The effect of somatotype characters on selected physical performance parameters

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The physical structure is considered as one of the elements for sporting success. The aim of this study was to investigate the effects of somatotype characters on selected physical performance parameters.

Material: This study was included 150 males (age: 22.10±2.46 years) participants who do not have habit of regular exercise. The somatotype characters of participants were determined and physical performance tests (30 m sprint, vertical jump, anaerobic power, aerobic capacity, and flexibility) were measured as an experimental design.

Results: As a result of the research, 9 different somatotype subgroups were identified. In this study, the statistically significant was found between groups in terms of explosive force, aerobic and anaerobic power output (p<0.05). We found no significant between groups in terms of flexibility (p=0.670), relative anaerobic peak (p=0.560) and mean power output (p=0.077). The results were obtained in favor of mesomorph-endomorph structure in terms of absolute peak and mean power, while mesomorph and ectomorph component contributed positively to explosive force and aerobic capacity scores.

Conclusions: Our study highlighted the fact that the subgroups of somatotype have an effect on performance parameters. The body-performance relationship can be examined in detail with more participants representing each somatotype group.

Keywords: body composition, performance, physical fitness, somatotype components.

Introduction

Exercise planning, ability level and genetic predisposition can be mentioned as the constituent structures of sporting success. In addition, it is possible to emphasize the need for a branch-specific body structure in order to achieve optimal sporting success. Since Sheldon's first studies on somatotypes, many researchers have attempted to determine the effects of somatotype on physical performance [1, 2]. Somatotype is a taxonomy that allows the interpretation of a body structure based on different elements. Carter and Heath [3] developed a three-dimensional and formula-based concept for the detailed classification of body structure This involves a classification based on 3 components (endomorph-mesomorph-ectomorph) and examines the body in detail.

All branches of sport have a unique set of specialized biomotor performance requirements. However, in addition to performance indicators such as strength [4], power [5], flexibility [6], endurance [7] and agility [8] among the factors that have a positive effect on the performance of athletes, physical structure is also considered as one of the elements for high performance [9]. It can be mentioned that the body type of elite or successful athletes competing in a particular sport has features that can provide a template in terms of current performance parameters. For example, while the mesomorph component of elite boxing athletes was noted to be high [10], it was stated that elite wrestlers had mesomorph-endomorph body type [11]. However, it can be seen that within a particular branch of team sport, body types differ depending on the position of the player. Busko et al. [12] found that in the somatotype classification of 14 female volleyball players, the lowest ectomorph and highest endomorph components were found in libero and setters respectively, the highest ectomorphs and lowest endomorphs were found in hitters and opposites respectively. It is considered that the role of somatic elements in the display of the relevant performance parameters can be used for the selection and development of athletes.

This research was based on the 9 groups of the somatotype characters proposed by Carter and Heath. In this context, we believe that the findings as to how the 9 different body types affect motor performance scores may contribute significantly to the literature.

The *hypothesis* was determined as follows: "somatotype body type differences would affect biomotor performance scores". *This study aimed* to evaluate the effect of different body types on selected physical test scores.

Material and Methods

Participants

A total of 150 volunteers, including 150 males participated in the study (age: 22.10±2.46 years). All participants were informed about the possible risks and details of the research before beginning the study and were made to sign voluntary consent forms. The study was approved by the Clinical Research Ethics Committee (code:2015/211) and conformed to the Helsinki declaration. The criteria for inclusion in the study were: (a) absence of any health problems in the participants during the performance of the tests, (b) having obtained

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doi:10.15561/20755279.2019.0602

consent from the participants (c) regular participation in all the tests and measurements in the study. The criteria for exclusion from the study were: (a) the occurrence of any health problem, (b) irregularity participation in the measurements, (c) careless behaviors with regard to the optimal execution of performance.

Procedure

Anthropometric measurements and field test protocols were applied to volunteers participating in the study. Participants were told to rest 24 hours before the measurements, away from any heavy physical strain. They were informed a day in advance, that they should not consume stimulants such as tea, coffee, and fizzy drinks. All the measurements and test protocols applied in the study were applied in the faculty of sport sciences physiology laboratory and sports hall. Somatotype measurements were made on all participants in a resting state in the morning after 8 hours of fasting. The participants' motor tests were measured between 09.00 and 11.00. A 5-min general warm-up protocol was applied to the volunteers participating in the study before all tests in order to minimize the risk of disability and to achieve optimal performance.

Somatotype

All the anthropometric measurements of the subjects were made in accordance with the measurement techniques and standards recommended by the International Society for the Advancement of Kinanthropometry. Carter-Heath [3] method was followed for somatotyping rating as follows:

Endomorphy = - 0.7182 + 0.1451 (X) – 0.00068 $(X)^2$ + 0.0000014 $(X)^3$

Where X= sum of triceps, subscapular and suprailiac skinfold and for height corrected endomorphy multiplied by 170.18 / body height in cm.

Mesomorphy = (0.858 x humerus breadth) + (0.601 x femur breadth) + (0.188 x corrected arm girth) + (0.161 x corrected calf girth) – (0.131 x height) + 4.5

Corrected arm girth: arm girth (cm) – (triseps skinfold / 10) (mm);

Corrected calf girth: calf girth – (calf skinfold / 10) (mm)

Ectomorphy = (0.732 x HWR) – 28.58

If HWR was found as 38.25 < RPI < 40.75, *Ectomorphy* = (HWR x 0.463) – 17.63.

If HWR was found as an equal to or less than 38.25 give a rating of 0.1

HWR: height (cm) / weight $^{-1/3}$ (kg)

In the study, each participant's body height was measured with a stadiometer with a sensitivity level of 0.01 meter (m) and their body weight was measured with an electronic scale (SECA, Germany) with a sensitivity level of 0.1 kilogram (kg). Then body girths (flexed and tensed upper arm girth and calf girth) were measured using flexible but non-stretchable tape (Holtain Ltd, Croswell, UK) to the nearest 0.1 cm. Biepicondylar humeral and femoral breadth were measured using bicondylar caliper (Holtain Ltd, Croswell, UK) to the nearest 0.1 cm. The participants' skinfold thicknesses values were determined with a skinfold caliper (Holtain Ltd, Croswell, UK) from 4 sites (triceps, suprailiac, subscapula, calf).

Field Tests

30 m Sprint Test

A "30 m sprint test" was performed to determine the participants' sprint times. Running scores were recorded in seconds using electronic timing gates placed on the start and finish lines (Smart Speed; Fusion Sport, Australia). Passive resting intervals of 3 min were applied between the repetitions. The test was repeated three times for each participant for the reliability of the test and the best performance score was recorded [13].

Counter Movement Jump (CMJ)

A single vertical jump test was performed to assess the participants' jumping heights. The participants jumped to the highest distance on the floor platform with their knees stretched and hands on their waist in the starting position (Smart Jump; Fusion Sport, Australia). Passive resting intervals of 3 min were applied between the repetitions. The test was repeated three times for each participant for the reliability of the test and the best performance score was recorded [14].

Wingate Anaerobic Test (WANT)

The participants' body weights were calculated before the test began. Then, the sitting heights were adjusted for each participant, so that there would not be more than 5 degrees of flexion during pedaling. A resistance of 7.5% of the body weight of each participant was calculated for the Wingate weight basket. A 5-min warm-up period was provided for each participant before the test began. The participants warmed up with 3 repetitions of maximal pedal speed for 5 sec. The test lasted for 30 seconds and the participants were verbally encouraged. At the end of 30 seconds the participants were allowed to pedal without weight on the bicycle until their heart rate was about 120 bpm [14]. The parameters obtained as a result of the test which was performed with the Monark 894 E (Sweden) bicycle ergometer connected to a computer and operating with a compatible software were calculated with the software in the computer as anaerobic peak power, anaerobic mean power absolute and relative values.

Maximal Oxygen Consumption (Vo2max)

With the purpose of determining the Vo2max of the participants, the YoYo-1 was used to evaluate people with low fitness levels [15]. The participants were given detailed information about the test procedures and after a routine warm-up the test started. The Vo2max values of the participants were calculated according to the YoYo-1 test result using the formula; "*Vo2max (mL/min/kg) = Running distance (m) * 0.0084 + 36.4*".

Flexibility Test

The sit and reach test was used to measure flexibility. This test was performed firstly to measure the knee-back tendon flexibility of the participants and secondly to measure the lower back, hip and calf flexibility. Each participant performed 3 repetitions, and only the best one was considered for statistical analysis.

Statistical Analysis

Looking at the "kurtosis and skewness" values (between +1.5 and -1.5) and because the number of participants was greater than 50, whether the research data were homogeneous or not was tested with the "Kolmogorov Smirnov" test. It was determined in the study that the data showed non-normally distribution. The data were analyzed using the "Kruskal Wallis H", one of the non-parametric tests used for evaluating more than two independent variables. When there was a statistically significant difference between groups, the "Mann-Whitney U" test was used to find out in which group's favor it was. All statistical analyses were performed with the "IBM SPSS 23" software package. All tests taken were expressed as median (min-max). The level of significance in the study was accepted as p <0.05.

Results

The measured values somatic and demographic parameters were presented in Table 1 as median (med.), minimum (min.) and maximum (max.) values. The somatochart maps of the participants identified as a result of the research were presented in Figures 1. The identified subtypes were shown in Table 2.

The somatotype values of participants were found as endo (2.8) - meso (4.3) - ecto (2.6) in Table 1. These results showed that 150 male participants had balanced mesomorph body type.

Table 2 shows that 9 different subtypes were identified. The highest variance was found in endomorphic mesomorph body type (n=44). However, the least variance was seen in the mesomorphic endomorph group (n=7).

When Table 3 is examined; there was a significant difference between the groups in terms of vertical jump (p = 0.015), 30 m sprint (p = 0.002) and Vo2max (p = 0.000).

Table 1. Median and min-max values of the descriptive statistics of the participants (n=150)

Parameters	Median	Min.	Max.
Age (year)	22	18	34
Body mass index (kg/m^2)	22.2	16.5	32.6
Body height (cm)	176	160	190
Body mass (kg)	67.6	49	101
Medial calf skinfold (mm)	7	2	18
Triceps skinfold (mm)	9	4	22
Subscapular skinfold (mm)	13	7	33
Supra-iliac skinfold (mm)	7	3	19
Flexed upper arm girth (cm)	31.7	26.5	38.5
Medial calf girth (cm)	36.4	29	45.5
Bi-Femoral breadth (cm)	6.5	5.6	7.9
Bi-Humeral breadth(cm)	9.3	7.5	11.8
Endomorphy	2.8	1.3	6.9
Mesomorphy	4.3	.2	7.1
Ectomorphy	2.6	.1	6.2

Table 2. Determined somatotype body types of participants.

Somatotypes	N	ENDO	MESO	ECTO
Balanced ectomorph	16	2.39	2.21	4.88
Balanced mesomorph	20	2.74	4.53	2.64
Central	13	3.20	3.76	3.07
Ectomorphic mesomorph	9	1.97	4.87	3.18
Endomorphic mesomorph	44	3.49	5.15	1.83
Mesomorph-ectomorph	13	2.11	3.69	3.60
Mesomorph-endomorph	13	4.54	4.74	1.81
Mesomorphic ectomorph	15	1.98	3.38	4.47
Mesomorphic endomorph	7	4.93	3.73	2.24

Table 3. Median and min-max values of field performance tests and Kruskal Wallis H test results of somatotype

Somatotype	VJ (cm)		30 m sprint (sec)		Flexibility (cm)		Vo2max ml/kg/min	
	Med.	Min-max	Med.	Min-max	Med.	Min-max	Med.	Min-max
Balanced ectomorph	36.8	32.4 46.5	3.9	3.8 4.1	30.5	19 43	47.4	43.7 58.2
Balanced mesomorph	35.9	26.9 53.5	3.9	3.8 4.5	29.6	12 47	49.8	45.8 62.9
Central	34.3	29.8 44.7	4	3.8 4.2	29	16 35	48.8	43.4 57.5
Ectomorphic mesomorph	41.3	30.5 54.3	3.8	3.6 4.1	26	10 40	53.8	46.4 64.2
Endomorphic mesomorph	35.2	20.6 64.4	3	3.7 4.6	34	13 48	49.6	39.7 63.9
Mesomorph-ectomorph	38.7	28.9 52.1	3.9	3.6 4.2	31	21 42	51.5	43.4 60.9
Mesomorph-endomorph	31.7	27.5 44.4	4.1	3.8 4.3	35	22.1 42	44.8	42.4 50.8
Mesomorphic ectomorph	35.2	29.6 41.5	4	3.7 4.2	29	15 39	50.5	43.4 63.6
Mesomorphic endomorph	33	28.3 42.1	4.2	3.9 4.3	32	17 42	46.4	42.4 50.1
X^2	19.056		24.217		5.801		28.726	
df	8		8		8		8	
p value	**p=0.015***		**p=0.002***		p=0.670		**p=0.000***	

*=p<0.05; VJ = Vertical jump; Vo2max = Maximum oxygen capacity; P value was calculated by Kruskal-Wallis Test

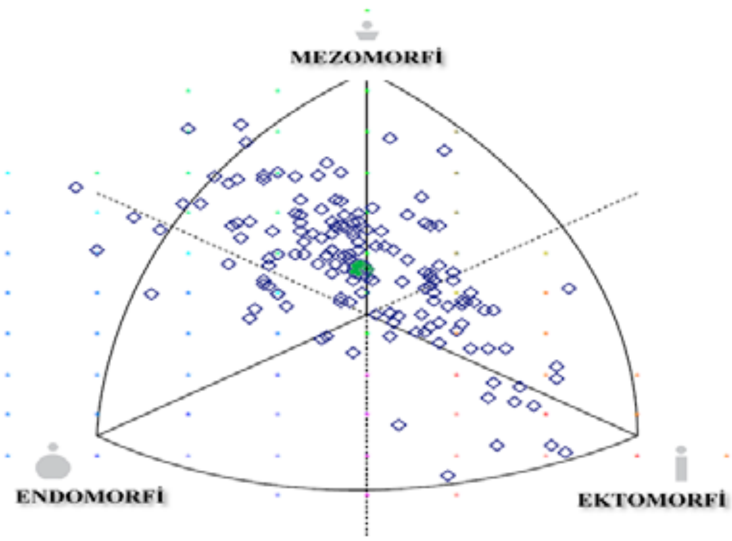

Figure 1- Individual somatoplots of participants and the mean somatoplot for all participants (circle).

Table 4 shows the difference between the body types. No correlation was found between flexibility and somatotype (p = 0.670).

There was a significant difference between the groups in terms of anaerobic power jump (p= 0.019), anaerobic capacity (p= 0.018) in Table 5. Table 6 shows the difference between the body types. No correlation was found between relative values and somatotype (p>0.05).

Discussion

The results of the study showed that somatotype body types have an important effect on the range of performance scores. It was seen that the mesomorphic character has a positive effect on sprint performance scores, while the endomorphic character has a negative effect on vertical jump scores. In addition, the mesomorphic and ectomorphic character has a positive effect on aerobic capacity. Also, it was found that those with a center type obtained the highest performance score in terms of anaerobic power values, while those with a mesomorphic ectomorph character showed the lowest performance scores. These findings reveal the importance of the morphological structure and anthropometric elements that significantly affect motor performance scores including power, strength, speed and endurance.

The average somatotype scores of the participants indicated a balanced mesomorph structure (2.8-4.3-2.6). As a rational explanation of this situation, it is known that even though the participants in the research group did not do sports at a professional level, they had a sports background, because they were students of the sport science faculty. It can be suggested that a dominant

Table 4. Mann-Whitney U test results of body types and performance tests with significant differences

Parameters	U	Z	p	Somatotypes
Vertical jump	45.000	-2.588	0.010	1>7
	22.000	-2.273	0.023	1>9
	28.500	-2.004	0.045	3<4
	91.500	-2.523	0.012	4>5
	17.500	-2.739	0.006	4>7
	28.500	-2.327	0.020	4>8
	12.000	-2.064	0.039	4>9
	38.000	-2.385	0.017	6>7
30 m sprint	33.500	-2.184	0.029	1>4
	15.000	-2.745	0.006	1<9
	45.000	-2.123	0.034	2>4
	27.000	-2.382	0.017	2<9
	23.000	-2.372	0.018	3>4
	41.500	-2.207	0.027	3>6
	19.000	-2.101	0.037	3<9
	93.500	-2.486	0.013	4>5
	14.000	-2.973	0.003	4<7
	33.000	-2.059	0.040	4<8
	48.000	-3.030	0.002	4<9
	175.000	-2.103	0.035	5<6
	62.000	-2.520	0.012	5<9
	29.500	-2.823	0.005	6<7
	6.500	-3.095	0.002	6<9
	16.500	-2.540	0.009	8<9
Maximum oxygen capacity	80.500	-2.538	0.011	1<2
	28.500	-2.465	0.014	1<4
	55.000	-2.151	0.031	1>7
	27.500	-3.786	0.000	2>7
	17.000	-2.944	0.003	2>9
	26.500	-2.141	0.032	3<4
	40.000	-2.286	0.022	3>7
	8.000	-3.376	0.001	4>7
	5.500	-2.764	0.006	4>9
	114.000	-3.274	0.001	5>7
	65.000	-2.439	0.015	5>9
	29.000	-2.852	0.004	6>7
	20.000	-2.028	0.043	6>9
	32.000	-3.022	0.003	7<8
	21.500	-2.190	0.026	8>9

(1) Balanced ectomorph; (2) Balanced mesomorph; (3) Central (4) Ectomorphic mesomorph (5) Ectomorphic mesomorph; (6) Mesomorph-ectomorph; (7) Mesomorph-endomorph; (8) Mesomorphic ectomorph; (9) Mesomorphic endomorph. P value was calculated by Mann-Whitney U test

Table 5. Median and minimum-maximum values of Wingate Test and Kruskal Wallis H test results of somatotype

Somatotype	Wingate Peak Power		Wingate Mean Power		Wingate Relative Peak Power		Wingate Relative Mean Power	
	Med.	Min-max	Med.	Min-max	Median	Min-max	Median	Min-max
Balanced ectomorph	630.1	428.3 784.6	437.1	336.6 533.1	9	7.1 12.1	6.8	5.8 7.9
Balanced mesomorph	664.5	439.6 891.2	467.2	338.6 598.5	9.7	7.4 11.3	7	5.5 8.1
Central	698.6	564.3 872.2	503.9	293 578	10	8.6 11.5	6.9	4.5 7.8
Ectomorphic mesomorph	656	552.3 825.7	461.5	444.9 534.1	10	8.9 12.3	7.2	6.5 7.9
Endomorphic mesomorph	692.5	494.7 1013	490.5	386 651.1	9.7	6.5 12.1	6.8	4.6 7.8
Mesomorph-ectomorph	656.8	591.6 871.8	481.3	423.4 569.9	10.7	8.8 12.4	7.3	6.3 8.3
Mesomorph-endomorph	747.9	551.7 954.9	512.5	378 613.8	10.2	7.3 12	6.7	5 7.7
Mesomorphic ectomorph	598.9	390.7 790.8	423.7	272.1 549.6	10.4	7.1 11.5	6.8	4.9 7.8
Mesomorphic endomorph	739	488 911.7	494.2	358.6 583.3	9.6	7.1 11.4	6.6	5.2 7.5
X^2	18.365		18.398		6.787		14.171	
df	8		8		8		8	
p value	**p=0.019***		**p=0.018***		p=0.560		p=0.077	

*=p<0.05; P value was calculated by Kruskal-Wallis Test

Table 6. Mann-Whitney U test results of body types and performance tests with significant differences

Parameters	U	Z	p	Somatotypes
Wingate Peak Power	51.000	-2.324	0.020	1<3
	184.000	-2.808	0.005	1<5
	43.000	-2.675	0.007	1<7
	26.000	-2.004	0.045	1<9
	51.500	-2.119	0.033	3>8
	184.000	-2.542	0.011	5>8
	43.000	-2.280	0.023	6>8
	40.000	-2.649	0.008	7>8
Wingate Mean Power	181.000	-2.859	0.004	1<5
	55.000	-2.149	0.032	1<6
	50.000	-2.368	0.018	1<7
	84.000	-2.200	0.028	2>8
	50.000	-2.188	0.029	3>8
	151.000	-3.116	0.002	5>8
	45.000	-2.418	0.016	6>8
	40.000	-2.649	0.008	7>8

(1) Balanced ectomorph; (2) Balanced mesomorph; (3) Central (4) Ectomorphic mesomorph (5) Ectomorphic mesomorph; (6) Mesomorph-ectomorph; (7) Mesomorph-endomorph; (8) Mesomorphic ectomorph; (9) Mesomorphic endomorph. P value was calculated by Mann-Whitney U Test

mesomorph character was detected for this reason. In research into the somatotype body types of similar age groups, Gualdi and Graziani [16] determined the somatotype scores of 717 male young sports participants and found them to be 2.7-4.7-2.7 for males. Similarly, Gasparini [17] found that the mesomorph character of 19 football players (mean age = 18.8 years) was greater than the other two components (2.9-4.5-2.9).

In this study, which used the 9 different body type classification proposed by Carter and Heath, statistically significant differences were found between the groups in terms of 30 m sprint and vertical jump performance. In this study, endomorphic mesomorph participants (3.4-5.1-1.8) scored best in terms of the 30 m sprint. In the literature, the results obtained in many studies where linear speed is important do not differ from this. Gontarev et al. [18] examined 5 different age groups in football players, and stated that the dominant component was mesomorph. Arjunan [19] examined the somatotype classification of 15 male 100 m and 200 m sprinters and found that the athletes had a dominant mesomorphic character (3.4-5.5-4.1). According to Marta et al. [20] mesomorphy may have a significant positive influence on sprint running gains, and the ectomorphic component may be positively associated with sprint running gains. A study found that somatotype rate influences the running time to 30.4% and also that the endomorphy rate was said to make a substantial contribution to the regression of the run split time [21]. In terms of vertical jumping, the best performance was obtained by the participants of the ectomorphic mesomorph (1.9-4.8-3.1). Pastore et al. [22] stated that beach volleyball players under the age of 19 and 21 who competed in the European championship were mesomorph-ectomorph. It can be said that the endomorphic component, which is an indicator of fatness on the part of athletes, may have a negative effect in the case of beach volleyball, where the jump performance on difficult ground is exhibited. Moss et al. [23] reported that counter movement jump height was also negatively-affected by higher body fat values. Busko et al. [12] found that there was a significant negative correlation between the rate of elevation of the center of body mass and the endomorphic component (r = -0.59). In the light of the findings obtained in this study, it can be said that the dominant mesomorph component in terms of 30 m sprint and the mesomorph-ectomorph component in terms of vertical jumping contribute positively to the performance results.

There was no significant difference between the groups in terms of flexibility performance and somatotype component (p = 0.670). In the literature, there are studies indicating that there is no relationship between hamstring flexibility and somatotype component [24]. Singh et al. [25] found a negative relationship between endomorph and flexibility in 8-year-old children, and in the same study found a significant positive relationship between endomorph and flexibility in 9-year-old children. This suggests that somatotype elements may cause inconsistent findings in terms of flexibility performance.

One of the reliable parameters in determining the sporting performance and the exercise levels of individuals is maximal oxygen capacity. In a study examining the effect of the somatotype character on ventilatory threshold and vVo2max values - the determinants of aerobic capacity – those participants (mean age: 21.4 years) with a mesomorph-ectomorph and mesomorph body type were found to have the greatest improvements scores in terms of aerobic capacity [26]. In a further study it was reported that the greatest gains in aerobic fitness were for individuals with ectomorphic dominance (odds ratio, 3.84; 95% CI, 1.20–12.27) [20]. In this study, a significant difference was found between the groups according to the results with regard to maximal oxygen capacity (p = 0.000). The highest scoring group was ectomorphic mesomorph (53.8 ml / kg / min), while the lowest scoring group was mesomorph endomorph (44.8 ml / kg / min). Sınırkavak et al. [27] found that there was a significant negative correlation between maximal oxygen consumption and body fat ratio per kilogram in women (r = -0.92), men (r = -0.52) and regardless of gender (r = -0.62). These findings show that mesomorph and ectomorph components make a positive contribution to performance in terms of aerobic capacity, but there may also be a negative correlation between endomorph score and Vo2max.

Peak power and mean power scores were significantly different between somatotype components (p= 0.019; p= 0.018, respectively). The highest score in terms of both peak power (747.9 watts) and mean power (512.5 watts) was shown by the mesomorph-endomorph participants. When absolute peak power output scores are examined, Sanchez-Puccini et al. [28] found a 591.9 ± 91.0 watt PP score in the case of elite male karate athletes who had a mesomorph-endomorph somatotype character. Also, Ramirez et al. [11] reported a 602.5 ± 89.3 watt PP score in the case of elite male wrestlers who had a mesomorph–endomorph somatotype character. Lewandovska et al. [29] examined the maximal muscle torques of the elbow, shoulder, hip, knee and trunk flexor-extensors of 13 judo athletes identified as endomorphic mesomorph. They found a significant positive correlation between the power outputs of all regions and the mesomorph component, together with a negative correlation between the power outputs of all regions and ectomorph components. Quarria and Wilson [30] found that rugby players with more endo-mesomorphic structures produce higher scrumming forces than ectomorphic athletes. The body fat and therefore the endomorph and mesomorph components can be said to have a positive effect on achieving peak power output.

Acknowledgements

This study was written by abridging Fahri Safa ÇINARLI's İnönü University Institute of Health Sciences, Physical Training and Sports Department master's thesis. We would like to thank students who participated in the study and Inonu University Scientific Research Projects Coordination Unit that provided financial support with the project number 2016/31 for the purchase of materials

used in the research.

Conclusion

According to the findings obtained from this study, somatotype body types have a significant role to play in terms of motor performance scores. In general, when explosive force and Vo2max scores are examined, it can be said that meso-ecto components can contribute positively to performance scores. When power output scores are examined, it can be said that meso-endo components can contribute positively to performance scores. It is thought that the relationship between basic sport performance skills and somatotype components may act as a selection and guidance tool for athletes in lower age groups.

Conflicts of Interest

The authors declare no conflict of interest.

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Cite this article as:
Çinarli FS, Kafkas ME. The effect of somatotype characters on selected physical performance parameters. *Physical education of students,* 2019;23(6):279–287.
https://doi.org/10.15561/20755279.2019.0602

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Received: 26.10.2019
Accepted: 17.11.2019; Published: 18.12.2019