PHYSICAL FITNESS OF THE TOP JUDOISTS IN JAPAN

(1962)

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In August last year (1961), the Society of Scientific Studies in Judo conducted a large scale survey of the physical fitness of the participants in the training camp sponsored by the Kodokan in order to fortify the candidates for the coming Olympic Games. As a result of this survey, many important data were obtained, together with many useful suggestions and problems.

This year (1962) again, a similar training camp was held for two weeks in Numazu, Shizuoka Prefecture. Availing of this opportunity, we conducted a further over-all survey on the physical fitness of the athletes, on the first day.

As regards items for measurement, reference was made to the results obtained last year, and in order to obtain a many-sided insight into the physical fitness of the athletes, careful selection of the items for measurement was made, and further items, such as leg strength, endurance, flexibility, and circulatory function were added.

ITEMS FOR MEASUREMENT

Morphological features: body weight, height, leg length, chest circumference, upper arm circumference (in flexion, in extension), forearm circumference, wrist circumference, thigh circumference, lower leg circumference, ankle circumference, hip circumference, span of finger reach, and subcutaneous fat.

Muscle strength: back strength, grip strength, arm strength, and leg strength.

Endurance: arm muscle endurance.

Flexibility: body ante-flexion, and body twisting.

Respiratory function: vital capacity, holding breath time.

Circulatory function: Harvard stepping test.

Agility: whole body reaction time, and stepping.

The 46 subjects selected for this study consisted of candidates for the coming Judo Olympic Games, and also auxiliary champions. Their names are as follows: Heavyweights: T. Kaminaga, M. Inokuma*, S. Matsushita, H. Yamagishi*, K. Sato, A. Takahashi*, M. Shigematsu*, A. Tanaka*, M. Matsunaga*, T. Murato, Y. Maeda, Y. Furuse, S. Kumamoto*, A. Shirasaki, A. Nakano, O. Kamiya, T. Yamamoto, S. Sakaguchi, T. Ikegami, M. Kato*, and M. Machida*, totalling 21 members.

Middleweights: O. Sato, K. Seki*, S. Enshu*, K. Sugihara, K. Ashida*, M. Hiraishi,

Table 1 Results of Measurements (Average)

Items \ Weight		1962 year heavy wgt. (21)	middle wgt. (12)	light wgt. (13)	average (46)	1961 year heavy wgt. (43)	middle wgt. (43)	light wgt. (15)	average (101)
Body weight	kg	95.8	78.0	66.4	82.9	89.7	74.9	63.7	77.5
Height	cm	179.2	173.5	165.3	173.8	174.4	172.5	162.3	171.8
Leg length	cm	98.4	91.7	88.9	94.0				
Chest circumference	cm	107.3	98.4	93.2	101.0	105.8	97.9	93.4	100.6
Upper arm circum. extension R.	cm	33.8	31.1	29.0	31.7	32.9	29.9	28.3	30.9
Upper arm circum. extension L.	cm	33.6	31.1	29.3	31.7	32.9	29.5	28.3	30.8
Upper arm circum. flexion R.	cm	38.6	25.5	33.4	36.3	36.7	33.6	31.7	34.6
Upper arm circum. flexion L.	cm	37.9	35.0	33.6	36.0	36.5	33.1	31.2	34.3
Forearm circum. R.	cm	31.4	29.2	27.7	29.8	29.2	27.3	25.7	27.9
Forearm circum. L.	cm	31.2	29.0	27.3	29.5	29.1	26.9	25.2	27.6
Wrist circum. R.	cm	19.6	18.6	17.4	18.7	18.9	17.8	16.7	19.1
Wrist circum. L.	cm	19.4	18.5	17.3	18.6	18.7	77.7	16.6	1ℒ.9
Upper leg circum. R.	cm	63.0	56.4	52.7	58.4				
Upper leg circum. L.	cm	62.7	56.6	52.7	58.3				
Lower leg circum. R.	cm	42.7	38.8	36.9	40.0	40.9	27 8	35.7	38.8
Lower leg circum. L.	cm	42.2	39.5	36.2	39.8	40.8	37.7	35.7	38.7
Ankle circum. R.	cm	25.3	23.0	55.3	23.7	24.7	23.3	21.9	23.7
Ankle circum. L.	cm	25.2	23.2	53.2	23.7	24.7	13.3	221.	23.7
Hip circum. R.	cm	105.2	96.1	91.5	98.9	95.5	87.0	80.8	89.7
Hip circum. L.									
Span of finger reach	cm	183.4	176.1	167.4	177.0	178.6	176.0	164.8	175.4
Subcutaneous fat	mm	16.9	9.6	8.4	12.6	31.2	12.6	8.2	20.0
Back strength	kg	173.6	165.2	152.9	165.6	148.6	142.2	123.4	142.2
Grip strength R.	kg	63.7	61.6	51.8	59.8	65.9	52.2	46.9	53.4
Grip strength L.	kg	60.8	53.4	51.0	57.2	52.9	49.8	42.9	50.1
Arm strength R.	kg	36.9	32.4	30.5	33.9	32.7	29.7	24.4	30.2
Arm strength L.	kg	37.6	33.1	31.0	34.6	33.5	29t1	24.2	30.2
Leg strength R.	kg	67.7	61.7	55.3	62.7				
Leg strength L.	kg	65.2	59.9	53.2	59.1				
Muscle endurance	times	64.3	66.1	67.0	65.5				
Body ante flexion	cm	13.3	16.1	16.8	15.0	12.0	15.2	17.5	14.2
Body twisting R.	Ang.	116.1	120.4	120.6	118.5				
Body twisting L.	Ang.	112.1	116.4	116.3	114.3				
Vital capacity R.	cc	5438.6	5098.3	4187.7	4996.3	4977.4	5058.1	4228.0	4900.5
Vital capacity L.									
Holding breath at rest	sec.	54.5	57.3	91.2	57.1	52.8	66.8	63.2	60.3
Holding breath after exercise	sec.	19.2	20.8	22.8	20.6	20.1	26.4	25.8	23.6
Harvard step test	point	87.6	98.8	101.2	94.5				
Body reaction time	sec.	0.364	0.374	0.363	0.366	0.397	0.379	0.372	0.385
Inception of reaction	sec.	0.210	0.223	0.218	0.215	0.220	0.213	0.212	0.216
Muscle contraction time	sec.	0.154	0.151	0.145	0.151	0.177	0.165	0.160	1.169
Stepping	times	98.6	104.4	101.5	100.9	93	94	97	94

S. Kitamura, N. Nakada, H. Nishikawa, M. Eguchi*, T. Sengoku, and K. Ito*, totalling 12 members. Lightweights: H. Iwata*, S. Ashigaki, Y. Uchino*, T. Nishimura*, N. Miyazaki, K. Ando, H. Nakaya, M. Hara, M. Haneda, H. Kitai, H. Tomita*, T. Shigeoka*, and K. Hayashida*, totalling 13 members.

The 20 Judoists marked with* participated in a similar study last year also, and their measurements were used as reference in the study of the effect of training. The ages of the Judoists ranged between 17 and 27 years, with an average of 21.2 years.

RESULTS OF MEASUREMENTS AND DISCUSSION

Table 1 shows averages of measurements classified according to weight class, and also the general averages of the measurements taken in 1961 and 1962. Table 2 shows comparisons of measurements taken in 1961 and 1962, of those 20 Judoists who participated in both events.

The present study will be mainly based on the comparisons of measurements taken in 1961 and 1962, however, in regard to new items of measurement, comparisons were made with similar measurements made on athletes of other sports.

1) Morphological features. The upper limit of the scale used for measuring body weight in this survey was 100 kg., consequently, those Judoists who weighed more than 100 kg. were recorded as weighing 100 kg.. Nearly all measurements of morphological features showed increases when compared to those of last year. The general average of body weight was 82.9 kg. showing an increase of 3.4 kg. to that of last year. The heavyweight Judoists, particularly, showed marked increases in body weight. Furthermore, increases in measurements when compared to those of last year were seen in the following items: 2.0 cm. in height, 0.4 cm. in chest circumference, 0.8 cm. in right upper arm circumference when extended, 0.9 cm. in left arm circumference when extended, 1.7 cm. in right upper arm circumference when flexed, 1.7 cm. in left upper arm circumference when flexed, 1.9 cm. in right forearm circumference, 1.9 cm. in left forearm circumference, 0.6 cm. in right wrist circumference, 0.7 cm. in left wrist circumference, 1.2 cm. in right lower leg circumference, 1.1 cm. in left lower leg circumference, 9.2 cm. in hip circumference, and 3.9 cm. in span of finger reach. Noteworthy were increases seen in upper arm circumference when flexed, and also in forearm circumference. However, the foregoing comparisons were made betweeen two different groups, because some of the Judoists who participated in the survey performed this year were not included in that of last year. Therefore, in order to investigate the effect of training, comparisons of measurements taken this year and last year on the same group of Judoists were also made (Table 2). As a result of this study, increases in this year's measurements as compared to those of last year were found in the following items: 1.6 kg. in body weight, 0.4 cm. in height, 0.8 cm. in right upper arm circumference when extended, 0.5 cm. in left upper arm circumference when extended, 1.7 cm. in right upper arm circumference when flexed, 1.5 cm. in left upper arm circumference when flexed, 1.4 cm. in right forearm circumference, 1.4 cm, in left forearm circumference, 0.4 cm. in right wrist circumference, 0.5 cm. in left wrist circumference, 0.6 cm. in right lower leg circumference, 0.1 cm. in left lower leg circumference, and 8.5 cm. in hip circumference. Particularly noteworthy were the marked increases in upper arm circumference when flexed, and in forearm circumference. From the foregoing, it is evident that in the same Judoists, and also in general, much improvement in physique is evident when compared to that of last year.

Thickness of subcutaneous fat. Although the Keys-Brozek's device for measuring the thickness of subcutaneous fat shows some individual differences depending on the measurer, results of last year's measurements were compared to those of this year's measurements. The general average of this year showed a decrease of 7.4 mm., and particularly, the heavyweights showed a marked decrease, this year. However, a tendency towards an increase was noted in the lightweights, which is somewhat alarming. Comparison of the thickness of subcutaneous fat measured this year and that measured last year in the same group of Judoists also show a similar tendency, indicating that the heavyweights put considerable effort in order to reduce subcutaneous fat. In the present study, measurements of abdominal skin thickness were not divided by two, but shows actual readings. From the foregoing, it is evident that as far as the morphological features are concerned, considerable improvements have been accomplished this year, but what about the functional aspect?

2) Muscle strength. Muscle strength is the maximum strength which a muscle is capable of exhibiting, regardless of time. It may be measured for example, by means of a squeeze dynamometer or a back strength dynamometer. Since muscle strength is considered to be the motive power of muscular motion, its measurement is an important item in the evaluation of physical fitness. Generally, measurement of muscle strength is divided into measurement of maximum muscle strength and measurement of muscle endurance. In this year's survey, besides

Table 2. Comparisons of the general averages of the measurements between 1961 and 1962. (same Judoists)

Genral average (20)

Items		1961	1962	Items		1961	1962
Body weight	kg	82.7	84.3	Grip strength R.	kg	56.0	60.8
				Grip strength L.	kg	51.6	59.5
Height	cm	172.6	173.0	Arm strength R.	kg	31.1	33.5
				Arm strength L.	kg	30.5	33.8
Chest circum.	cm	102.4	102.4	Leg strength R.	kg		62.3
				Leg strength L.	kg		60.3
Upper arm circum. extension R.	cm	31.4	32.2	Muscle endurance	times		15.8
Upper arm circum. extension L.	cm	30.9	31.4				
Upper arm circum. flexion R.	cm	35.1	36.8	Body ante flexion	cm	14.7	15.8
Upper arm circum. flexion L.	cm	34.4	35.9				
Fore arm circum. R.	cm	28.6	18.4	Body twisting R.	Ang.		117.0
Fore arm circum. L.	cm	28.2	18.0	Body twisting L.	Ang.		114.0
Wrist circum.	cm	18.4	18.8	Vital capacity R.	cc	4904.0	5078.0
	cm	18.0	18.5	Vital capacity L.			
Upper leg circum. R.	cm		58.7	Holding breath after exer.	sec.	55.9	62.2
Upper leg circum. L.	cm		58.6	Holding breath at rest	sec.	21.7	20.6
Lower leg circum. R.	cm	39.9	40.5	Harvard step test	point		94.7
Lower leg circum. L.	cm	39.9	40.0				
Ancle circum. R.	cm	23.9	23.7	Body reaction time	sec.	0.385	0.361
Ancle circum. L.	cm	23.8	23.7				
Hip circum.	cm	61.6	100.1	Inception of reaction	sec.	0.216	0.209
Span of finger reach	cm	177.4	177.1	Muscle contraction time	sec.	0.169	0.125
Subcutaneous fat	mm	22.6	14.5	Stepping	times	96.8	104.4
Back strength	kg	138.8	168.5				

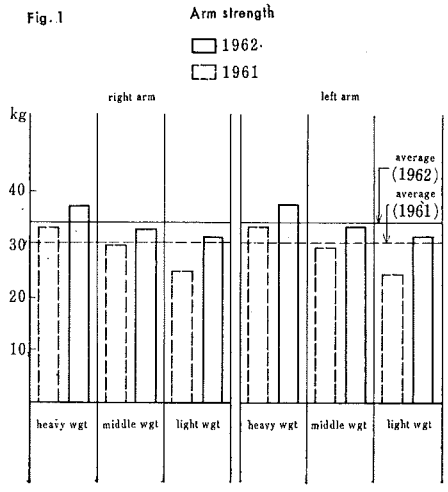
measurements of back strength, grip strength, and arm strength (flexed), such items as leg strength (extended), and arm muscle endurance were added. As shown in Table 1 results of this year's measurements show considerable increases over those of last year in back strength (165.6 kg). and grip strength (right, 59.8 kg., left, 57.2 kg.). Measurements on the same group of Judoists also show considerable increases this year (Table 2).

Arm strength (flexed) which is an important factor in Judo was studied by measuring the maximum output of arm muscle strength by further flexing the elbow from a flexed (90°) position. The arm strength measurements when compared to those of last year show considerable increases: right, 33.9 kg. (+3.7 kg.), and left, 34.6 kg. (+4.4 kg.) (Fig. 1). Measurements in the same group of Judoists, also show increases when compared to those of last year (right, +2.4 kg.: left, +3.3 kg.) These results indicate that muscle strength training had been effective.

Leg strength (extension leg strength) was studied by measuring the maximum output of leg muscle strength by extending the knee from a flexed (90°) position. The general average of leg strength was 62.7 kg. and 59.1 kg. for the right and left legs, respectively. Ikegami's (heavyweight) leg strengths were 89 kg. and 85 kg. for the right and left legs, respectively. The average leg strengths of the track and field athletes (Olympic candidates) were 77.6 kg. and 76.4 kg. for the right and left legs, respectively, indicating that the track and field athletes, in general, have more powerful leg strength than the Judoists.

Muscle endurance. There are two kinds of muscle endurance. One is measured by the length of time one can hold a weight, the other is measured by the number of times one can lift a weight. The former is called static endurance, and the latter kinetic endurance. In Judo, kinetic endurance is more important than static endurance. Fig. 2 is a diagramatic representation of the device used in measuring kinetic endurance. A weight, 1/3 of the maximum muscle strength was lifted at the rate of once every second by flexing the elbow from 120° to 90°, until the rhythm became irregular and confused. The number of times which the subject could lift the weight rhythmically was designated as representing kinetic endurance. The general average of the kinetic endurance thus measured was 65.5 times, and it was found that those with more powerful absolute muscle strength were not necessarily superior in kinetic endurance. For example, among the heavyweights, Kato who was inferior in muscle strength lifted the weight 97 times and surpassed all others in kinetic endurance. The average of the track and field athletes

Fig. 1



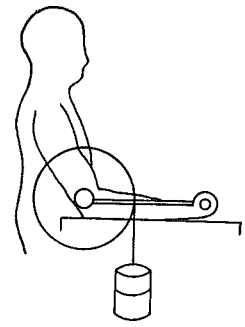


Fig. 2
Apparatus of endurance
(Arm Ergometer)

was 50.9 times, indicating a very low average, however, that of the university students (non-Judoists) was 75 times, showing a higher average than the general average of the Judoists. From the special characteristics of Judo, it is thought that kinetic endurance is of great importance, and the results of the aforementioned measurements suggest that further training in this field is much to be desired (Fig. 3).

In order to practice training in kinetic endurance effectively, let us first consider more deeply what is involved in muscle endurance. For a muscle to work continuously, the nervous factor is also of great importance besides the muscular factor. In other words, the nerves controlling the muscles must have the ability to function continuously in order that the muscle work continuously. The ability of the nerves to function continuously is, in other words, the ability to endure, and this will to continue is an important factor in muscle endurance. Also, together with the will to continue, the ability to co-ordinate the nerves is of great importance. The muscles involved in the flexion and extension motions when operating the arm ergometer are the biceps (flexion) and triceps (extension) muscles, and when the muscles have to perform this sort of repeated motion, contraction and relaxation of the muscles alternate rhythmically in a way so that when the biceps muscle is contracting, the triceps muscle is simultaneously relaxing, and vice versa. The nerves play an important role in order to perform this well co-ordinated motion, i.e., when the flexor muscle enters the contraction phase, the nerves controlling the extensor muscles are reflexly inhibited. This is due to what in physiology is termed reciprocal innervation. In short, nervous impulses from the cerebrum are sent punctually to the extensor and flexor muscles, alternately, and it is of utmost importance that the alternation of the production or inhibition of these impulses are performed rapidly.

Furthermore, besides the nervous factor there is another important factor to be considered, i.e., the blood supply to the muscles. Consequently, in order to improve muscle endurance, it is more important to develop the capillary blood supply to the muscles than to just thicken the muscles. So it is that in order to improve muscle endurance, there are three important factors to be considered, i.e., blood supply to the muscles, continuation of the will, and nervous control of the muscles.

Since today, Judoists are classed according to weight, it is not wise to lay stress only on putting on body weight—more importance must be laid on developing muscle strength to

Fig. 3

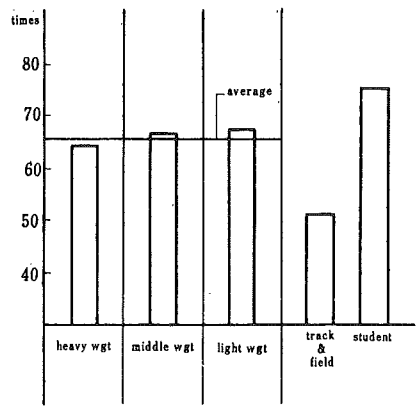
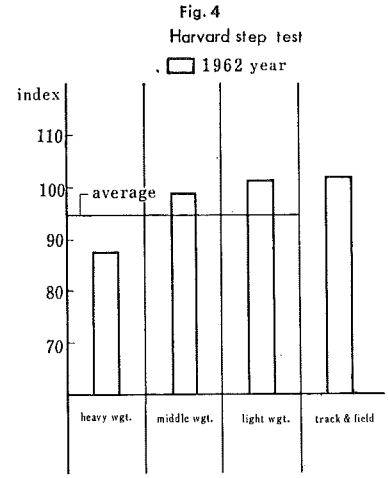


Fig. 4



match body weight. This being the case, we shall now consider the ratio of muscle strength to body weight, and also the ratio of muscle strength to the cross section of the muscle.

A study of the ratio of muscle strength to body weight indicates that the middleweight and lightweight Judoists have superior muscle strength output in relation to bodyweight than the heavyweight Judoists (Table 3). Especially noteworthy were Hara (lightweight), Tomita (lightweight), and Ito (middleweight) whose back strength in relation to body weight was remarkably powerful, whereas Yamagishi (heavyweight) had considerable weak back strength in relation to body weight. It was also found that the heavyweights were also inferior in grip strength, arm strength, and leg strength in relation to bodyweight.

We shall now consider arm strength and leg strength in relation to the circumference of the arm and leg, respectively. This may be done by dividing the arm strength and leg strength by the circumferences of the arm and leg, respectively. In this way we are able to compare muscle output per cross section of the muscle. Unlike the ratio of arm strength to body weight, the ratio of arm strength to arm circumference was found to be the highest in the heavyweights. However, no significant difference among the weight classes was found in the ratio of leg strength to leg circumference. Consequently, although the cross section ratios were about the same, the absolute muscle strength was the greatest in the heavyweights which is in accordance with the general principle that the thicker the muscle the more the muscle strength. The fact that the heavyweights were inferior in body weight ratio than in the cross section ratio indicates that there is something else other than muscle to increase their weight.

From the foregoing, the following two points must be given due consideration in muscle strength training.

1) Removal of unnecessary fat.

2) Increase in muscle strength per unit cross section of muscle.

Removal of unnecessary fat around muscle fibers means reducing weight, and at the same time replacement of fat by muscle fibers. This may be accomplished by uninterrupted training, thereby preventing the accumulation of unnecessary fat. The extent of the removal of fat may be roughly judged by measuring skin thickness (thickness of subcutaneous fat).

Increase in muscle strength per unit cross section of muscle means concentrated use of energy, and it may be accelerated by training in mental concentration. In terms of physiology, this is to develop the ability to send from the cerebrum nervous impulses which will activate all the muscle fibers to their maximum efficiency. This may be accomplished by weight training, and has a bearing on the problem of whether to use weight corresponding to the maximum muscle strength or 2/3 of the maximum muscle strength. If the object of the training is to thicken muscle fibers, it is sufficient to use weight corresponding to 2/3 of the maximum muscle strength. However, if the object is to obtain an ability to display one's maximum muscle efficiency it is necessary to use weight corresponding to the maximum muscle strength. In short, this sort of training is aimed at making the motor nerves to function actively rather than to thicken the muscles.

3) Flexibility. It goes without saying that flexibility is an important factor in every sport. Usually, the degree of ante-flexion of the body has been designated as the criterion of flexibility. The general average of the flexibility of the Judoists thus measured was 15 cm. which when compared to those of the athletes of other sports is not inferior. However, the average of the heavyweight Judoists was 13.3 cm. indicating a lower flexibility than the

middleweight and lightweight Judoists. This year, in addition to body ante-flexion, body twisting was measured by the following method. A pole is held behind the athlete's back and without moving the legs the body is twisted. The degree of torsion is measured by the angle of shift of the string suspended from the pole. The general average was approximately 120°, and was about the same as that of the university students. As in the case of ante-flexion, the heavyweights showed the lowest degree of torsion.

4) Respiratory Function. Measurements of vital capacity, and the length of time one could hold one's breath (at rest, and after exercise) were used as the respiratory function test. The general average of the vital capacity as well as individual vital capacity showed slight increases as compared to those of last year, however, the duration of time for holding one's breath (both at rest and after exercise) was shorter than that of last year.

5) Circulatory Function. Measurement of pulse rate and blood pressure have been usually used as circulatory function tests. This year, in order to study the endurance of the heart and lung, Harvard stepping test was also used. This test consists in stepping up and down a platform 20 inches (50.8 cm.) high at the rate of once in 2 seconds. This is continued for 5 minutes after which, the subject rests on a chair for 1 minute, thereafter the pulse rate is examined from 1-1:30 minutes ,2-2:30 minutes, and 3-3:30 minutes. Physical fitness index is calculated by using the following formula:

$$\text{Harvard stepping test index: } \frac{\text{stepping time} \times 100}{2 \times (\text{sum of pulse rate taken 3 times})}$$

The higher the index, the better it is, and for the general public above 90 is considered good. However, for athletes the standard is somewhat higher, and above 110 is considered excellent. This test shows how quickly the heart and lungs are able to adapt themselves to physical exertion. As shown in Fig. 4, the lightweight Judoists showed a high index, corresponding to that of the track and field athletes, however, the heavyweight Judoists showed a considerably low index. In other words, since in the heavyweight Judoists, the respiratory function, breath holding time, and circulatory function were inferior when compared to those of the other weight classes, the oxygen transportation system centering on the heart and lungs, of the heavyweight Judoists may be said to be functioning rather inefficiently. The cause may be attributed to undue accumulation of subcutaneous fat, and lack of training for increasing stamina.

Table 3. Muscle strength per body weight and cross section of muscle

	Back strength / Body wgt.	Grip strength / Body wgt.	Arm strength / Body wgt.	Leg strength / Body wgt.	Arm strength / Up. arm circum.	Leg strength / Up. leg circum.
Heavy weight	1.81	0.67	0.43	0.72	0.12	1.10
Middle weight	2.12	0.79	0.40	0.77	0.95	1.10
Light weight	2.21	0.80	0.38	0.84	0.94	1.05
Average	2.03	0.74	0.43	0.77	0.98	1.09

6) Agility. Agility is manifested in different ways depending on the kind of sport, however, together with muscle strength, it is an indispensable factor in the analysis of physical fitness. Various tests, such as the Burpee test, and the side step test are used in measuring agility however, the most fundamental form of investigating agility is the measurement of reaction time. Especially, in sports, since general reaction is of more importance than local reaction, in the present study, general reaction time was measured by the apparatus deviced at the Institute of Physical Education, Tokyo University. This method consists in having the athlete stand on a platform equipped with a strain-meter, and in response to a light signal jumps up as quickly as he can. The time which elapses between the moment the light signal is given and the moment the subject jumps in response is measured. The special characteristics of this method are: 1) It is a motion which consists in elevating one's body. 2) The general reaction time may be divided into a) time required to start the motion in response to the signal, and b) time during which the muscles are contracting. The former shows reaction time of the nerves, and the latter the speed of muscle contraction. The main reasons underlying the individual differences in reaction time are the difference in transmission time of the nervous impulses within the cerebrum and also the difference in the speed of muscle contraction. Adequate training will result in facilitation of the synapse and increase in the speed of muscle contraction. In order to investigate the effect of training done during the past one year, a comparison was made between the results obtained this year and those of last year. As seen in Table 1, results obtained this year show considerable improvement over those of last year, particularly in the speed of muscle contraction. Also, noteworthy is the marked improvement attained by the heavyweight Judoists. Improvement in the nervous factor was attained uniformly, regardless of the weight class. However, when compared to the general reaction time of the track and field athletes there is still much room for improvement (general reaction time of track and field athletes, 0.321 seconds; inception of reaction, 0.196 seconds; muscle contraction, 0.125 seconds).

In the stepping test the subject sits on a chair and moves his legs alternately for 10 seconds, as fast as possible. This test is used to determine whether the motor nerves of the legs are functioning adequately. The average, this year, was 100.9 times showing a great improvement over that of last year. Heavyweight Judoist, Sakaguchi showed the lowest with 60 times, and needs attention in this respect.

SUMMARY

As a result of this year's survey, further insight regarding the physical fitness of Judoists was obtained. Distinct improvements over the conditions of last year were observed in the morphological features, muscle strength, and agility. However, in muscle endurance, and respiratory and circulatory functions there remains much room for further improvement. This was especially so in the case of the heavyweight Judoists who, the survey indicate, require further effort to remove unnecessary fat in order to lighten the burden of the heart, and to increase muscle strength per unit body weight, and also to increase endurance. On the whole Judoists have a large athletic capacity, and there is much room for further improvement.

Needless to say the object of the present study was to obtain a clear insight into the physical fitness of the Judoists, thereby enabling those concerned to formulate the most effective method of training in order to increase the abilities of the athletes.