PROFESSIONAL ARTICLE

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MORPHOLOGICAL AND MOTOR STATUS OF HIGH SCHOOL STUDENTS

Summary

Morphological status of an athlete (student) represents their ID based on which they can be recognized as a certain constitutional type. It also provides data on their body height, body mass, BMI, and even their age is analyzed. Morphological characteristics represent the most obvious space in the biopsycho-sociological status frame of the human population. Morphology is defined by the set of characteristics such as constitution, body posture, physique or composition as an organized and relatively constant whole of features and their interrelationship. This set is usually formed by endogenous (inner) factors and, in smaller extent, exogenous (outer) factors. Motor skills are usually defined as the indicators of the level of development of basic human movement dimensions that are the key for a successful implementation of movement, regardless of whether the skills are acquired through training. This paper analyzes morphological characteristics and motor skills. This research included 19 students (15 male and 4 female) from the High Technical School in Trebinje. The main purpose of this research is to determine the link between morphological characteristics and basic motor skills among high school students. Variables measured for morphological characteristics are: body height, body mass, derived Body Mass Index and Lorenz's constitution index, whereas variables for motor skills are the following: standing long jump, 30-meter dash standing start, 60-second crunches, pull-ups, pull-up hold and push-ups.

Key words: *body height, body mass, mean thorax circumference, derived body mass index, coefficient of variability, students.*

1. INTRODUCTION

The basic methodological orientation of all sciences dealing with humans is the interdisciplinary approach to studying personality. Accordingly, human anthropological status is also a study-matter in the area of physical culture (gr. anthropos – human, gr. logos – science). According to Malacko (2000), the anthropological status includes the following human features and characteristics: morphological characteristics (growth and development), functional abilities (structure and function of certain organs and organic systems), motor skills (solving motor tasks), biomechanical characteristics (knowledge of the structure of human body constituent parts (bones, joints, muscles) and of the way physical laws control that structure (mechanics)), cognitive abilities (recognition, process and transfer of data), conative characteristics (human behaviour modalities) and sociological characteristics (status of an individual in a group and relationships in groups). Morphological characteristics represent the most obvious space in the biopsycho-sociological status frame of the human population. Morphology is defined by the set of characteristics such as constitution, body posture, physique or composition as an organized and relatively constant whole of features and their interrelationship. This set is usually formed by endogenous (inner) factors and, in smaller extent, exogenous (outer) factors.(Cvetković 2009).

Based on numerous studies the model of latent structure of morphological dimension has been formed and it contains four dimensions like: the factor of longitudinal dimensionality of the skeleton, which is responsible for bone growth in length (body height, sitting height torso, leg length, foot length, ...); the factor of transversal dimensionality of the skeleton, responsible for

bone growth in width (shoulder width, hips width, knee diameter, elbow diameter, ...); the factor of circular dimensions of the body - the volume and weight of the body, which is responsible for the total weight and volume of the body (body weight, neck circumference, mean thorax circumference, forearm circumference, ...); factor of the subcutaneous fat which is responsible for the total amount of body fat (upper arm and forearm skinfold thickness, skinfold thickness of the back and the abdomen).

Motor skills are complex structures that include general and special components which develop depending on the specific development of other skills. They occur at the expense of innate qualities and manifest as a result of development and work. This all implies possibility that one, as a bio-psycho-social and cultural being, achieve success in a particular activity. (Milanović 2011). Recently, new researches were conducted aiming at revealing functional mechanisms that regulate manifestation of motor skills. Through phenomenological interpretation of motor space structure, researchers have defined certain action type factors the fundaments of which are quantitative (strength, pace, stamina) and qualitative (coordination, flexibility, balance, precision and agility) marks. Motor skills are very complex, genetically determined, with high inborn coefficients (speed, coordination, balance, precision), and must be well known to be able to work on their increase (Nićin 2000).

There is a potential for a certain influence on the development of motor skills through specific training methods, and is the basis of each learning of the motor skills of a particular technique, and it can be considered to represent a fundamental value in the overall human motor space.Speed, explosive force and overall performance are highly genetically determined, while the balance, flexibility and coordination are somewhat less genetically determined. The smallest influenece of genes are on repetitive power and dynamic power, which means that they can be affected by regular exercising the most.(Kukolj 1996). In many researches, specific action dimensions are present, such as repetitive strength, static strength, explosive strength, or, regarding pace – basic movement speed, complex movement speed, etc. Morphological dimensions are greatly under influence of endogenous (inner) and exogenous (outer) factors where only the socio-economic status of athletes and body activity have a certain role. Researches conducted in our country (Kurelić, et al. 1975, Stojanović, et al. 1975) confirmed that the morphological space is four-dimensional and that, while choosing anthropometric measures, variables with best metric characteristics should be used: longitudinal dimensionality of skeleton, transversal dimensionality of skeleton, body volume and mass and subcutaneous fat tissue.

2. WORK METHOD

The research included 19 students (15 male and 4 female students) with the average age of 17-18 years (± 6 months). Variables taken into analysis are those defining morphological characteristics: body height (AHEI-cm), body mass (AMAS-kg), body mass index (BMI), Lorentz-s constitution index (LCI). Variables for estimating motor skills are: standing long jump (MSLJ), 30-meter dash standing start (M30S), 60-second crunches (MC60), push-ups (MPU), pull-ups, pull-up hold. The main purpose of this research is to determine the link between morphological characteristics and basic motor skills among high school students.

In this paper, standard statistical methods are used to calculate the basic descriptive parameters of variables: Arithmetic mean (AM), Minimun (Min) and Maximum (Max), Standard deviation (SD), Variability coefficient (VC).

The data obtained in this study were analyzed by T-test for independent causes.

3. RESULTS AND DISCUSSION

Tables 1-5 show the test results of morphological characteristics. Tables 6-7 show student LCI values. Tables 8-12 show motor skills values. Table 1 shows BMI values. Tables 2-3 shows BMI values of the students tested. Tables 4-5 shows descriptive parameters of variables. Table 6 shows student LCI values. Table 7 shows LCI variables.

Table 1. BMI values

Male	Female	
< 20.7	< 19.1	BMI too low
20.7 – 26.4	19.1 – 25.8	BMI ideal
26.5 – 27.8	25.9 – 27.3	BMI slightly above normal
27.9 – 31.1	27.4 – 32.2	BMI high
31.2 – 45.4	32.3 – 44.8	BMI too high
> 45.4	> 44.8	BMI extremely high

Table 2. BMI values of male students

N	Body height ABH (cm)	Body mass ABM (kg)	BMI
B.D	185	80	23.4
B.N.	183	69	20.6
B.M.	192	85	23.1
B.V.	188	85	24
D.J.	182	69	20.8
G.S.	185	70	20.5
G.L.	183	65	19.4
K.V.	180	70	21.6
M.V.	190	93	25.8
M.A.	179	72	22.5
M.D.	178	72	22.7
P.J.	180	65	20.1
P.N.	183	65	19.4
S.R.	194	90	23.9
Š.V.	183	71	21.2

N-participants body height (ABH), body mass (ABM), body mass index (BMI)

Table 3. BMI values of female students

N	Body height ABH (cm)	Body mass ABM (kg)	BMI
G. J.	170	56	19.4
K. J.	172	64	21.6
K. I.	172	57	19.3
P. J.	171	55	18.8

N-participants body height (ABH), body mass (ABM), body mass index (BMI)

Analyzing the results collected by calculating BMI index of 15 male testees (calculated based on body height and body mass), we can conclude that 11 testees have the ideal BMI value, i.e. the ideal body mass, while 4 testees have the BMI value too low, i.e. malnutrition.Analyzing the results collected by calculating BMI index of 4 female testees (calculated based on body height and body mass), we can conclude that 2 testees have the ideal BMI value, i.e. the ideal body mass, while 2 testees have the BMI value too low, i.e. malnutrition.

Table 4. Descriptive parameters of variables for male testees

	Body Height (cm)	Body mass (kg)	BMI
AM	184.33	74.73	21.93
SD	4.59	9.05	1.81
VC	3.80	15.39	9.104
Min	178	65	19.4
Max	194	93	25.8

Arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimun (Min) and Maximum (Max).

Using standard statistic processes, basic descriptive parameters of variables for male testees have been calculated: Arithmetic mean (AM), Minimum result (Min), Maximum result (Max), Standard deviation (SD) and Variability coefficient (VC). The arithmetic mean (AM) value for student height is 184.33 cm, 74.73 kg is the arithmetic mean value for body mass, whereas 21.93 is the arithmetic mean value for BMI. Standard deviation indicates in what percentage elements altogether deviate from the arithmetic mean. The standard deviation (SD) value for body height is 4.59, 9.05 kg is the standard deviation value for body mass, whereas 1.81 is the standard deviation for BMI. The minimum (Min) value in relation to body mass is 65 kg, and in relation to body height is 178 cm. The minimum BMI value is 19.3. The maximum (Max) value in relation to body mass is 93 kg, and in relation to body height is 194 cm. The maximum BMI value is 25.8. The variability coefficient for student height is 3.80, for body mass 15.39, and for BMI 9.104.

Table 5. Descriptive parameters of variables for female testees

	Body Height (cm)	Body mass (kg)	BMI
AM	171.25	58	19.77
SD	0.82	3.53	1.07
VC	0.55	7.03	6.29
Min	170	55	18.8
Max	172	64	21.6

Arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimun (Min) and Maximum (Max).

The arithmetic mean (AM) value for female student height is 171.25 cm, 58 kg is the arithmetic mean value for body mass, whereas 19.77 is the arithmetic mean value for BMI. The standard deviation (SD) value for body height is 0.82, 3.53 kg is the standard deviation value for body mass, whereas 1.07 is the standard deviation for BMI. The minimum (Min) value in relation to body mass of female students is 55 kg, and in relation to body height is 170 cm. The minimum BMI value is 18.8. The maximum (Max) value in relation to body mass is 64 kg, and in relation to body height is 172 cm. The maximum BMI value is 21.6. The variability coefficient for female student height is 0.55, for body mass 7.03, and for BMI 6.29.

Lorentz's constitution index – this variable is calculated from the mean thorax circumference and abdomen circumference (LCI = CT - CA - 14 = thorax mean circumference - waist circumference - 14) **LCI = CT - CA - 14**

Table 6. Lorentz's constitution index

N	CT (cm)	CA (cm)	LCI
B. D.	103	82	7
B. N.	93	81	-2
B. M.	102	86	2
B. V.	105	84	7
D. J.	96	81	1
G. S.	81	73	-6
G. L.	82	75	-7
G. J.	83	66	3
K. J.	84	66	4
K. I.	83	71	-2
K. V.	95	84	-3
M. V.	105	82	9
M. A.	98	83	1
M. D.	92	73	5
P. J.	85	75	-4
P. J.	78	63	1
P. N.	93	75	4
S. R.	104	75	15
Š. V.	99	88	-3

Mean thorax circumference (CT), Abdomen circumference (CA), Lorentz's constitution index (LCI)

The table shows the LCI (Lorentz's constitution index) values for 19 testees, which are gathered by calculating mean thorax circumference and abdomen circumference measures. Positive LCI values point out that testees have a good muscular development, and negative LCI values point out that testees have a bad muscular development.

***Table 7**. LCI variables*

	CT (cm)	CA (cm)	LCI
AM	92.68	77	1.68
SD	9.12	7.22	5.52
VC	9.84	9.38	328.23
Min	81	63	-7
Max	105	88	15

Arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min), Maximum (Max), Mean thorax circumference (CT), Abdomen circumference (CA), Lorentz's constitution index (LCI)

The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean (AM) value for CT (Mean thorax circumference) is 92.68 cm, 77 cm is the arithmetic mean value for CA (abdomen circumference). The arithmetic mean for Lorentz's constitution index (LCI) is 1.68. The standard deviation of CT (Mean thorax circumference) is 9.12, 7.22 is the standard deviation for CA (Abdomen circumference). The standard deviation for LCI is 5.52. The minimum value (Min) for mean thorax circumference (CT) is 81 cm, and the minimum value for abdoment circumference (CA) is 63 cm. The minimum value for LCI is -7, from which we can conclude that the given testee has a bad muscular development. The maximum value (Max) for mean thorax circumference (CT) is 105 cm, and the maximum value for abdomen circumference (CA) is 88 cm. The maximum value for LCI is 15, from which we can conclude that the given testee has a good muscular development.

***Table 8**. Standing long jump*

	N	Standing long jump (cm)
AM	19	194
SD	19	0.22
VC	19	11.61
Min	19	150
Max	19	230

Number of testees (N), arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min); Maximum (Max)

The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean (AM) for standing long jump is 194 cm. The standard deviation (SD) is 0.22, and the variability coefficient is 11.61. The minimum value (Min) for standing long jump is 150 cm (the lowest result in this test), and the maximum value (Max) is 230 cm (the highest result in this test).

***Table 9**. 30-meter dash standing start*

	N	30-meter dash standing start (s)
AM	19	4.74
SD	19	0.55
VC	19	0.55
Min	19	4.03
Max	19	6.50

Number of testees (N), arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min); Maximum (Max)

The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean (AM) for 30-meter dash standing start is 4.74 s. The standard deviation (SD) is 0.55, and the variability coefficient is 0.55. The minimum value (Min) for 30-meter dash standing start is 4.03 s, from which we can conclude that the given testee had the highest result in this test. The maximum value (Max) for 30-meter dash standing start is 6.50 s, from which we can conclude that the given testee had the lowest result in this test.

***Table 10.** 60-second crunches*

	N	60-second crunches
AM	19	51.10
SD	19	9.31
VC	19	18.12
Min	19	25
Max	19	60

Number of testees (N), arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min); Maximum (Max)

The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean (AM) for 60-second crunches is 51.10. The standard deviation (SD) is 9.31, and the variability coefficient is 18.12. The minimum value (Min) for 60-second crunches is 25, from which we can conclude that the given testee had the lowest result in this test. The maximum value (Max) for 60-second crunches is 60, from which we can conclude that the given testee had the highest result in this test.

***Table 11**. Pull-up hold, pull-ups*

	N	Pull-up hold (s)	N	Pull-ups
AM	4	41.75	15	13.33
SD	4	12.71	15	5.70
VC	4	30.44	15	43.62
Min	4	31	15	5
Max	4	60	15	20

Number of testees (N), arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min); Maximum (Max)

Pull-up hold test was conducted on 4 testees and pull-up test was conducted on 15 testees. The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean (AM) for pull-up hold test is 41.75 s. The standard deviation is 12.71, and the variability coefficient is 30.44. The minimum value (Min) for pull-up hold test is 31 s, which represents the lowest result in this test. The maximum value (Max) for pull-up hold test is 60 s, which represents the highest result in this test. The arithetic mean for pull-up test is 13.33. The standard deviation is 5.70, and the variability coefficient is 43.62. The minimum value (Min) for pull-up test is 5, which represents the lowest result in this test. The maximum value (Max) for pull-up test is 20, which represents the highest result in this test.

***Table 12**. Push-ups*

	N	Push-ups
AM	19	15.10
SD	19	5.72
VC	19	37.89
Min	19	5
Max	19	20

Number of testees (N), arithmetic mean (AM), Standard deviation (SD), Variability coefficient (VC), Minimum (Min); Maximum (Max)

The below results were gathered by calculating basic descriptive parameters of variables: (AM), (SD), (VC), (Min) and (Max). The arithmetic mean for push-up test is 15.10. The standard deviation is 5.72, and the variability coefficient is 37.89. The minimum value (Min) for push-up test is 5, which represents the lowest result in this test. The maximum value (Max) for push-up test is 20, which represents the highest result in this test.

4. CONCLUSION

This research is used to analyze morphological characteristics and motor skills of 19 students from the High Technical School in Trebinje. Variables measured for morphological characteristics are: body height, body mass, derived Body Mass Index and Lorentz's constitution index, whereas variables for motor skills are the following: standing long jump, 30-meter dash standing start, 60-second crunches, push-ups, pull-up hold and pull-ups. Using the analysis of the gathered results, we can see the differences in achieved results between male and female testees, male testees being the ones achieving better results in comparison to female testees. In addition, using the analysis of the gathered results, we can see the differences between results achieved by students who were doing a certain physical activity or were included in a training process and results achieved by the testees that do not engage in physical activities or are not included in a training process.

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