

5-3. AN ANALYSIS OF SOMATOTYPES AND POSTURES OF JUDOISTS

—In the case of Japanese and French Judoists—

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It has been known that there are specific differences of the somatotype and the posture between Judoists and other sports players. However, only a few reports have been published regarding the comparative analysis of Judoists' somatotypes and postures.

It would be possible to make a fairly good guess from the weight as to whether he is a man of obesity or a slender person. However, the taller a person is, the heavier he must be and thus it is difficult to judge right, whether he is stout or slender only from weight. The physique index has been devised in order to be able to judge accurately. It is called Quetelet's Index to divide weight by height and to multiply it by 100. It is generally called the body weight ratio.

Kaup's Index is to divide weight by the square of height and to multiply it by 10^3 . The figure gained by dividing weight by the cube of height and multiplying it by 10^7 is called Rohrer's Index. Since a cube is the closest form to the human body, Rohrer's Index is more frequently used.

Takeuchi¹⁾ of Shinshu University calculated the Rohrer's Index of the Judoists at Tokyo Olympics and reported that the average value of heavy weight class Judoists was 160.7, of middle weight class was 147.1, and of light weight class was 137.8. Besides Rohrer's Index there are Livi's Index, Ponderal Index, and standard body weight. These are effective to judge the average people's physique, but they are not proper to judge the body composition of a muscular person such as a sports player.

Sheldon devised a method of judging physique types based on the germ layer theory of biology, dividing the body types into three; endomorphy, mesomorphy, ectomorphy. However, Sheldon's method shows lots of ambiguous points reflecting the observer's subjectivity because of the ocular inspection based on the full length picture. Therefore, palpation was added, and the method of dividing the somatotypes objectively based on the body measurement value has recently been adopted. This method is the classification system by Heath and Carter, by measuring height, body weight, skinfold fat thickness, epiphysis width and girth in order to calculate each element factor.

Recently, Farmosi of Physical Education University in Hungary (School of PE) took a morphological measurement of Hungarian National Judo Team by Heath-Carter method classifying somatotypes. As one of the characteristics of Judoist's posture, it gives an unfavorable impression of being distorted with stoop and bandy legs. In fact, Asami and his colleague recorded the spinal column curvature of college Judoists and indicated that their posterior curvature of thoracic vertebrae and anterior curvature tendency of lumbar are more remarkable than other sports players. In this survey we measured the morphology and posture of Reinforced All-Japan Judoists (13 players) and of French Team (10 players), and have tried to clarify some of the characteristics of each Judoist's somatotype and posture.

Table 1 Morphology and Somatotype of Reinforced All-Japan Judo Players

body weight	classification/ name	height (cm)	weight (kg)	Quetelet I.	Kaup I.	Rohrer I.	Livi I.	Ponderal I.	endom.	mesom.	ectom.
-60kg	M · A	164.9	63.0	38.20	23.17	140.5	24.13	41.44	1.5	6.5	2.0
	T · D	162.7	64.5	39.64	24.37	149.8	24.65	40.57	2.0	7.0	1.0
-65kg	Y · A	166.1	66.0	39.73	23.92	144.0	24.33	41.10	1.5	7.5	1.5
	T · M	163.3	64.0	39.26	24.00	147.0	24.54	40.75	3.5	7.5	1.5
-78kg	T · A	175.0	81.0	46.29	26.45	151.5	24.72	40.45	1.5	8.5	1.0
	H · T	175.7	83.0	47.24	26.89	153.0	24.83	40.28	3.5	7.5	1.0
-86kg	S · N	176.0	87.5	49.72	28.25	160.5	25.22	39.64	2.0	8.5	0.5
	H · S	177.7	91.0	51.21	28.82	162.2	25.31	39.51	2.5	8.5	0.5
-95kg	M · I	176.0	106.0	60.23	34.22	194.4	26.89	37.19	5.5	10.0	0.5
	H · M	178.0	99.5	55.90	31.40	176.4	26.03	38.41	6.0	10.0	0.5
+95kg	I · M	183.0	125.0	68.31	37.33	204.0	27.32	36.60	6.5	11.0	0.5
	K · T	178.2	117.0	65.66	36.84	206.8	27.45	36.43	6.5	10.5	0.5
	K · A	201.1	112.0	55.69	27.69	137.7	23.97	41.70	2.0	8.0	2.0
	n	13	13	13	13	13	13	13	13	13	13
	mean	175.2	89.19	50.54	28.72	163.6	25.33	39.54	3.38	8.54	1.00
	S. D.	10.18	21.49	10.16	4.85	24.06	1.20	1.82	2.00	1.42	0.58

Table 2 Morphology and Somatotype of Reinforced French Judo Players

body weight	classification/ name	height (cm)	weight (kg)	Quetelet I.	Kaup I.	Rohrer I.	Livi I.	Ponderal I.	endom.	mesom.	ectom.
-60kg	G · D	161.4	68.0	42.13	26.10	161.7	25.29	39.54	2.0	8.0	1.0
	P · N	162.2	64.5	39.77	24.52	151.1	24.72	40.44	1.5	8.5	1.0
-65kg	J · H	174.3	66.0	37.87	21.72	124.6	23.19	43.13	2.0	6.0	3.0
-71kg	M · P	171.4	76.0	44.34	25.87	150.9	24.71	40.46	2.0	8.0	1.0
	S · D	171.9	75.0	43.63	25.38	147.7	24.53	40.76	2.5	8.0	1.5
-78kg	M · N	175.4	80.0	45.61	26.00	148.3	24.57	40.71	1.5	8.5	1.5
	J · G	173.0	78.0	45.09	26.06	150.6	24.70	40.49	2.0	7.5	1.5
-86kg	B · T	176.9	89.0	50.31	28.44	160.8	25.24	39.62	3.0	7.5	1.0
	J · M	184.9	84.5	45.70	24.72	137.7	23.73	42.14	3.0	6.0	2.5
-95kg	R · V	183.3	94.0	51.28	27.98	152.6	24.81	40.31	2.0	7.5	1.0
	n	10	10	10	10	10	10	10	10	10	10
	mean	173.47	77.5	44.57	25.68	148.6	24.55	40.76	1.15	7.55	1.50
	S. D.	7.62	9.77	4.155	1.868	10.79	0.64	1.09	0.53	0.89	0.71

I. Method

Applying the Heath-Carter body type criterion the measurements were made on the following portions; height, body weight, skinfold fat thickness (the skinfold fat thickness of mid-brachium—triceps—, sub-scapular, upper ilium, and the calf were measured by Eiken system of skinfold fat thickness measurement in 0.5 mm), humerus epiphysis width, femur epiphysis width (the epiphysis width of a humerus and femur bone were measured with slide calipers) the girth of flexed upper arm, and the girth of calf in standing posture (measuring the maximum flexed upper arm girth and the calf girth in vertical form by a tape measure).

The measured figures were recorded in the Heath-Carter system chart. The point of endomorphy was calculated from the total skinfold fat thickness of mid-brachium (triceps), sub-scapular, and upper ilium. The point of endomorphy was calculated from the values of height, epiphysis width, and girth. The essential point of ectomorphy was calculated from Ponderal's Index. These figures were located in the Trigonal Chart.

The static standing posture was taken by the players and the spinal curvature line, the position of center of gravity, the distribution of body weight, the difference of bi-acromion height were measured and the perpendicular line test was employed.

(1) Spinal Curvature

By using the conformateur the curvature line of spine was drawn. The angle of anterior inclination of cervical lumbar and posterior inclination of dorsal lumbar, and dorsal flex were measured to find out the inclination of the upper body. The angle of posterior inclination of the upper back and anterior inclination of lumbar were measured to find out the inclination of spine, and the vertical angle of sacrum lumbar was measured to find out the promontory of nates.

(2) The Position of Center of Gravity

In accordance with Cureton's method, the position of center of gravity from heels was measured by using two weight meters. The ratio was also calculated setting the foot length as 100%.

(3) The Distribution of Body Weight

The weight distribution of both legs and Morton's "three-portion ratio" were calculated by using weight distribution meter.

(4) The Difference of Bi-acromion Height

The acromion height difference of both shoulders was measured by using Martin's rod ruler at the same time.

(5) Perpendicular Line Test

Taking a picture of the Judoist from the right side, and the observation was made whether the following five points were located on the same line; the tragus point, the center of shoulder joint, the center of hip joint (the greater trochanter), the front of knee joint and the fifth metatarsal bone tuberosity. The subjects were the 13 of Reinforced All-Japan Judoists under 60 kg—M.A., and T.D., under 65 kg—Y.A. and T.M., under 78 kg—T.A. and H.T., under 86 kg—S.N. and H.S., under 95 kg—M.I. and H.M., over 95 kg—I.M., K.T. and K.A. The 10 subjects of Reinforced French Judoists were under 60 kg—J.D. and P.N., under 65 kg—J.H., under 71 kg—M.P. and S.D., under 78 kg—M.N. and J.G., under 86 kg—B.T. and J.M., and under 95 kg—R.V.

II. Result and Discussion

(1) Comparison of Morphology and Somatotype

The height, body weight, physique index, and the Heath-Carter's point of body type of the Reinforced All-Japan Judoists are listed in Table 1. The figures of measurement of the Reinforced French Judoists' morphology and somatotypes are listed in Table 2. The Japanese team exceeds the French team in the average values of height and body weight. The Japanese team has a Judoist whose height is 201.1 cm. Except the one the average height is 173.05 cm, which is almost the same as that

Table 3 Body Fat and Lean Body Mass of Reinforced All-Japan Judo Players

weight classif.	name	height (cm)	weight (kg)	skinfold thickness(mm)		body fat %	total body fat (kg)	lean body mass (kg)
				mid-brachium (triceps)	lower scapular			
-60kg	M · A	164.9	63.0	3.5	7.0	8.0	5.0	58.0
	T · D	162.7	64.5	6.0	9.0	10.0	6.4	58.1
-65kg	Y · A	166.1	66.0	4.0	8.0	8.6	5.7	60.3
	T · M	163.3	64.0	10.0	13.5	13.5	8.6	55.4
-78kg	T · A	175.0	81.0	4.5	5.5	7.8	6.3	74.7
	H · T	175.7	83.0	7.0	13.0	12.0	10.0	73.0
-86kg	S · N	176.0	87.5	5.5	8.5	9.5	8.3	79.2
	H · S	177.7	91.0	6.5	10.5	10.7	9.8	81.2
-95kg	M · I	176.0	106.0	7.0	26.5	17.9	18.9	87.1
	H · M	178.0	99.5	12.5	26.0	20.1	20.0	79.5
+95kg	I · M	183.0	125.0	20.0	28.5	24.6	30.7	94.3
	K · T	178.2	117.0	11.5	32.0	22.3	26.1	90.9
	K · A	201.1	112.0	6.5	10.0	10.5	11.8	100.2
	n	13	13	13	13	13	13	13
	mean	175.2	89.19	8.04	15.23	13.49	12.89	76.30
	S. D.	10.18	21.49	4.52	9.38	5.75	8.35	14.83

Table 4 Body Fat and Lean Body Mass of Reinforced French Judo Players

weight classif.	name	height (cm)	weight (kg)	skinfold thickness(mm)		body fat %	total body fat (kg)	lean body mass (kg)
				mid-brachium (triceps)	lower scapular			
-60kg	G · D	161.4	68.0	4.5	8.0	8.8	6.0	62.0
	P · N	162.2	64.5	5.5	7.0	8.8	5.7	58.8
-65kg	J · H	174.3	66.0	5.0	8.0	9.0	6.0	60.0
-71kg	M · P	171.4	76.0	6.5	7.5	9.0	6.9	69.1
	S · D	171.9	75.0	6.5	10.0	10.5	7.9	67.1
-78kg	M · N	175.4	80.0	5.0	6.5	8.4	6.7	73.3
	J · G	173.0	78.0	6.0	9.5	10.1	7.9	70.1
-86kg	B · T	176.9	89.0	11.0	11.0	12.9	11.5	77.5
	J · M	184.9	84.5	9.5	11.0	12.2	10.3	74.2
-95kg	R · V	183.3	94.0	6.5	8.0	9.7	9.1	84.9
	n	10	10	10	10	10	10	10
	mean	173.47	77.5	6.6	8.65	9.96	7.79	69.7
	S. D.	7.62	9.77	2.08	1.62	1.51	1.95	8.19

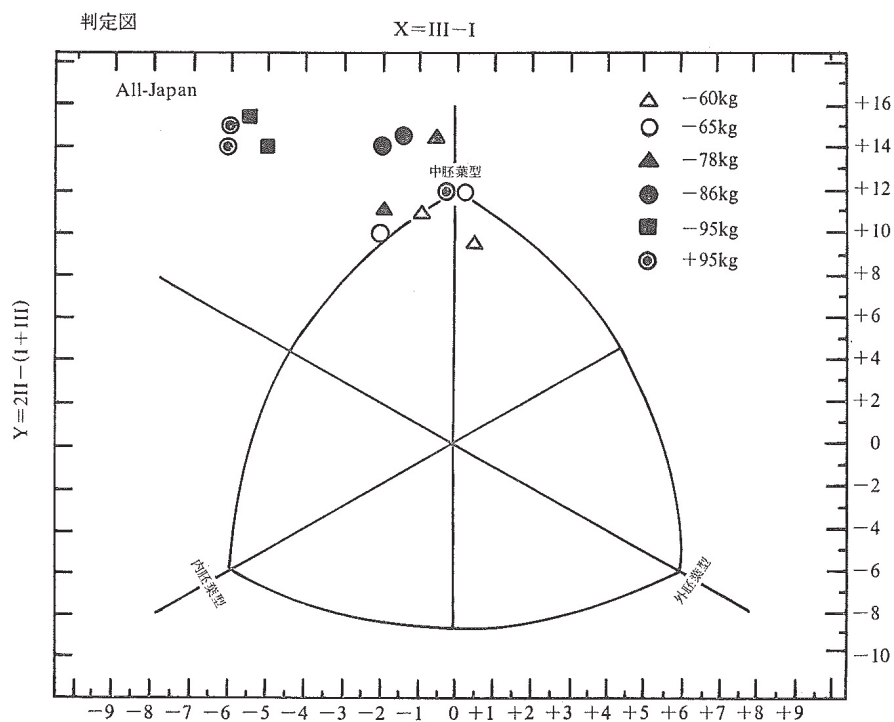


Fig.1 Judgemental Diagram of Reinforced All-Japan Judo Players' Somatotype

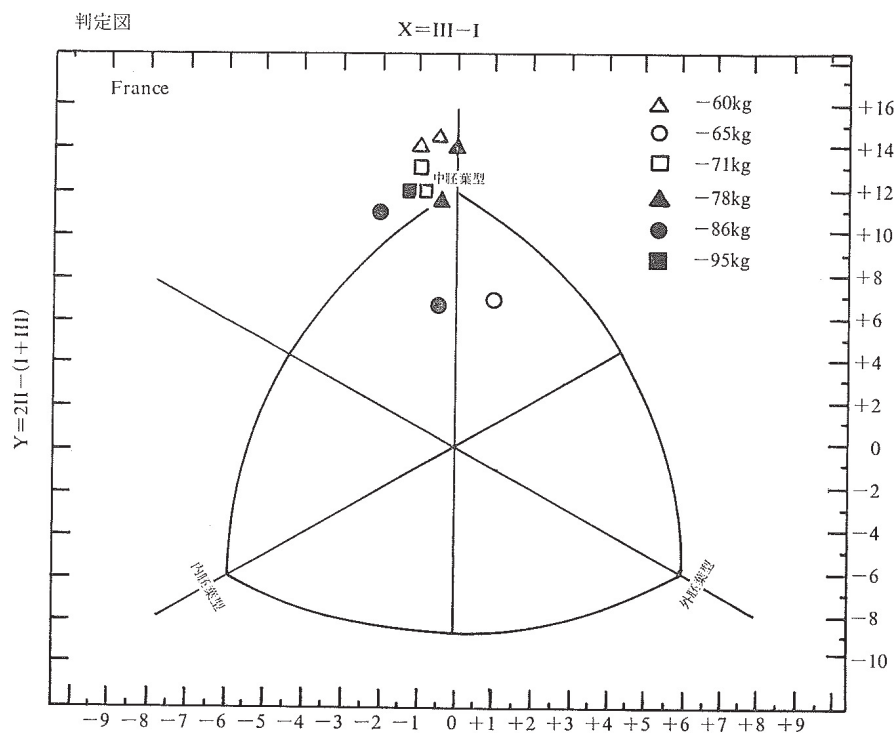


Fig.2 Judgemental Diagram of Reinforced French Judo Players' Somatotype

of the French team. Since there is no one over 95 kg in the French team, among under 95 kg class the Japanese team is 2 cm lower on average than the French team. The Japanese team's average of body weight is 12 kg heavier than the French team's, because three of them are over 95 kg Judoists. The Japanese team's average weight of up-to 95 kg Judoists is 80.55 kg, which is 3 kg heavier than the French team's.

It is said that Quetelet's Index, Kaup's Index, Rohrer's Index, and Livi's Index indicate a corpulent tendency as the numeral value increases. The Japanese team's index value is larger than the French team's, which indicates that the Japanese Judoists are heavier for their height. Especially the big difference of average value in Rohrer's Index appears the three dimensional indication. Ponderal's Index indicates the degree of lean as the numeral value increases, which means that the French Judoists are leaner than the Japanese Judoists. K.A. of the Japanese team shows the largest value in Ponderal's Index and the smallest value in Livi's Index, from which we define that he is light in weight for his height.

It is possible to make a fairly good judgement of somatotypes from these indexes, however, it is not certain to judge from a 100 kg body weight whether it is because of the accumulation of fat or the thickness of muscles. Then, the Heath-Carter method stands to reason; the first element (endomorph) indicates the deposition status of skinfold fat, the second element the developing status of muscles and the third element whether the body is lean or not.

The average of endomorphy element of the Japanese players is 3.38, while that of the French players is 1.15. It denotes that the skinfold fat of the Japanese players is obviously thicker than that of the French players. The Japanese players' average of skinfold fat thickness of sub-scapular where the fat deposition status is most copious, is 15.2 mm, which is about twice as much as the French players'. In the case of I.M. and K.T., whose Rohrer's Index is over 200 and have 28.5 mm and 32 mm respectively they have 5 to 6 times as much fat compared with T.A.'s 5.5 mm, the least fat in the team. The average body fat from mid-brachium (triceps) and sub-scapular of the Japanese players is 12.9 kg (13.5%) calculated by Nagamine's Formula*, which is much larger in quantity than the French players (7.8 kg, 9.9%) (Table 3 and 4). The same can be said of the Japanese players of under 95 kg class. Their average body fat quantity is 9.9 kg, while that of the French players is 7.8 kg, and there is only a little difference in the lean body mass (70.65 kg and 69.7 kg).

The average mesomorphy element of Japanese players is 8.54, which is comparatively high. Especially the four subjects of under 95 kg class and over 95 kg class (except K.A.) showed more than 10, which is extremely high. This indicates that the body weight comes not only from the deposition of fat but also from a remarkable development of muscles.

The value of ectomorphy element of both Japanese and French players is very small, which means that they are not slender persons. Plotting these values into the Trigonal Chart, the All-Japan players' values are shown in Fig. 1 and the French players' are shown in Fig. 2. The Japanese heavy weight players' values (except K.A.'s) are at the upper left far out from the triangular diagram, which designates the volume of their muscles and fat are extremely large. As to the eight French players' values are concentrated around 7 and 8 in mesomorphy element from which we can make a guess that their somatotypes are quite similar to each other in spite of the body weight differences.

Farmosi's⁴⁾ somstotype (diagram of judging body composition) of Hungarian Judoists is shown in Fig. 3. Though there are two extremely fat players with well-developed muscles, the total distribution of body composition is very similar to that of the Reinforced All-Japan players.

(2) Comparison of Posture

Spinal curvature angle, difference of bi-acromion height, position of center of gravity, body

* Nagamine's Formula

D (body density) = $1.0913 - 0.00116x$

Body Fat = $4.201/D - 3.813$

weight distribution, "three-portion ratio" of body weight distribution, and the result of perpendicular test of the Reinforced All-Japan players are shown in Table 5, and those of the Reinforced French players are shown in Table 6.

(2)-1 Angle of Spinal Curvature

The average value of inclination of cervical lumbar-line (angle) to find the anterior angle of a head is -0.46° in the case of the Japanese players, and $+1.45^\circ$ in the case of the French players, which designates the French players' heads are positioned farther forward than the Japanese players. The dorsal lumbar posterior inclination angle and dorsal flex angle are in the relation of supplement angle. Thus the total of the two makes a 180° . The fact that the French players' dorsal flex angle is smaller indicates that their upper body inclination is large. Average thoracic posterior curvature angle to find out whether one has a stoop or not is 158.4° in the case of the Japanese players and 154° in the case of the French players. This result indicates that the French players have a stronger tendency of a stoop. Lumbar anterior curvature angle to find out the curvature of lumbar is slightly smaller in the French players (2°), which indicates their flexion is large. Japanese players' average of vertical angle of sacrum is 9.85° , and the French players' is 11.45° . The French players' nates inclination is slightly stronger.

From these results, it is obvious that the French players thrust their heads forward and they are inclined to have round backs and sticking hips.

(2)-2 Difference of Bi-acromion Height

The observation of the shoulder top height difference reveals that the players of these two countries showed minus average value: the left shoulder is higher than the right shoulder (i.e. right shoulder drop).

(2)-3 Position of Center of Gravity

To give a distance from a heel to the center of gravity perpendicular in the ratio of a foot length (100%), the average of the Japanese players was 41.9% and that of French players was 39.6%. The center of gravity of the French players was slightly toward the heel. The ones whose centers of gravity were extremely toward the toe were H.T. and H.M. The value 51.4% indicates that the center of gravity is slightly forward from the center of a foot. On the contrary, it was K.A. whose center of gravity was extremely backward.

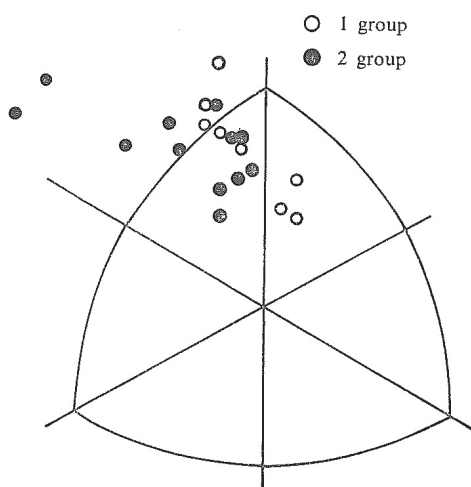


Fig. 3 Judgemental Diagram of Hungarian Judo Players' Somatotype

Table 5 Posture Measurement Result of All-Japan Reinforce Players

Body weight	Name	Spinal Curvature (Deg.)						Shoulder Unbalance (cm)	Center of Gravity (backward and forward) (%)	Body Weight Distribution (left and right) (kg)	Body Weight Distribution (three-portion ratio)						Perpendicular line Test
		anterior inclination angle from neck to waist	Posterior inclination angle from back to waist	posterior curvature angle of upper back	anterior curvature angle of lumbar	dorsal arching angle	vertical angle of lumbar				great toe		four digits		heel		
											left	right	left	right			
-60kg	M · A	-1.5	5.0	162.5	164.0	175.0	10.0	-4.0	43.0	1.0	1.0	1.0	2.2	2.7	2.4	3.0	2.0
	T · D	-1.0	9.5	158.5	157.0	170.5	12.0	-1.7	40.0	0.5	1.0	1.0	3.3	3.3	1.0	0.7	4.0
-65kg	Y · A	-2.0	9.0	157.0	156.0	171.0	13.0	0.3	36.8	- 5.0	1.0	1.0	2.8	2.7	5.8	4.0	3.0
	T · M	0	11.0	154.0	160.5	169.0	10.0	-1.8	40.8	- 8.0	1.0	1.0	2.0	1.8	2.0	1.6	4.0
-78kg	T · A	1.0	9.0	159.0	161.0	171.0	9.5	-1.9	43.9	1.0	1.0	1.0	2.8	3.6	2.8	4.1	3.0
	H · T	-7.0	9.0	155.0	156.5	171.0	14.5	-1.8	51.4	- 1.0	1.0	1.0	1.7	2.1	0.4	1.1	3.0
-86kg	S · N	-1.5	9.5	157.5	161.5	170.5	7.5	-3.3	40.1	6.5	1.0	1.0	3.3	2.7	4.0	2.5	2.0
	H · S	-2.0	9.5	157.0	155.0	170.5	12.0	-1.9	44.8	-11.0	1.0	1.0	1.9	2.2	5.3	4.5	2.0
-95kg	M · I	2.0	9.5	156.0	160.0	170.5	10.0	-3.4	38.6	- 2.0	1.0	1.0	2.6	2.3	3.4	4.0	1.0
	H · M	4.0	10.0	158.0	159.0	170.0	11.0	-0.2	51.4	- 4.5	1.0	1.0	1.7	2.9	1.1	0.7	2.0
+95kg	I · M	1.5	10.0	162.0	164.5	170.0	7.0	-1.7	44.1	8.0	1.0	1.0	2.7	1.6	3.6	1.6	3.0
	K · T	1.0	10.5	164.0	162.5	169.5	8.0	-0.5	38.5	1.0	1.0	1.0	1.0	3.2	1.4	3.3	3.0
	K · A	-0.5	9.5	159.0	163.5	170.5	3.5	3.5	30.8	-12.0	1.0	1.0	4.0	7.0	8.0	19.0	2.0
	n	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
	mean	-0.46	9.31	158.4	160.1	170.7	9.85	-1.41	41.9	- 1.96	1.0	1.0	2.5	2.8	3.2	3.9	2.61
	S.D.	2.65	1.42	2.93	3.18	1.42	2.88	1.93	5.60	6.05	0	0	0.8	1.4	2.2	4.8	0.87

Table 6 Posture Measurement Result of French Reinforce Team.

Body weight	Name	Spinal Curvature (Deg.)							Shoulder Unbalance (cm)	Center of Gravity (backward and forward) (%)	Body Weight Distribution (left and right) (kg)	Body Weight Distribution (three-portion ratio)					Perpendicular line Test
		anterior inclination angle from neck to waist	posterior inclination angle from back to waist	posterior curvature angle of upper back	anterior curvature angle of lumbar	dorsal arching angle	vertical angle of lumbar	great toe				four digits	heel				
-60kg	G · D	5.5	12.0	147.0	153.5	168.0	15.0	-2.2	35.9	3.5	1.0	1.0	1.6	3.1	3.3	6.0	1.0
	P · N	0.5	9.5	156.5	152.0	170.5	19.5	-0.7	39.2	-4.0	1.0	1.0	0.8	1.9	0.7	2.2	3.0
-65kg	J · H	4.5	8.0	157.5	165.0	172.0	7.5	-0.5	42.4	-0.5	1.0	1.0	3.7	2.7	4.6	4.0	1.0
-71kg	M · P	0.5	11.5	153.0	159.0	168.5	10.0	-3.0	39.9	2.0	1.0	1.0	3.0	3.7	5.7	6.0	1.0
	S · D	2.5	10.0	153.0	160.5	170.0	7.5	-2.3	43.1	9.0	1.0	1.0	2.4	8.6	3.4	5.2	1.0
-78kg	M · N	-2.0	10.0	153.0	158.5	170.0	9.0	-0.7	33.5	-2.0	1.0	1.0	2.4	2.1	4.4	3.8	1.0
	J · G	3.0	11.0	156.0	162.0	169.0	10.0	-0.7	49.4	-4.0	1.0	1.0	2.1	5.7	2.1	4.8	1.0
-86kg	B · T	3.0	12.0	152.0	161.0	168.0	9.0	-3.3	31.9	5.0	1.0	1.0	1.4	1.1	2.3	3.4	1.0
	J · M	-3.0	6.0	161.5	158.0	174.0	12.5	-1.2	38.1	-9.5	1.0	1.0	1.6	2.5	2.4	6.0	2.0
-95kg	R · V	0	14.5	150.5	150.5	165.5	14.5	-2.1	42.7	-4.0	1.0	1.0	2.0	2.6	2.6	2.5	1.0
	n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	13
	mean	1.45	10.45	154.0	158.0	169.6	11.45	-1.67	39.61	-0.6	1.0	1.0	2.10	3.40	3.15	4.39	2.61
	S.D.	2.73	2.35	4.04	4.64	2.35	3.88	1.04	5.15	5.40	0	0	0.83	1.45	2.20	1.43	0.67

(2)-4 Body Weight Distribution

In the case of the right foot overweight is marked with a plus sign, and the left foot overweight is a minus sign. The average value of the Japanese players is minus 1.96 kg and that of the French players is minus 0.6 kg. The tendency of the left foot overweight is stronger among the Japanese players. Noticeably K.A., H.S., and J.N. are the cases of the extreme left foot overweight. On the contrary, S.D. and I.M. showed quite a strong tendency of the right foot overweight.

(2)-5 "Three-portion Ratio" of Body Weight Distribution

D.J. Morton describes in his book *The Human Foot* that the ideal ratio of body weight distribution is a great toe (hallux) 1 to four digits 2 to heels 3. The ratio of the Japanese players' left foot is 1 to 2.5 to 3.2 which is closer to Morton's ideal values, and the right foot is 1 to 2.8 to 3.9. The ratio of the French players' left foot is 1 to 2.1 to 3.15 and the right foot is 1 to 3.4 to 4.39, which shows the unbalance of a right foot.

(2)-6 Perpendicular Line Test

It is given 5 points when the five points line up on the perpendicular line. Those who obtained 4 points are T.D. and T.M. None of the French players obtained 4 points, while P.N. got 3 points. In comparison to the average value of the French and Japanese players Japanese obtained higher points. This indicates that there are comparatively many players with good posture.

III. Summary

(1) According to physique indexes of Quetelet, Kaup, Rohrer, Livi, and Ponderal, the Reinforced All-Japan players showed the tendency of corpulence in comparison with the Reinforced French players. It is conjectured that it is because of the large volume of body fat.

(2) Observing the elements of endomorphy, mesomorphy, and ectomorphy by the Heath-Carter method, it was found that the Japanese heavy-weight class players and a large accumulation of fat as well as well-developed muscles.

(3) From the measurement of curvature angle of spines, it was found that the French players have a tendency to stick their head forward and the nates backward with a round back.

(4) Both French and Japanese players showed a tendency of right shoulder drop.

(5) In the position of the center of gravity the French players showed a tendency of being more closer to heels than the Japanese players.

(6) The tendency of over weight on the left foot was stronger among the Japanese players.

(7) From the observation of "three-portion ratio" of body weight distribution, the French and Japanese players showed unbalance in the right foot. The tendency is rather stronger among the French players.

(8) The Japanese players obtained higher points in the perpendicular line test.

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