}}{\text{body weight}} \times 100$	$\frac{\text{r. arm str.}}{\text{r. arm circum.}} \times 100$
Judo	178.9	67.2	38.0	78.3
Wrestling	253.9	75.0	58.1	115.5
Track & Field	267.6	81.3	38.1	85.5

From this Table it will be seen that the track and field athletes had the strongest back strength and grip strength in comparison to body weight, and that in the Judoists the strength output was comparatively small. In other words, in the Judoists the efficiency of the muscles is comparatively low. This tendency is especially marked in the back muscle.

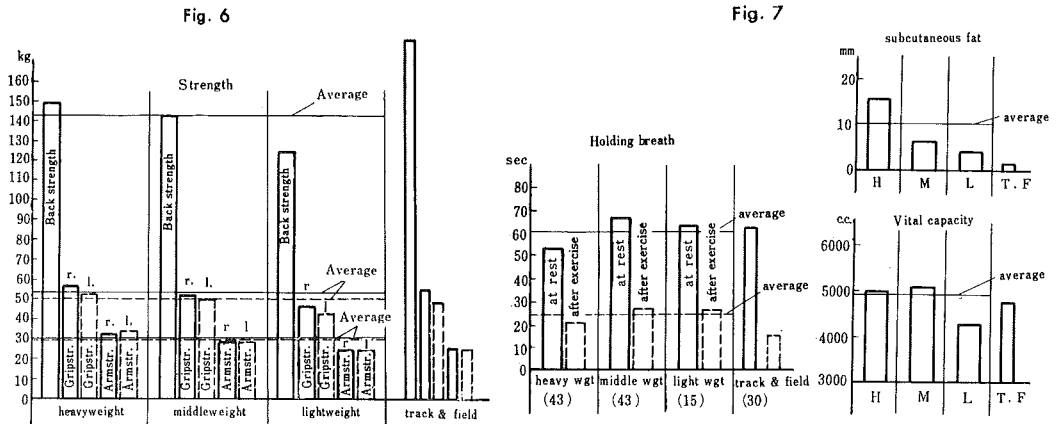
In regard to arm strength, the wrestlers had the greatest muscle strength output in comparison to body weight. The Judoists and the track and field athletes were about the same, but considerably lower than the wrestlers. A similar tendency was found when the arm strength was divided by the circumference of the flexed upper arm. Although the absolute arm muscle strength of the Judoists was very large, when compared to the cross section area of the upper arm it was comparatively smaller than that of the wrestlers. From the above Table it is evident that in muscle strength the Judoists when compared to the wrestlers were inferior in back strength and arm muscle strength, and surpassed the wrestlers slightly in grip strength only. This fact reveals that the muscle efficiency of the Judoists is comparatively low and is thought to be due to lack of muscle strength training and deposit of unnecessary subcutaneous fat.

4. Respiratory Function. Endurance time of holding one's breath was taken. The experimental subjects were made to expire as much as possible, then inspire deeply, and then expire slightly after which he was told to hold his breath as long as possible.

The endurance time at rest for holding one's breath was approximately 60 sec. for both the Judoists and the wrestlers (Fig. 7), however, the endurance time at rest and after physical exertion of the heavyweight Judoists was the shortest. Endurance time after physical exercise was taken directly after making the experimental subjects run for 1 min. at the rate of 3 steps per second. The average endurance time for the Judoists after physical exercise was 23.6 sec., and apparently showed a better average than the track and field athletes, however, a bigger load was applied to the latter, and consequently the two cannot be compared.

Vital capacity was measured by the KYS type spirometer. Three measurements were taken for each individual and the highest value was used. The Judoists showed the highest vital capacity (4,900 cc.). The average of the middleweight Judoists showed a slightly higher value than that of the heavyweight Judoists, and the difference between the averages of the middleweight and the lightweight Judoists was considerably large.

5. Subcutaneous Fat (fig. 7). Thickness of subcutaneous abdominal fat was measured by the Keys and Brozek Skinfold caliper. The figures shown in the column for subcutaneous fat in Table 2 are 1/2 of the actual measurement values. The average of the Judoists was 10 mm.,



that of the wrestlers, 4.4 mm., and that of the track and field athletes 2.1 mm., revealing that the Judoists in comparison to the other athletes had considerable amount of subcutaneous fat. Especially, the heavyweight Judoists showed an average of 15.6 mm., and one individual even had as much as 28.5 mm., indicating clearly an excess of subcutaneous fat. From this it is evident that the heavy weight was due to subcutaneous fat, and it is only natural that in these Judoists the ratio of muscle strength to body weight was comparatively low.

6. Agility. The usual method of measuring reaction time is by measuring the time required for the arm or leg to move in response to a signal, such as sound or light, in other words it is measurement of local reaction time. However, in sports the "reaction" is more generalized, and several large muscle groups take part, such as in jumping or running. In the present investigation, therefore, a jumping motion was adopted as the reaction in response to a light or sound signal. The apparatus used in the measurement was devised at the Tokyo University, Department of Scientific Studies in Physical Education. With this apparatus the time of inception of the jumping motion and also its termination may be recorded. It is thought that in the former reaction a nervous mechanism is involved, and in the latter a muscular mechanism. Consequently, the time of inception of reaction, and the time of muscular contraction as shown in Tables 8 and 9 indicate that the general reaction is considered to be divided into two factors. The averages of the reaction time of the Judoists were for sound 0.375 sec., and for light 0.385 sec., indicating that they were slower than the track and field athletes. When these values are compared to those of athletes of other sports and to those of the ordinary layman, it will be seen that the Judoists are comparatively slow (tables 10, 11) indicating that the Judoists lack in this form of agility both in the nervous and muscular aspects. This may be due to the fact that Judo requires a very complex form of agility, and consequently, the Judoists are not well practiced in this form of simple nervous pattern. The reason for the longer muscle contraction time may be due to the heavier body weight which the muscles have to support, as evidenced from the fact that the lightweight Judoists had a considerably shorter reaction time than the heavyweight Judoists. Among the Judoists the lightweights were the most agile, then came the middleweights followed by the heavyweights. It is difficult to foretell which aspect of general body reaction may be quickened by training, but it is fully expected that the muscle contraction time may be shortened. By employing a training method which cultivates instantaneous muscular reaction, and which increases concentration of attention, it is expected that agility among the Judoists may be considerably enhanced.



Fig. 8

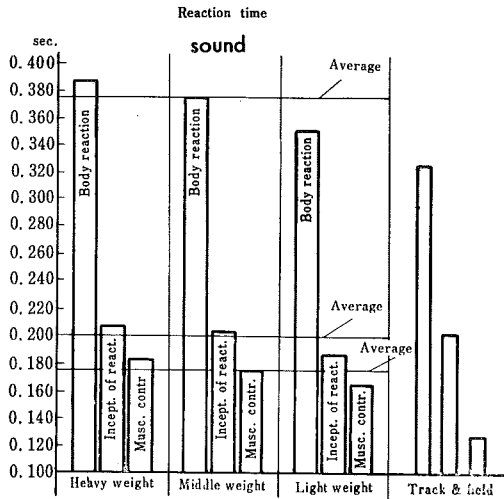


Fig. 9

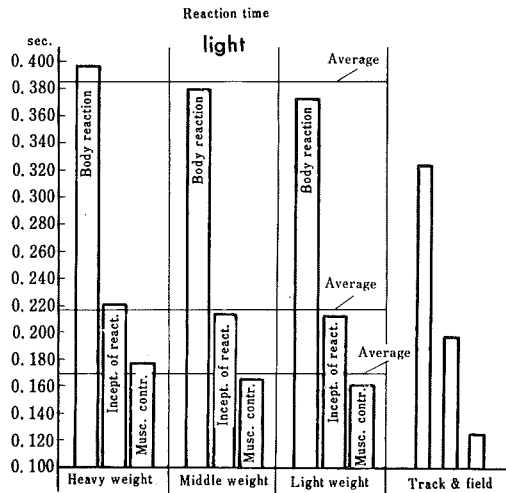


Fig. 10

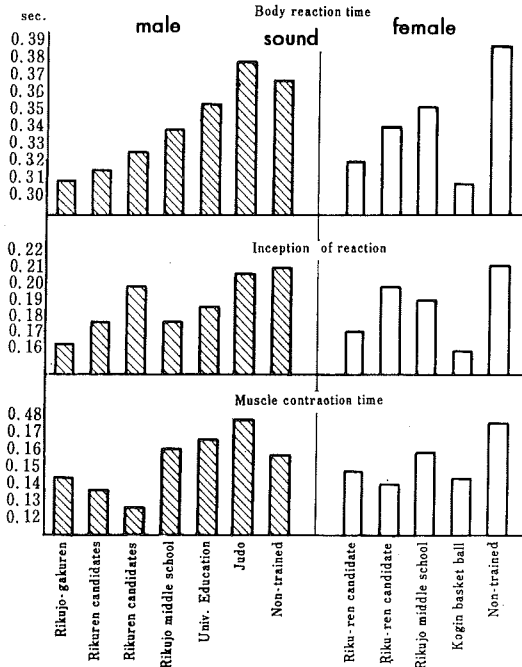
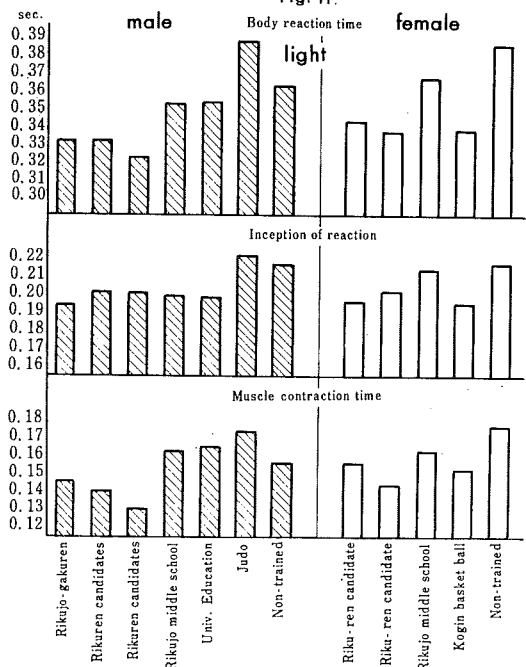


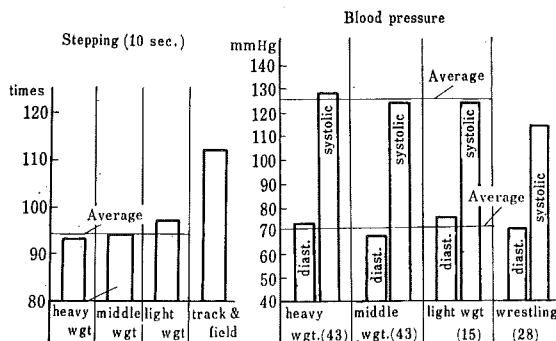
Fig. 11



In the 10 second stepping test which show agility of the legs, the average of the Judoists was similar to that of the ordinary layman, but considerably lower than that of the track and field athletes (fig. 12).

7. Circulatory Function. Blood pressures—systolic and diastolic—were measured by the Riva Rocci manometer.

Fig. 12



The average blood pressures for the Judoists were: systolic pressure, 125.5 mm. Hg. and diastolic pressure, 70.8 mm. Hg, showing a considerably higher systolic pressure than the wrestlers (systolic pressure, 114.4 mm. Hg, diastolic pressure, 70.1 mm. Hg). However, in spite of the comparatively high systolic pressure there is no need for concern as the pulse pressure was 54.7 mm Hg. A few, however, registered a pressure higher than 150 mm. Hg, indicating a possibility of becoming hypertensive.

### SUMMARY

- 1) Average body weight of Judoists was 71.5 kg., indicating that these athletes were heavier than the athletes of other sports (excluding professional wrestlers).
- 2) Average height was 171.8 cm.. There was more handicap between the lightweight and the middleweight Judoists than between the heavyweight and the middleweight Judoists.
- 3) The circumference of the upper arm both during flexion and extension was greater in the Judoists than in the wrestlers and track and field athletes. However, the rate of increase by muscular contraction was the greatest in the wrestlers.
- 4) Average chest circumference of the Judoists was 100.6 cm. and far exceeded that of the other athletes.
- 5) Hip circumference was 10% shorter than the chest circumference.
- 6) Average span of finger reach was 3.6 cm. longer than that of height, and as with height the handicap between the middleweight and lightweight Judoists was greater than that between the heavyweight and the middleweight Judoists.
- 7) The heavyweight Judoists remarkably lacked in flexibility.
- 8) The Judoists were slightly superior than the wrestlers only in grip strength, but in back strength and arm strength the former were far inferior than the latter. Furthermore, in the Judoists the ratios of grip strength, back strength, and arm strength to body weight were lower than those in the wrestlers. A similar tendency was found in the ratio of arm strength to arm circumference.

9) The heavyweight Judoists had the shortest endurance time for holding breath, both at rest and after physical exertion.

10) Vital capacity of the Judoists was greater than the wrestlers.

11) Generally, subcutaneous fat was comparatively thick in the Judoists. This was especially marked in the heavyweight Judoists.

12) In comparison to athletes of other sports, general body reaction time was remarkably slow in the Judoists. This was especially so in the heavyweight Judoists.

13) Systolic pressure was slightly higher in the Judoists than in the other athletes, however, since the pulse pressure was quite high there was no need for concern.

From the foregoing analysis it is concluded that the Judoists, although in possession of excellent physique, are not fully exhibiting their potential capabilities, especially in their muscle strength and agility. This is thought to be particularly due to the presence of unnecessary subcutaneous fat, and also to lack of rational and efficient training in the development of muscle strength and agility. It is erroneous to assume that since back strength is not very necessary in Judo, its development may be disregarded; the harmonious and over-all development of muscle strength is of the utmost importance.

The Judoists showed a fairly good flexibility, however, there is ample room for improvement. Further investigations in the respiratory-circulatory function by the Harvard Step test, and the Treadmill test are necessary. In the present study, due to limitations in the number of investigators and apparatuses, measurements of endurance, balance, physical capacity were not made, and consequently further studies are necessary in order to obtain an over-all understanding of the whole aspect of physical fitness of Judoists.

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