BODY COMPOSITION, FUNCTIONAL AND PERFORMANCE CHARACTERISTICS IN TOP CZECH YOUNG ATHLETES

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Abstract

The actual motor performance and thus the actual state of physical fitness of subjects is partly a consequence of their genetic predisposition and partly a consequence of the moving training they undertake. The basic problem by interpretation of exercise testing results in young subjects is a determination of actual (biological) state of subjects. Body composition (BC) may be used as a criterion of their development state. Dependence between selected maximal variables (maximal oxygen uptake per kg body mass - $VO_{2max}.kg^{-1}$, calculated total work - CTW, and maximal power output - MPO), and BC (%BF, FFM, BCM and ECM/BCM) were studied in a group of 665 top Czech young athletes (433 boys and 232 girls) of different sports events in age ranged from 10 to 18 years. The functional variables were assessed by incremental treadmill test. According to our results we present the basic physiological predispositions for success in some sports in both - boys and girls at the age of 15. These data play a decisive role in the selection of talent for the particular sports event.

Keywords: young athletes, body composition, functional testing, physical performance.

Introduction

It is necessary to assess three general areas of fitness if we have interest to characterize the predisposition for sport performance: anthropometry (mainly body dimensions and body composition); muscular strength, endurance and power (often determined by help of motor performance in field or laboratory conditions); and aerobic and anaerobic fitness (mainly characterized with help of maximal oxygen uptake and lactate or variables which may describe the anaerobic production of an energy) (Maud, Foster 1995).

Majority of these variables could be determined by sub-maximal and/or maximal exercise load. The advantages of sub-maximal exercise are connected with weaker dependence on subject´s motivation, greater training induced changes in followed parameters, and higher possibility to differ among similarly trained subjects. Typical example of sub-maximal exercise load is an anaerobic threshold. The advantages of maximal exercise testing are mainly connected with evaluation of strength or speed predispositions. The actual motor performance and thus the actual state of physical fitness of subjects is partly a consequence of their genetic predisposition and partly a consequence of the moving training they undertake. In practice it is difficult to separate these two components.

It is assumed that children and youth, who have inherited genetic information from their parents, will resemble their mothers or fathers both in size and in physical characteristics. Investigations regarding the degree of genetic influence on body dimension indicate that while this is largely true, there are many exceptions. Comparative studies of identical twins (who share the same genetic information) and fraternal twins (who don´t) suggest that the genetic contribution to a child´s stature as well as his or her eventual adult height is approximately 60 % (Rowland 1996). The development of physiological variables in the growing human is an example of biological maturation. The mechanisms that drive biological maturation are multiple, complex, and resistant to simplistic explanations. At the same time, this is a potentially fertile area of inquiry, since an examination of factors that influence the rates of skeletal, somatic, and sexual maturation might be expected to provide insight into the determinants of exercise physiology in the growing human. This subject was extensively reviewed by Malina and Bouchard (1991).

Both aerobic and power and speed predispositions must be assessed in young athletes. The genetic influence is higher in speed and power predispositions, and these variables may improved by training about 20%. The aerobic predispositions are not so strongly dependent of heredity, and these may be improved by 30 or more percentages. Numerous studies have reported relatively high mean VO2max values for various groups of athletes that are comparable to those reported for athletes in single-event endurance sports and clearly above those reported for untrained individuals (Astrand and Rodahl 1986). In longer events and with more elite athletes, VO_{2max} correlates less well with performance.

The energy requirement per unit of time (mainly 1 min) (metabolic power requirement - E) for proceeding at speed of moving v is given by

$$E = C\,v + E_0 \qquad (1)$$

where *C*, defined as the energy cost of moving, is expressed in $J.kg^{-1}.m^{-1}$ and moving speed *v* in $m.s^{-1}$, E_0 resting energy requirement for cover of basal human functions.

Evaluation of changes in cardiorespiratory or metabolic variables during submaximal exercise may help to explain the adaptation (actual training state) of athletes to their training stimulus (Astrand and Rodahl 1986). This is because maximal functional variables in homogeneous groups of trained subjects cannot adequately evaluate changes in the state of training. The changes observed in the maximal values of functional variables during the year are almost at the borderline of measurement error (Bunc et al. 1987).

The quality and/or an effect of imposed training process could be assessed by the changes of some functional variables that are influent by training. An assessment of body composition (BC) is necessary to properly identify a subject's predispositions for physical performance. This assessment can then be used to estimate not only subject's ideal body mass but it is able to contribute to better formulate a training and diet regimen (Heyward and Wagner 2004). Periodic BC assessment can be used to assess the effectiveness of exercise and diet interventions or monitor changes in BC associated with growth and maturation and/or with highly intensive physical training. Thus, there is a clinical need to measure not only percentage of body fat (%BF), but fat distribution, muscle mass, total body water (TBW), body-water compartments (extracellular - ECW, and intracellular water - ICW), body-water volumes changes, extracellular mass – ECM, body cell mass – BCM, and bone mass as well (Heyward and Wagner 2004). In highly trained subjects the continuous monitoring of BC may contribute to regulation of training load in the training process and positively affect their form. The monitoring of BC may also be beneficial for the determination of an adequate volume of load in the design of exercise diagnostics (Bunc 2001; Heyward and Wagner 2004; Knechtle and Kohler 2007).

The parameters which may characterize the physical performance in laboratory like calculated total work (CTW) and maximal power output (MPO) are highly associated with absolute values of maximal oxygen uptake. Relative values of VO_{2max} are strongly related to the size and quality of the free fat component of body mass, which is logical because oxygen uptake during exercise depends on the oxygen demands of the exercising muscles (Astrand and Rodahl 1986, Bunc et al. 2001).

The aim of this study was: 1. to evaluate the young top Czech athletes of both sexes in the laboratory. 2. according to our data and data presented in the literature to determine the physiological standards for young top athletes.

1 Methods

The groups of the top Czech female and male Czech athletes (listing of groups and selected anthropometrical characteristics are collected in Table 1) were evaluated by means of an incremental exercise test to subjective exhaustion on a treadmill at 5% inclination. The initial speed of running ranged between 9 km.h-1 to 13 km.h-1 depending on speed predispositions of followed subjects. The running speed was increased each minute by 1 km.h-1 till subjective exhaustion.

All subjects were the best young Czech athletes. The best of them regularly participated in international competitions and were successful in Europe- or World junior Championships. All subjects trained at least 6 days a week and had been engaged in high-intensity training for at least 5 years, and the mean time spent in intensive sports training unit was a 2 hour.unit-1. The body composition was determined by whole body impedance method. These variables were calculated with help of prediction equations for these athletes that was controlled with data determined by DEXA method (Bunc 2001). The respiratory variables and gas exchange were measured using an open system (Jaeger or TEEM 100). Both analyzers were calibrated throughout the physiological range of measurement using gases of known concentration. Both these apparatus were compared and the differences between the data determined by both apparatus were lower than 1.5%. Heart rate was monitored by means of sport-tester (Sport-tester, Polar). The coefficients of energy cost of running were calculated from the maximal intensity of exercise where a reliable relationship between the intensity of exercise and the energy expenditure was still observed, this corresponds to the "ventilation threshold - VT" (Bunc et all. 1987).

The CTW was calculated as the sum of the workloads of all completed stages plus the workload of the last incomplete stage. The MPO was calculated by linear interpolation from power output during the previous completed stage and power increment between the last stage and the previous completed stage.

Conventional statistical methods were used to calculate mean values and standard deviations. For evaluation of differences a non-paired t-test was used, and the Pearson´s correlations were employed to obtain a coefficient of correlation.

2 Results

The selected anthropometrical data together with BMC and relationship ECM/BCM are collected in Tables 1 and 2.

Tab. 1 Means and standard deviations of selected physical characteristics of male subjects

	age (years)	mass (kg)	height (cm)	%fat (%)	BCM (kg)	ECM/BCM
Triathletes (n=78)	15.3±1.8	69.5±6.9	179.6±4.1	10.4±2.2	36.2±3.9	0.72±0.06
L.D. runners (n=29)	15.0±0.8	63.9±4.9	178.1±4.5	8.0±1.9	33.9±3.2	0.71±0.07
M.D. runners (n=35)	15.4±1.1	66.2±4.1	179.5±4.0	9.0±2.0	35.4±2.3	0.70±0.09
C.C. skiers (n=28)	15.3±0.8	67.5±4.1	176.8±3.4	8.1±3.0	36.3±3.3	0.71±0.08
Biathlonists (n=76)	15.4±0.7	68.2±3.8	179.3±3.2	9.4±2.7	35.9±3.5	0.72±0.07
Cyclists (n=15)	15.5±0.6	65.9±3.1	177.0±3.0	8.6±1.4	35.0±2.7	0.72±0.08
Soccers (n=92)	14.9±1.2	70.9±3.0	180.6±2.1	9.6±1.2	36.8±2.9	0.74±0.07
Basketballers (n=17)	15.4±0.9	85.4±2.9	196.1±4.2	11.9±1.6	42.3±4.0	0.78±0.10
Squashers (n=16)	14.8±1.8	66.5±3.0	178.5±4.5	9.7±2.1	34.1±3.0	0.76±0.08
Tennis players (n=12)	14.9±1.5	68.5±2.7	179.1±3.7	10.2±2.2	34.8±2.8	0.77±0.09
Canoeists (n=21)	15.4±0.8	74.5±5.1	179.5±4.6	11.4±1.9	38.8±3.7	0.70±0.06
Swimmers (n=14)	15.3±0.9	73.6±3.5	182.3±3.2	12.0±2.4	36.6±4.3	0.73±0.11

The percentage of body fat was higher in female athletes than in male of the same sports event. The lowest values of body fat content were found in subjects with the longest race duration (long-distance runners) and the highest in swimmers. The lowest values of BCM were similarly found like in %BF in subjects with long duration of exercise – in boys it were long-distance runners and in girls in cyclists. The lowest values of ECM/BCM relationships were found in both sexes in long-distance runners.

Tab. 2 Means and standard deviations of selected physical characteristics of female subjects

	age (years)	mass (kg)	height (cm)	%fat (%)	BCM (kg)	ECM/BCM
Triathletes (n=59)	15.1±1.1	61.3±3.6	169.3±2.0	12.5±1.9	30.8±2.9	0.74±0.08
L.D. runners (n=12)	15.1±0.9	56.8±1.9	167.3±2.1	9.4±1.3	29.8±3.3	0.73±0.10
M.D. runners (n=18)	15.2±1.0	57.3±2.2	169.5±2.4	10.3±2.0	29.9±2.4	0.72±0.09
C.C. skiers (n=16)	15.4±1.1	59.2±1.9	171.2±2.1	9.5±1.4	31.2±2.3	0.72±0.08
Biathlonists (n=41)	15.2±0.8	61.3±1.7	171.8±1.8	10.6±1.5	31.6±3.2	0.73±0.09
Cyclists (n=11)	15.1±0.8	57.4±2.4	168.3±1.9	11.1±1.7	29.3±3.5	0.74±0.09
Soccers (n=10)	14.9±0.7	56.3±2.1	165.3±1.7	13.0±1.9	27.2±2.2	0.80±0.08
Basketballers (n=12)	15.0±0.8	72.3±2.6	183.1±1.9	14.2±2.1	33.9±3.7	0.83±0.07
Squashers (n=14)	14.3±0.8	57.4±5.0	167.2±4.0	14.5±2.0	26.4±2.8	0.86±0.10
Tennis players (n=11)	14.5±0.9	58.5±4.0	168.1±3.6	14.7±2.2	26.7±2.7	0.87±0.08
Canoeists (n=15)	14.5±0.8	65.7±5.2	172.3±4.1	12.8±1.6	32.6±4.0	0.76±0.08
Swimmers (n=13)	15.2±1.1	64.8±2.5	172.6±2.0	13.9±1.9	31.9±3.6	0.75±0.10

We found the significant negative relationships between %BF and $VO_{2max}.kg^{-1}$ (r = -0.581, p<0.0001 in boys; r = -0.596, p<0.0001 in girls), MPO (r = -0.598, p<0.0005; r = -0.537, p<0.0005), and CTW (r = -0.627, p<0.0001; r = -0.596, p<0.0001).
The significant positive relationships were found between FFM and CTW (r = 0.611, p<0.0001; r = 0.529, p<0.0005), MPO (r = 0.508, p<0.0001; r = 0.559, p<0.0001), and $VO_{2max}.kg^{-1}$ (r = 0.371, p<0.0005; r = 0.332, p<0.0005).
Also we found significant relationships between BCM and CTW (r = 0.698, p<0.0001; r = 0.702, p<0.0001), MPO (r = 0.703, p<0.0001; r = 0.698, p<0.0001), and $VO_{2max}.kg^{-1}$ (r = 0.716, p<0.0001; r = 0.732, p<0.0005).
The ECM/BCM relationship was significantly negatively correlated with CTW (r = -0.751, p<0.0001; r = -0.704, p<0.0001), MPO (r = -0.723, p<0.0001; r = -0.699, p<0.0001) and $VO_{2max}.kg^{-1}$ (r = -0.783; p<0.0001; r = -0.752, p<0.0001).

We did not found any significant differences in ECM/BCM values between followed groups of athletes. Tables 3 and 4 present a profile of the scores on some of the maximal functional variables for both groups of young athletes.

Tab. 3 Means and standard deviations of selected maximal functional variables determined by help of treadmill ergometry (5% slope) in male athletes

	$VO_{2max}.kg^{-1}$ (ml)	V_{max} ($l.min^{-1}$)	v_{max} ($km.h^{-1}$)	LA_{max} ($mmol.l^{-1}$)
Triathletes (n=78)	71.9±5.9	137.6±15.7	18.8±1.3	12.8±2.1
L.D. runners (n=29)	74.8±3.6	121.6±12.4	19.0±0.8	12.6±1.8
M.D. runners (n=35)	69.7±4.5	138.7±16.7	19.1±0.9	13.4±2.0
C.C. skiers (n=28)	76.9±2.3	147.1±8.9	19.6±0.5	13.6±1.4
Biathlonists (n=76)	75.3±2.7	145.5±9.1	18.8±0.6	13.5±1.6
Cyclists (n=15)	68.4±5.2	132.3±19.6	18.1±0.7	13.3±1.7
Soccers (n=92)	60.9±2.9	127.5±9.6	17.6±0.7	12.6±1.9
Basketballers (n=17)	56.2±1.9	142.5±10.4	16.8±0.9	12.4±1.6
Squashers (n=16)	58.9±8.5	106.2±12.8	17.0±0.9	13.4±0.8
Tennis players (n=12)	57.5±5.2	109.5±9.6	16.5±0.8	13.1±1.2
Canoeists (n=21)	62.2±3.0	137.4±18.1	17.8±0.8	12.9±1.2
Swimmers (n=14)	63.5±3.1	148.6±18.7	17.5±0.8	11.8±2.4

We have not found any significant differences among the endurance oriented athletes. Maximal oxygen uptake per kg body mass in endurance athletes was significantly higher than in swimmers (p<0.05).

Tab. 4 Means and standard deviations of selected maximal functional variables determined by help of treadmill ergo-metric (5% slope) in female athletes

	$VO_{2max}.kg^{-1}$ (ml)	V_{max} ($l.min^{-1}$)	v_{max} ($km.h^{-1}$)	LA_{max} ($mmol.l^{-1}$)
Triathletes (n=59)	61.9±2.4	126.6±13.0	15.7±0.6	12.7±1.2
L.D. runners (n=12)	65.7±2.6	119.3±12.4	16.4±0.6	12.5±1.6
M.D. runners (n=18)	62.3±2.1	118.6±12.7	16.4±0.8	13.7±2.4
C.C. skiers (n=16)	66.5±2.3	119.1±8.6	16.3±0.9	13.3±2.0
Biathlonists (n=41)	64.7±2.0	117.5±9.1	16.0±0.9	13.0±1.8
Cyclists (n=11)	59.8±2.0	116.2±12.9	15.4±0.8	12.9±1.8
Soccers (n=10)	50.6±1.6	94.1±7.8	14.7±0.6	12.1±1.2
Basketballer (n=12)	48.9±1.8	109.5±6.4	14.3±0.7	12.0±1.8
Squashers (n=14)	53.4±5.7	86.8±6.0	14.5±0.9	13.0±0.7
Tennis players (n=11)	52.9±3.2	90.8±8.4	14.3±0.8	13.1±1.0
Canoeists (n=15)	51.8±2.3	120.3±11.8	15.6±0.9	13.0±1.6
Swimmers (n=13)	57.9±2.2	133.4±14.8	15.2±0.5	11.7±2.4

The mean values for selected functional variables at the ventilation threshold in these groups of athletes are given in Tables 5 and 6. The same table presents the value for the coefficient of energy cost of running C. The values of C were non-significantly lower in girls than in boys. The lowest values of C were found in long-distance runner in both sexes. These values of selected functional variables at VT level are practically the same in groups of endurance oriented athletes.

Tab. 5 Means and standard deviations of selected functional variables on the level of VT and coefficients of energy cost of running C (treadmill with slope of 5%) in male athletes

	$VO_2.kg^{-1}$ (ml)	$\%VO_{2max}.kg^{-1}$ (%)	v ($km.h^{-1}$)	$\%v_{max}$ (%)	C ($J.kg^{-1}.m^{-1}$)
Triathletes (n=78)	59.5±4.9	82.7±2.1	15.4±1.5	81.9±2.6	3.74±0.13
L.D. runners (n=29)	62.8±4.5	83.9±2.9	16.1±1.8	84.7±2.3	3.70±0.11
M.D. runners (n=35)	57.8±4.2	82.9±2.7	16.2±2.0	84.9±2.0	3.69±0.10
C.C. skiers (n=28)	64.4±2.8	83.7±1.9	15.8±0.7	80.6±1.1	3.74±0.09
Biathlonists (n=76)	62.4±2.1	82.8±1.6	15.1±0.6	80.3±1.0	3.75±0.09
Cyclists (n=15)	57.0±5.1	83.3±2.3	14.9±1.2	82.5±2.9	3.80±0.12
Soccers (n=92)	48.6±3.1	79.8±2.6	13.8±0.9	80.4±1.6	3.76±0.10
Basketballers (n=17)	44.2±1.0	78.6±2.0	12.8±0.8	76.3±2.0	3.90±0.11
Squashers (n=16)	46.6±1.9	79.2±1.6	13.4±0.5	78.8±2.3	3.84±0.12
Tennis players (n=12)	45.2±2.1	78.6±2.4	13.2±0.6	80.0±2.1	3.87±0.10
Canoeists (n=21)	49.4±3.1	78.9±2.0	14.1±0.5	79.3±2.4	3.86±0.14
Swimmers (n=14)	50.4±3.7	80.3±2.2	14.2±1.8	81.1±1.9	3.84±0.09

In endurance oriented young athletes the correlation analyses showed a non-significant relation between sport performance (triathlon race time which was obtained three weeks after the laboratory evaluation) and pulmonary ventilation and blood lactate when estimated jointly in both sexes. In contrast, we have found a significant relationship between competition performance and VO2max (in men r ranged from -0.631 to –0.811, in women from -0.706 to –0.875), maximal speed of treadmill running (in men from -0.598 to –0.805, and in women from -0.656 to –0.872), speed of running at the anaerobic threshold level (in men from -0.563 to – 0.821, and in women from –0.714 to -0.784) (all $p<0.05$).

Tab. 6 Means and standard deviations of selected functional variables on the level of VT and coefficients of energy cost of running C (treadmill with slope of 5%) in female athletes

	$VO_2.kg^{-1}$ (ml)	$\%VO_{2max}.kg^{-1}$ (%)	v ($km.h^{-1}$)	$\%v_{max}$ (%)	C ($J.kg^{-1}.m^{-1}$)
Triathletes (n=59)	51.4±2.9	83.1±1.9	13.2±0.8	84.0±1.9	3.71±0.13
L.D. runners (n=12)	54.3±3.4	83.7±2.0	13.8±1.0	84.3±2.1	3.71±0.09
M.D. runners (n=18)	51.6±2.7	82.9±2.3	13.7±1.2	83.7±2.2	3.70±0.10
C.C. skiers (n=16)	55.2±2.8	83.0±2.0	13.6±1.3	84.0±2.1	3.74±0.09
Biathlonists (n=41)	53.1±2.2	82.1±1.7	12.8±1.2	80.0±1.8	3.76±0.08
Cyclists (n=11)	49.7±2.9	83.1±2.4	12.6±0.9	82.0±2.5	3.82±0.08
Soccers (n=10)	39.6±1.8	78.1±1.6	11.7±0.6	79.8±2.0	3.84±0.07
Basketballers (n=12)	38.0±1.7	77.6±1.8	11.3±0.7	79.2±1.8	3.86±0.08
Squashers (n=14)	42.6±1.6	79.7±1.6	11.9±0.9	82.1±1.9	3.82±1.00
Tennis players (n=11)	41.8±2.0	79.0±1.9	11.7±0.8	81.8±2.2	3.85±0.09
Canoeists (n=15)	41.0±2.4	79.1±1.8	12.4±1.1	79.8±2.0	3.84±0.09
Swimmers (n=13)	46.8±3.0	80.9±1.7	12.4±1.1	81.5±2.0	3.86±0.10

3 Discussion

It is a case study of an explorative character. The results describe the specific group of top junior white water canoeists.

When comparing the basic anthropometric data of young endurance oriented athletes we did not find any significant differences. In other groups of endurance oriented athletes the body mass was slightly lower in athletes with longer race duration than in canoeists or the swimmers.

The lowest values of relationship ECM/BCM were found in athletes with higher part of speed and/or strength activities long- and middle-distance runners, and cross-country skiers. Oppositely the highest values, the lowest actual predisposition for physical exercise was found in non-trained subjects of the same age.

The ECM/BCM data in female athletes of similar training state are slightly higher than in males. This could be explained by the higher muscle mass in male that female and better predisposition for highly intensive exercise in males what is following from higher percentage of FT fibers in their muscles (Astrand and Rodahl 1986, Bunc and Heller 1989).

The cause of significantly higher seasonal changes in BC than in functional variables connected with VO2max could be found in the structure and orientation of imposed training and in the selectivity of followed variables on the used training stimulus. We may conclude that the parameters that may characterize the BC better reflect the changes in the quality and quantity of the imposed training load and/or training state than the maximal functional variables in highly trained subjects. Thus the BC is an important determinant of functional and training state in highly trained subjects that cannot be overlooked.

Variations in the ECM/BCM index were due to accretion of BCM, which was associated with quality of imposed training load and with an increase in ICW (Heyward and Wagner 2004).

Mean fat mass in females is greater than in males from mid-childhood on. This difference becomes more obvious in the pubertal years as girls accumulate greater adipose tissue. Percent of body fat slowly declines during early childhood in both sexes after an early jump in infancy (Malina and Bouchard 1991). As puberty approaches, females demonstrate a progressive rise that continues throughout adolescence. Males, on the other hand, show a slight increase in relative fatness in the late pre-pubertal age; %BF then slowly declines, reflecting the development of FFM at puberty. Consequently, females have greater %BF than males throughout childhood after age 3-4 years. In the late teen years, the average female has about 50% higher relative fatness of her counterpart.

Values of VO2max (related to kg body mass) are typical for athletes with high endurance abilities (Astrand and Rodahl 1986; Maud and Foster 1995; Rowland 1996). Both specific muscle mass and oxidative capacity of working muscles may be increased by specific training and thus the VO2max.kg-1 reflects actual specific predispositions for endurance exercise. Maximal oxygen uptake in trained athletes is generally higher in work situations that allow optimal use of specifically trained muscle fibers VO2max.kg-1 (Wilmore and Costill 1994). This may be one of the decisive causes of differences in "running" VO2max.kg-1 when we compare results of specialists in long-distance running, cyclists and swimmers. The values of VO2max.kg-1 were similar to those of top young Czech triathletes, long-distance runners and/or cyclists and slightly higher than elite top swimmers of the same age, which were evaluated by the same protocol. Maximal oxygen uptake has routinely been used to assess endurance running performance. In fact, successful performance in competitive distance running has been primarily attributed to VO2max.kg-1. A number of investigators found highly significant correlations between VO2max and distance running success in cross studies (Astrand, Rodahl 1986, O´Toole, Douglas 1995).

The range of VO2max.kg-1 was relatively large in all groups of endurance oriented athletes, and these values are slightly lower than values in top adult athletes of the same sports event. The higher values in maximal oxygen uptake in subjects with higher performance levels suggest that a high VO2max.kg-1 is necessary to become a world-class athlete. Thus, only limited possibilities appear to exist to compensate for a low VO2max.kg-1. A high level of VO2max per se does not guarantee good physical performance, since technique of motion and psychological factors may have an influence either positively or negatively. In practice this means that if we wish to characterize the state of aerobic training, we must evaluate VO2max.kg-1 and physical performance at the same time.

The literature regarding the physiological characteristics of elite young endurance athletes reveals that nearly all male competitors have VO2max.kg-1 values higher than 73 and female higher than 65 ml.kg-1.min-1. (Astrand, Rodahl 1986; Wilmore and Costill 1994). Thus, a high VO2max.kg-1 is considered to be a prerequisite for success in distance running and sets the limits of a runner's endurance potential. The importance of the run segment to overall triathlon performance was recently made evident by a study which noted it to be the best predictor of overall time in a triathlon (O´Toole and Douglas 1995).

Metabolic adaptation, which can be indirectly characterized as the ability to utilize effectively the functional capacity of the organism during a prolonged period, can be evaluated according to percent of maximal functional variables (mainly maximal oxygen uptake) at the VT level (Bunc et al. 1987). In untrained subjects, the values of % VO2max.kg-1 are in the range of 50%-70% of maximal oxygen uptake; in trained subjects, these values are in the range of 80%-90% of VO2max (Bunc et al. 1987; Wilmore and Costill 1994). Coefficient C can be used for the evaluation of the adaptation to the moving (Bosco et al. 1987, Bunc and Heller 1989). The higher the level of adaptation to a given type of exercise, the lower the amount of energy necessary to transfer 1 kg of body mass along a distance 1 m. If we assume that the adaptation to running is the highest in runners, then this is reflected by the lowest values of c which were recorded in runners of both sexes (Bunc and Heller 1989). The lowest values of C is obviously result of running training of these athletes who were forced to exercise at very high speed – in middle distance runners of both sexes.

Tab. 7 Standards of selected functional variables for 15 year old athletes from the international race success – endurance (triathlon, long-distance running, cross-country skiers, biathlon, cycling), games (soccers, basketballers, squashers, tennis players), water sports (canoeing, swimming)

	ECM/BCM	$VO_{2max}.kg^{-1}$ (ml)	v_{max} (km.h^{-1})	$W_{max}.kg^{-1}$ W.kg^{-1}	v_{AT} (km.h^{-1})	%VO_{2max} (%)	C (J.kg^{-1}.m^{-1})
Endurance boys	<0.72	>75	>19.5	>6.7	>16.0	>82.5	<3.74
Endurance girls	<0.74	>68	>17.5	>6.1	>14.2	>82.5	<3.72
Games boys	<0.71	>62	>17.5	>6.3	>13.5	>80.5	<3.78
Games girls	<0.73	>58	>16.0	>5.8	>12.8	>80.5	<3.76
Water sports	<0.70	>68	>17.5	>6.2	>13.8	>81.5	<3.80
Water sports	<0.72	>60	>16.0	>5.8	>13.0	>81.5	<3.77

Conclusion

According to our results and according to the data from the literature we are able to establish the physiological predispositions of international success of athletes of 15 years of age. These data are summarized in Table 7. As in other sports events of an endurance native, the physiological data are not the sole predictor of racing success. On the other hand we must remark than these standards are necessary but not sufficient conditions for success in the race. These data play an important role in selection of talents for particular sports event.

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TĚLESNÉ SLOŽENÍ, FUNKČNÍ A VÝKONOVÉ CHARAKTERISTIKY MLADÝCH ČESKÝCH SPORTOVCŮ

Motorický výkon jedinců, a tedy skutečný stav tělesné zdatnosti subjektů, je zčásti důsledkem jejich genetické predispozice a z částí důsledkem jejich pohybového tréninku. Základní problém interpretace výsledků testování výkonu u mladých jedinců je stanovení skutečného (biologického) stavu hodnocených osob. Složení těla (BC) může být použito jako kritérium jejich aktuálníhop vývojového stavu. Závislost mezi vybranými funkčními proměnnými (maximální spotřeba kyslíku vztažená na kg tělesné hmotnosti – $VO_{2max}.kg^{-1}$, počítaná celková práce - CTW, a maximální výkon - MPO) a BC (% BF, FFM, BCM a ECM / BCM) byly studovány ve skupině 665 trénovaných českých mladých atletů (433 chlapců a 232 dívek), z různých sportovních disciplín ve věku v rozmezí 10 až 18 roky. Funkční proměnné byly hodnoceny pomocí stupňovaného zatížení na běhátku. Na základě našich výsledků můžeme prezentovat základní fyziologické předpoklady pro úspěch v některých sportech jak u chlapců i dívek ve věku 15 let. Tyto údaje hrají rozhodující roli při výběru talentů pro konkrétní sportovní disciplíny.

KÖRPERZUSAMMENSETZUNG, FUNKTIONS- UND LEISTUNGSCHARAKTERISTIKEN JUNGER TSCHECHISCHER SPORTLER

Die motorische Leistung der Personen und damit der tatsächliche Zustand der körperlichen Fitness ist teilweise Folge ihrer genetischen Prädisposition und zum Teil Folge ihres Bewegungstrainings. Das Grundproblem bei der Interpretation der Ergebnisse der Leistungtests mit jüngeren Personen ist die Bestimmung des tatsächlichen (biologischen) Zustands der Probanden. Die Körperzusammensetzung (BC) kann als Kriterium für ihren aktuellen Entwicklungszustand verwendet werden. Die Abhängigkeit zwischen ausgewählten Funktionsvariablen (maximaler Sauerstoffverbrauch pro kg Körpermasse - VO2max.kg-1 , die berechnete Gesamtarbeit - CTW, und die maximale Leistung - MPO) und BC (% BF, FFM, BCM und ECM / BCM) wurden in einer Gruppe von 665 jungen tschechischen Athleten im Alter von 10 bis 18 Jahren (433 Jungen und 232 Mädchen) aus verschiedenen Sportdisziplinen untersucht. Die Funktionsvariablen wurden durch gesteigerte Belastung auf dem Laufband bewertet. Auf der Grundlage unserer Ergebnisse können wir grundlegende physiologische Voraussetzungen für den Erfolg in einigen Sportarten sowohl bei Jungen als auch bei Mädchen im Alter von 15 Jahren präsentieren. Diese Angaben spielen bei der Auswahl von Talenten für konkrete Sportdisziplinen eine entscheidende Rolle.

BUDOWA CIAŁA, CECHY FUNKCYJNE I WYCZYNOWE CZESKICH MŁODYCH SPORTOWCÓW

Motoryczne zdolności jednostek, czyli faktyczny stan tężyzny fizycznej osób, są w pełni zależne od ich predyspozycji genetycznych, a częściowo są efektem ich treningu fizycznego. Zasadniczy problem w interpretacji danych wynikających z testowania wyników młodych osób stanowi określenie faktycznego (biologicznego) stanu podlegających ocenie osób. Budowa ciała (BC) może być stosowana jako kryterium ich aktualnego stanu rozwoju. Zależność pomiędzy wybranymi zmiennymi funkcyjnymi (maksymalne zużycie tlenu odnoszące się do masy ciała – VO2max.kg-1, przeliczeniowa całkowita praca – CTW, maksymalna wydajność – MPO) i BC (%BC, FFM, BCM i ECM/BCM) badano w grupie 665 poddających się treningowi czeskich młodych osób (433 chłopców i 232 dziewcząt), z różnych dyscyplin sportowych w wieku od 10 do 18 lat. Zmienne funkcyjne badano przy pomocy zwiększanego obciążenia na bieżni. Na podstawie naszych wyników można zaprezentować podstawowe fizjologiczne przesłanki sukcesu w niektórych dyscyplinach sportu, zarówno u chłopców, jak i dziewcząt w wieku 15 lat. Informacje te odgrywają decydującą rolę w wyborze osób utalentowanych w konkretnej dyscyplinie sportu.