COMPARATIVE ANALYSE OF BASIC PHYSICAL MARKS WITH MEN AND WOMEN – RUNNERS OF MIDDLE AND LONG DISTANCES

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Summary

The purpose of this study is to increase the effectiveness of the training process by showing of optimal basic physical parameters in athletes in middle and long distance running. 73 runners of middle and long distances were researched, which was examined this marks: high, weight, body fats, muscle mass, VO₂max, maximum speed. The researched anthropometric measurements were part of functional exam in competitors. To increase the efficiency of the training process in competitors in middle and long distance we have developed optimal value of basic marks. It clearly shows theoretically optimal ranges of each mark. Therefore, when a significant disparity between different marks could be purposefully affect on some anthropometric parameters such as to reduce body fat and increase muscle mass. Periodic monitoring of the levels of anthropometric marks has important information for the ongoing monitoring of the effects of the applied training approaches. We concluded that the influence of anthropometric marks on sporting achievement in middle and long distances running is higher in men than in women. The values of the researched indicators provide opportunities for individual assessment of the relevant levels on each mark as itself and in the context of basic correlations with the others.

Key words – athletics, anthropometric, VO₂max, maximum speed

Introduction

The development of modern sport with its increasingly specialization required to deepen the knowledge about the structure of the human body. The modern world practice and research in the field of athletics convincing evidence that the role of anthropometric marks is extremely important, regardless of the sport level, age and gender [S. Fleck 1983, S. Hollings 1991, T.J. Housh 1984, M. Marfell-Jones 2006, J.L. Pacheco 1996; G. Pastor 2009, T. Stellingwerff 2007). This requires more detailed disclosure of relationships between body composition and functional capabilities of human to improve their methods of research, creation of model morphological characteristics in different sports disciplines.

The purpose of this study is to increase the effectiveness of the training process by showing of optimal basic physical parameters in athletes in middle and long distance running.

Methods

Object of research are 40 men (22 runners of middle distance (MMDR) and 18 runners of long distances (MLDR)) and 33 women (20 runners of middle distance (WMDR) and 13 runners of long distances (WLDR), which been examined this marks: high, weight, body fats (by measuring the skin folds using regression equations J. Parizkova (1977) muscle mass, active body mass, BMI. The researched anthropometric measurements were part of functional exam in competitors. Later of the results of functional researching has been used the individual maximal speed (S_{max}), achieved during the research and VO₂max. The received data were subjected to statistical analysis by programs SPSS and Microsoft Excel.

Results

Tables 1, 2, 3 and 4 shows the variation analyze of the results.

Table 1. Variation analyze men middle distance running (MMDR)

Men MDR	n	Xmin	Xmax	R	X	S	V	As	Ex
High	22	172.5	183.0	10.5	178.3	2.8	1.58	-0.52	-0.73
Weight	22	57.2	78.4	21.2	67.5	6.0	8.92	0.07	-1.00
Fat%	22	6.5	13.7	7.2	9.1	1.6	17.71	0.92	0.98
MM%	22	44.6	52.4	7.8	48.0	2.2	4.53	0.04	-0.92
S max	22	18.4	20.4	2	19.6	0.6	3.16	0.35	-1.32
VO2max/kg	22	51.4	76.6	25.2	63.8	5.9	9.22	0.16	-0.39

Table 2. Variation analyze men long distance running (MLDR)

Men LDR	n	Xmin	Xmax	R	X	S	V	As	Ex
High	18	164	182.5	18.5	172.2	3.2	6.54	-0.43	-0.67
Weight	18	53.6	66.2	12.6	60.3	6.4	9.42	0.32	-0.13
Fat%	18	7.2	13.2	6	9.8	2.5	5.67	0.76	-0.76
MM%	18	44.0	49.2	5.2	46.8	2.8	5.12	0.11	-0.87
S max	18	18.2	20.1	1.9	19.4	2.2	2.78	0.23	-0.89
VO2max/kg	18	51.0	72.4	21.4	61.4	4.6	11.24	0.21	0.21

Table 3. Variation analyze women middle distance running (WMDR)

Women MDR	n	Xmin	Xmax	R	X	S	V	As	Ex
High	20	159.0	171.5	12.5	167.5	3.6	2.15	-0.97	-0.28
Weight	20	45.8	57.0	11.2	53.0	3.1	5.79	-0.80	0.24
Fat%	20	6.0	13.3	7.3	10.1	2.0	19.81	-0.19	-0.86
MM%	20	40.1	45.9	5.8	42.9	2.0	4.61	0.20	-1.64
S max	20	16.8	20.0	3.2	17.7	0.9	5.22	0.69	-0.21
VO2max/kg	20	51.0	64.3	13.3	57.4	4.0	6.98	-0.09	-1.17

Table 4. Variation analyze women long distance running (WLDR)

Women LDR	n	Xmin	Xmax	R	X	S	V	As	Ex
High	13	157.8	170.9	13.1	164.2	3.1	4.34	-0.65	-0.54
Weight	13	43.6	53.1	9.5	48.0	3.4	6.34	-0.54	0.23
Fat%	13	8.0	16.3	8.3	12.9	4.2	17.54	-0.52	-0.65
MM%	13	38.8	44.1	5.3	41.4	4.5	6.42	0.65	-0.87
S max	13	16.0	18.6	2.6	16.9	3.2	7.42	0.12	-0.56
VO2max/kg	13	50.3	61.1	10.8	55.9	5.1	5.24	-0.34	-1.01

High is the basic and permanent mark of the physical development of man. His values are mostly genetically determined and have the age and gender specificity. Affected are also systemic and specific training activities. The average value in the examined men (MMDR) is $178.3 \text{ cm} \pm 2.8 \text{ cm}$. The growth of the MLDR ranged from 164.0 cm to 182.5 cm and the average value of the index is 172.2 centimeters.

The high of the examined (WMDR) ranged from 159.0 cm to 171.5 cm, and the average value of the

analyzed mark is 167.5 cm. WLDR are with high between 157.8 and 170.9 cm. The coefficients of variation shows that the variance of the values is small. Distribution of values is normal kurtosis and asymmetry of frequency, as the majority of the values observed about Xmax.

Weight characterize the total mass of the human body (muscle, bones, internal organs, subcutaneous fat, etc.). Keeping in optimal range is crucial for the realization of high sports result in middle and

long distance running. The average weight of the MMDR is $67.5 \text{ kg} \pm 6 \text{ kg}$. There is a large amount of waving $R = 21.2 \text{ kg}$. This is explained by the fact that some athletes are more gracile and others – with more advanced and massive musculature (sprint type). The weight of researches MLDR ranged from 53.6 kg to 66.2 kg, and the average value is 60.3.

Weight of the researched WMDR variates from 45.8 kg to 57.0 kg and the average value is 53.0. The mass of the examined WLDR ranges between 43.6 and 53.1 kg.

In anthropology it is known that body weight has two basic components – body fat and free fat mass. This separate is based on the most highly applied anthropology model – the model Behnke (1974). Body fat had two characteristics: absolute amount of body fat and proportion (%) of body weight. More objective information about body composition gives mark of the proportion of body fat – body fat percentage, because through it immediately gave the impression so, what is the share and the free fat mass. The average value of contingent research MMDR is $9.1\% \pm 1.6\%$. Body fat in MLDR ranged between 7.2% and 13.2%. The arithmetic mean of the mark is 9.8.

Body fat in the researched WMDR varyate between

6.0% and 13.3%. The arithmetic mean is 10.14% and the spread $R = 7.30$. We can say that the sample is approximately uniform as the coefficient of variation $V = 19.81$. Coefficients of skewness and kurtosis indicates that the distribution of the variable is normal. WLDR have body fat between 8.0 and 16.3%. The average value is 12.9%.

Muscle mass is a major anthropometric mark with big importance to the sport result. Durability in running in middle distances in track and field is expressed by the relationship between muscle strength and time to maintain her (W. Thorland, 1981). From the results it is clear that middle-distance runners have high values of this mark – an average of $48\% \pm 2.2\%$. The coefficient of variation $V = 4.533$, which indicates homogeneity of the sample. MLDR logical have less muscle mass – 46.8%.

Our research showed that the tested WMDR have high values of this mark – values ranged between 40.1% and 45.9%, the average is 42.86% and the spread $R = 5.8$. WLDR also like MLDR have less muscle mass than WMDR.

Tables 5, 6, 7 and 8 shows the dependencies between all tested marks.

Table 5. Correlation matrix of the marks (MMDR)

MMDR	High	Weight	Fat%	MM%	VO2max/kg	S max
High	1	0.79	0.58	0.69	0.57	0.49
Weight		1	0.88	0.51	0.72	0.43
Fat%			1	-0.55	-0.33	-0.52
MM%				1	0.61	0.39
VO2max/kg					1	0.61
S max						1

Table 6. Correlation matrix of the marks (MLDR)

MLDR	High	Weight	Fat%	MM%	VO2max/kg	S max
High	1	0.84	0.51	0.58	0.44	0.32
Weight		1	0.96	0.42	0.59	0.39
Fat%			1	-0.67	-0.39	-0.57
MM%				1	0.54	0.45
VO2max/kg					1	0.57
S max						1

Table 7. Correlation matrix of the marks (WMDR)

WMDR	High	Weight	Fat%	MM%	VO2max/kg	S max
High	1	0.58	-0.39	-0.27	-0.34	-0.25
Weight		1	0.70	0.72	-0.44	0.15
Fat%			1	0.41	-0.44	-0.20
MM%				1	-0.47	-0.19
VO2max/kg					1	0.55
S max						1

Table 8. Correlation matrix of the marks (WLDR)

WLDR	High	Weight	Fat%	MM%	VO2max/kg	S max
High	1	0.51	-0.25	-0.05	-0.04	-0.31
Weight		1	0.56	0.64	-0.14	0.32
Fat%			1	0.02	-0.39	-0.16
MM%				1	-0.34	-0.22
VO2max/kg					1	0.41
S max						1

The high at women has meaning correlation with body weight. This is logic and good for the athletes, because the taller competitors have longer bars of witch they work. Missing of high correlation depending of maximal speed of running and muscle mass could be explained by the fact that well trained athletes reach and keep high speed of running witch is not so different with heavy and light athletes, so the best interrelation of realizing speed potential is achieving at runners with lower body mass.

The weight correlated most highly with overall strength of the body muscles. Higher strength allows athletes to run with a bigger step, without reducing significantly the frequency. This leads to later onset of fatigue during the competition, when the long length hardly reduced. This is evidenced by the concentration of lactate in blood, which increases significantly more gradual than in competitors with less length and with a higher frequency of the step (W. Thorland, 1981).

Missing of high correlation depends of the maximum speed of running with body mass can be explained by the fact that high qualified athletes could reach and maintain high speed of running, which is

not very different in heavy and light athletes which means that the best relation for realizing speed potential is obtained in athletes with low body mass.

The high has highly correlation with body weight. On one hand, it is logical, on the other hand, and advantageously, because the higher competitors have longer levers, on the acting muscles. Therefore in the equally longer levers provide bigger amplitude of movements (and the length of the running step), but also require less frequent moves for economical running, which is important for long running distances in athletics.

Like the women, the body mass correlating most highly with basic strength of the body muscles (muscle mass). The bigger strength allows the athletes to run with a bigger step, without reducing significantly the frequency. This leads to later onset of fatigue during competition when the stride length hardly reduced.

To increase the efficiency of the training process in competitors in middle and long distance we have developed optimal value of basic marks (table 9 and 10). It clearly shows theoretically optimal ranges of each mark.

Table 9. Optimal ranges of marks (men)

		High	Weight	Fat%	MM%	VO2max/kg	S max
OPTIMAL RANGE	MMDR	175.5–181.1	61.5–73.5	7.5–10.7	45.8–50.2	62.2–74.8	18.8–20.2
	MLDR	169.5–179.2	56.7–61.2	9.6–11.3	44.1–47.7	54.2–70.4	18.2–19.4

Table 10. Optimal ranges of marks (women)

		High	Weight	Fat%	MM%	VO2max/kg	S max
OPTIMAL RANGE	WMDR	163.9–171.1	49.9–56.1	8.1–12.1	40.9–44.8	51.5–63.8	17.0–19.2
	WLDR	162.2–170.4	47.2–52.2	8.8–14.6	40.2–43.6	51.0–61.2	16.3–17.8

Discussion

Compared to men, muscle mass in women does not have a major impact on motor and functional performances. This phenomenon is also observed in the other studied morphological marks. In our opinion, this means that women's training approaches must maintain a constantly and stable level of anthropometric parameters, while in men the increasing in muscle mass (preferably lower limbs) is essential for the improvement of specific physical capacity.

The maximum speed of running does not have high correlation correlations with our morphological marks. This can be explained by the fact that well-trained (highly qualified) athletes reach and maintain a high speed of running, which is not very different in heavier and lighter athletes. This means that the best ratio to realize the speed potential is obtained with lower body weight competitors, unlike men where maintaining high levels of muscle mass, as well as the reduction of body fat is a matter for increasing the speed of the athletes.

The main performance mark ($\text{VO}_{2\text{max}}$) in man has significant correlations with weight. These high marks gives us reason to determine the maintenance of an optimal body weight that is at the expense of high levels of muscle mass as a basic factor in increasing the functional capabilities of competitors in medium and long distance running.

Therefore, when a significant disparity between different marks could be purposefully affect on some anthropometric parameters such as to reduce body fat and increase muscle mass. Periodic monitoring of the levels of anthropometric marks has important information for the ongoing monitoring of the

effects of the applied training approaches.

Conclusion

1. The influence of anthropometric marks on sporting achievement in middle and long distances running is higher in men than in women.
2. Muscle mass is a basic anthropometric mark which impacts directly on the maximum speed of running in men.
3. The effectiveness of the training process of women could be explained by a stable level of some of the anthropometric marks: muscle mass and fat mass.
4. The values of the researched indicators provide opportunities for individual assessment of the relevant levels on each mark as itself and in the context of basic correlations with the others.
5. The created models could be helpful for sports theory and practice in the following areas:
 - assessment the effectiveness of the training process;
 - changing the nutrition.

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