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Anthropometric characteristics in Czech elite female gymnasts

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ABSTRACT

Hedbávný, P., Cacek, J. & Svobodová, L. (2014). Anthropometric characteristics in Czech elite female gymnasts. *J. Hum. Sport Exerc.*, 9(Proc1), pp.S481-S489. The aim of this paper is a description of selected parameters of body composition of elite sport gymnasts from the Czech Republic (30th place at 2010 World Championship). Eight Czech representatives (aged 18.4 \pm 3.39) participated in this cross-sectional study realized in 2013. Data were measured according to standard testing protocols. Body height and arm spread via anthropometer (cm), body composition and body weight using 6-frequency bio impedance (InBody 720), circumference characteristics using band meter. Body height of the researched group was 161.0 cm (\pm 5.34), compared to average body height of American Olympic team (2nd in World ranking) was only 153cm in 2008 (\pm 7) (Sands et al. 2012). Body weight of Czech gymnasts was 55.7 kg (\pm 5.46), American women gymnasts according to Sandse et al. weighed only 47.5 kg (\pm 5.7). BMI ($\text{kg}\cdot\text{m}^{-2}$) was measured 21.35 (\pm 1.66) which is a higher value than according to Grasgruber et al (2008) an average value of this parameter in participants of 2003 World Championship finals (18.77 Europeans, 16.73 Asians). Average amount of subcutaneous fat 13.33 % (\pm 2.81) was, on the contrary, lower than stated by Georgopoulos et al. in a study of 113 participants of European and World championships in last 15 years (16.4 %; \pm 4.99). Hip-waist ratio was 0.85 (\pm 0.03). Arm spread, particularly important in gymnastics due to effectiveness of leverage mechanisms, was measured 164.9 cm (\pm 6.85), showing relatively long leverages, or above-average shoulder width considering average height of the group 161 cm. Long leverages are beneficial for floor exercise and vault. Overall, compared to World competition, Czech gymnasts show above-average height as well as BMI value. Considering relatively low amount of subcutaneous fat we speculate that compared to elite world competition, Czech gymnasts will show higher relative values of skeletal muscles which may disadvantage them in some aspects of performance. **Key words:** SOMATIC CHARACTERISTICS, SPORT GYMNASTICS, THE CZECH REPUBLIC.



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INTRODUCTION

Sport gymnastics have been historically the most successful sport in Czechoslovak, and then in the Czech Olympic history, therefore we try to discover the reasons of contemporary level of our female representatives who ranked 30th at the last world championship. We hope that this study will contribute to discovering the reason of their non-success and will help to find the ways out of the crisis.

After WW2 at the 1948 Olympic Games in London the female artistic gymnasts' team from Czechoslovakia won gold medals and the team remained at the high-ranking positions until 1968 when the Czechoslovak team of female artistic gymnasts triumphed with 6 Olympic medals (Martínková, 1981). It was in 1988 when the female team managed to qualify for the Olympic Games and ranked 7th. Since 1988 Olympic Games only individual female artistic gymnasts have participated in Olympic Games (Dobrovodský, 1989). At 2010 World Championship in Rotterdam the Czech team ranked 30th, which is historically the worst achievement. The current condition is not a result of a single cause, however, we think that this study may help to solve the crisis at which the Czech artistic gymnastics lies.

Every type of sport performed on a professional level places demands on somatotype characteristics and its parameters (Carter & Heath, 1990). In past 50 years artistic gymnastics moved considerably forward considering the technique and exercise difficulty. This trend is reflected in anthropometric characteristics of professional gymnasts, such as height, body weight, BMI, arm spread, WHE, % of body fat and other.

As mentioned above, the Czech artistic gymnastics ruled the world until 1968, therefore we want to start the comparison right in this period of the biggest fame of the Czech artistic gymnastics (Hirata, 1966). At 1964 Olympic Games in Tokyo the average age of participants was 22.7 years, the average weight 52 kg, the average height 157 cm from 102 gymnasts considered. The BMI can thus be calculated – 21.1. At the following 1968 Olympic Games in Mexico only the average age of the sportswomen changed considerably, De Garay et al. (1974) state the average values - age 17.8 years, height 156.9, weight 49.8, however only 21 female sports gymnasts were measured. The responding BMI is 20.13. At 1972 Olympic Games in Munich where 133 participants were measured Hirata (1979a, 1979b) states the age 19.0 years, height 159, weight 49.5 with corresponding BMI 19.38. Lopez et al. (1979) state the research results from 1976 Olympic Games in Montreal where 99 female participants had following average results: age 18.2, height 158.6, weight 47.4, BMI 18.68. Another available sample was 161 female participants of 1983 World Championship in Budapest (Gajdos, 1984) where the average age of the participants was under 17 – 16.8 years, height 154.4, weight 44.0, BMI 18.55. The last bigger complex analysis of anthropometric data was conducted at 1987 World Championship in Rotterdam in 1987 (Cleassens et al., 1991) where 201 probands was of average age 16.5, height 154.3, weight 45.6 and with corresponding BMI 18.97.

As can be seen from the above mentioned values, the anthropometric characteristics of the female artistic gymnasts participating in elite competitions stabilized after 1976 when BMI got under 19. This level can be considered as optimal for achieving average results in this sports field. As dominant is here body height which advantages the female artistic gymnasts in many aspects, mainly when exercising on uneven bars and balancing beam (Cleassens et al., 1999). The maximum width of bars is given by rules and cannot be regulated according to competitor's needs, therefore a taller gymnast is to some extent disadvantaged. In balancing beam which is 10 cm wide is a taller competitor disadvantaged as well. Taller gymnasts may benefit in vault, however the contemporary equipment constructions and vault technique Yurchenko enables also taller gymnasts to perform a vault with a difficulty corresponding to multicontest competition, but they cannot perform the vault in such extend as the gymnasts of lower height. We are interested in

where our elite female artistic gymnasts can be classed according to anthropometric prerequisites. From this reason this study focuses on identification and description of anthropometric parameters of our elite female artistic gymnasts and their comparison with the parameters of the best female world sport gymnasts in the world.

Aim

The aim of this work is to describe and compare selected somatotypic parameters of elite Czech and world's female gymnasts.

MATERIAL AND METHODS

Research sample

Cross section study of selected somatotypic characteristics was conducted in 2013. Data of 8 elite Czech female gymnasts (representatives in gymnastic multicontest) were measured during an international competition "Jan Gajdoš Memorial" in Brno. The average age at the time of data acquisition was 18.4 ± 3.39 . Parents of girls aged less than 18 signed an inform consent with the measurement. All sportswomen participated in the research consentingly and with parents' and trainers' consent.

Measurements

A study protocol included laboratory and clinical non-invasive measurement of body composition, body height, weight, and height in sitting position. Body height was measured using standard measurement procedure and with a standard scale. Laboratory measurement was conducted with the aim of finding out the selected aspects of body composition and body weight.

The measurement was conducted on a device InBody 720 (Biospace, Korea), and the identified parameters were: % of body fat, waist to hip ratio (WHR), body weight, BMI. Before the measurements the tested persons followed the instructions of the device producer regarding the body hydration.

The results of the selected parameters (BMI, body height and weight) of the Czech gymnasts were compared with data of finalists in gymnastic multicontest (8 women) and finalists on individual gymnastic equipment (8 women in each discipline) from the 2008 Olympic Games in Beijing. The number of compared data in some equipment was influenced by missing data of the competitors. Instead of data from 8 finalists some data were statistically analysed with only 7 women. Authors are aware of the fact that the stated data from the Olympic Games were not obtained using the same techniques and devices as the data of Czech gymnasts.

Statistic processing

Two group t-test for independent variable was used to compare data between two different groups. Significance level was set to 5 %. All statistics were realized using a programme Statistica version 12.

RESULTS

The average values of data for all tested parameters in all Czech female sport gymnasts are stated in Table 1. It results from the table that average body height of Czech gymnasts is 161 cm (SD 5.34), average body weight is 55.7 kg (SD 5,46) and average BMI was measured 21.35 (SD 1.66).

When comparing somatotypic characteristics of elite Czech gymnasts with finalist of Olympic Games in Beijing (Table 2) we found out that Czech gymnasts show significant differences compared to elite Olympic gymnasts in all observed disciplines, in both all gymnastic disciplines and gymnastic multicontest.

Table 1. Basic statistical characteristics of Czech female sport gymnasts

Variable	Descriptive Statistics				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
BMI W4	8	18,4075	15,5600	21,9300	1,988494
Body Height W4 (cm)	8	148,5000	138,0000	160,0000	7,289915
Body Weight W4 (kg)	8	40,7500	32,0000	52,0000	6,519202
BMI WV	8	19,5450	18,3100	22,0600	1,245346
Body Height WV (cm)	8	155,1250	151,0000	165,0000	4,580627
Body <u>Weight</u> WV (kg)	8	47,1250	43,0000	55,0000	4,823677
BMI WB	7	18,6371	15,5600	20,5700	1,742582
Body Height WB (cm)	8	152,8750	138,0000	161,0000	7,567553
Body Weight WB (kg)	7	43,8571	35,0000	53,0000	7,174691
BMI WBB	7	17,9829	17,1000	19,5000	0,927590
Body Height WBB (cm)	8	149,8750	141,0000	160,0000	6,749339
Body Weight WBB (kg)	7	39,8571	34,0000	45,0000	4,180453
BMI WF	8	19,0913	16,3300	21,9300	1,852824
Body Height WF (cm)	8	149,2500	140,0000	160,0000	6,386369
Body Weight WF (kg)	8	42,6250	32,0000	52,0000	5,629958
%BF CZ	8	13,3250	10,1000	16,9000	2,809550
WHR CZ	8	0,8475	0,8000	0,8900	0,029155
BMI CZ	8	21,3500	19,1000	23,5000	1,657020
Body Weight CZ (kg)	8	55,7000	48,4000	63,7000	5,455796
Body Height CZ (cm)	8	161,0250	152,2000	170,0000	5,338472

Table 2. Anthropometric parameters of finalist of 2008 Olympic Games in Beijing

BMI	TH	TV	BMI	TH	TV	BMI	TH	TV	BMI	TH	TV	BMI	TH	TV
17,58	160	45	18,31	155	44		152	N	19,5	145	41	21,93	154	52
19,5	145	41	18,8	153	44	17,58	160	45	17,58	160	45	19,5	145	41
15,56	150	35	18,61	152	43	15,56	150	35	18,61	152	43	17,58	160	45
18,38	138	35	22,06	155	53	20,57	159	52	18,61	152	43	16,33	140	32
19,37	149	43	20,2	165	55	18,55	154	44	17,36	146	37	18,77	146	40
16,33	140	32	20,03	158	50	18,38	138	35	17,12	145	36	18,61	152	43
18,61	152	43	19,74	151	45	19,37	149	43	17,1	158	34	18,61	152	43
21,93	154	52	18,61	152	43	20,45	161	53		141		21,4	145	45
18,41	149	40,8	19,55	155	47	18,64	153	44	17,98	150	40	19,09	149,3	42,6
All-around			vault			Uneven bars			Balance beam			Floor		

In BMI values (Fig. 1) the differences on $p < 0.05$ were identified between Czech gymnasts ($n = 8$) and OG finalists ($n=8$) in multicontest $p=0.0062$ (BMI 21.35 vs 18.40), with OG finalists in vault ($n=8$), where the value $p = 0.027$ (BMI 21.35 vs 19.54), with OG finalist in uneven bars ($n=7$) $p = 0.0086$ (BMI 21.35 vs 18.64), with finalists on balancing beam ($n=7$) $p = 0.0003$ (BMI 21.35 vs 17.98) and finalist on floor ($n=8$) where $p = 0.0222$ (BMI 21.35 vs 19.09).

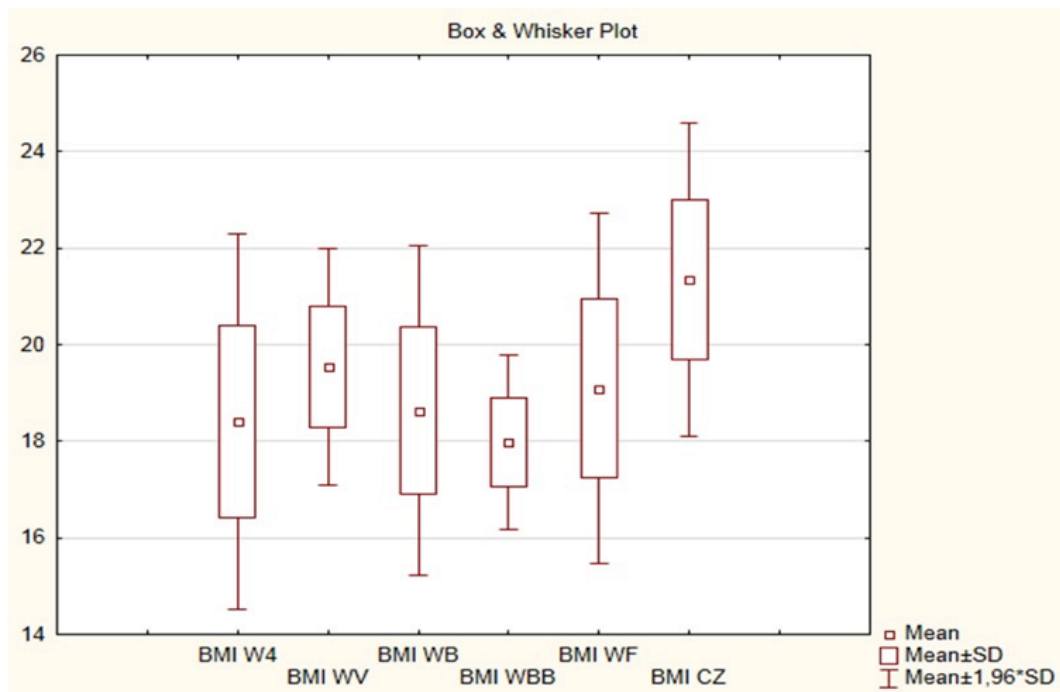


Figure. 1. Box BMI of gymnasts, finalists (according to disciplines) 2008 Olympic Games in Beijing and elite Czech gymnasts; W4 = finalists of OG in multicontests; WV = finalists of OG in vault; WB = finalists of OG in uneven bars; WBB = finalists of OG in balancing beam; WF = finalists of OG in floor exercise; CZ = elite Czech gymnasts.

Similar results and statistically significant differences $p < 0.05$ were observed also in parameter body height (BH) between the best Olympic gymnasts and elite Czech gymnasts (Fig. 2). Czech gymnasts showed higher values of BH (161 vs 148.5) than OG finalists ($n = 8$) in multicontest ($p = 0.0015$), in vault ($n=8$), where $P = 0.0325$ (BH 161 vs 155.1), in uneven bars ($n=8$), where $p=0.0260$ (BH 161 vs 152.9), in balancing beam ($n = 8$), where $p = 0.0025$ (BH 161 vs 149.9), in floor exercise ($n=8$), where $p = 0.0013$ (BH 161 vs 149.2).

Comparison of values of body weight (BW) shows a significant higher weight of Czech gymnasts compared to elite world's gymnasts. Czech gymnasts had average weight 55.7 kg compared to weight of 40.8 kg ($p=0.0002$) of elite world's female gymnasts doing multicontest ($n=8$). Similarly, elite Olympic gymnasts in vault ($n=8$) had lower average value of body weight 47.1 kg ($P=0.0050$) than elite Czech gymnasts (55.7 kg). An average value of BW of world's uneven bars gymnasts ($n=7$) was 43.86 kg ($p = 0.0031$) and elite balancing beam gymnasts ($n=8$) was 39.86 ($p=0.0003$). An average value of BW of gymnasts on floor (42.6 vs 55.7) was again lower in Olympic gymnasts ($n=8$), than in Czech elite gymnasts ($p=0.0003$). The lowest BW values had OG finalists doing balancing beam and multicontest (Fig. 3). Other observed parameters were obesity indicators: amount of subcutaneous fat and waist-hip ratio (WHR). Elite Czech gymnasts showed values 13.3 % (SD 2.81) of fat and WHR = 0.85 (SD 0.03).

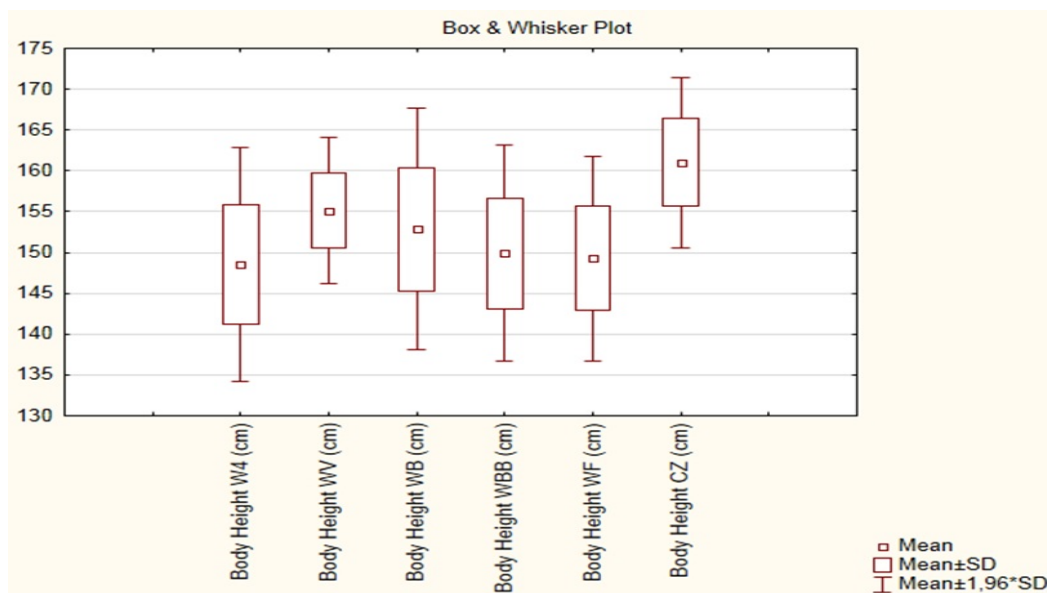


Figure. 2. Box plot of body height of female gymnasts, finalists (according to disciplines) of 2008 OG in Beijing and elite Czech gymnasts; W4 = finalists of OG in multicontest; WV = finalists of OG in vault; WB = finalists of OG in uneven bars; WBB = finalists of OG in balancing beam; WF = finalists of OG in floor exercise; CZ = elite Czech gymnasts.

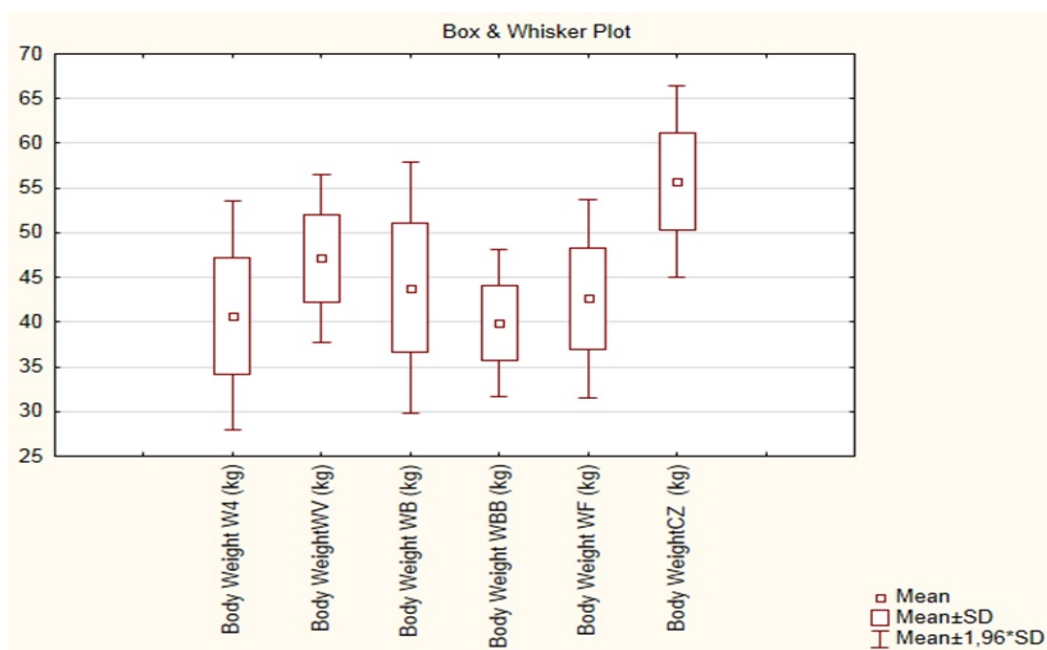


Figure. 3. Box plot of body weight of female gymnasts, finalists (according to disciplines) of 2008 OG in Beijing and elite Czech gymnasts; W4 = finalists of OG in multicontest; WV = finalists of OG in vault; WB = finalists of OG in uneven bars; WBB = finalists of OG in balancing beam; WF = finalists of OG in floor exercise; CZ = elite Czech gymnasts.

DISCUSSION

When comparing the data with values measured at world competitions in the past (Table 3) we may point out that the body composition of Czech female gymnasts correspond to parameters of gymnasts competing in 1964 Olympic Games in Tokyo.

Table 3. Basic anthropometric parameters of gymnasts at world's competitions and contemporary Czech elite female gymnasts

tournament	n	Age(year)	Height(cm)	Weight(kg)	BMI
OG Tokyo1964 (Hirata, 1966)	102	22,7	157	52	21,1
OG Mexico 1968 (Garay et.al., 1974)	21	17.8	156,9	49,8	20,13
OG Munich 1972 (Hirata 1979 a.b)	133	19	159	49,5	19,38
OG Montreal 1976 (in Lopez et al., 1979)	99	18,2	158,6	47,4	18,68
WC Budapest 1983 (Gajdos 1984)	161	16,8	154,4	44	18,55
WC Rotterdam 1987 (Claessens 1991)	201	16,5	154,3	45,6	18,97
OG Beijing 2008	98		154,1	45.7	18,97
Czech elite gymnasts	8	18,4	161,3	55,3	21,22

Comparison of elite Czech and world female gymnasts show some interesting differences which may be important from the point of view of performance limitation of elite Czech gymnasts. Globally, Czech gymnasts show, compared to world competition, above-average height, weight and BMI values. Body height of the selected group was 161.0 cm (± 5.34), on the contrary, average height of American Olympic team (2nd in World ranking) was only 153 cm in 2008 (± 7) (Sands et al., 2012). The body weight of Czech gymnasts was 55.3 kg (± 5.46), American gymnasts according to Sands et al. weighed only 47.5 kg (± 5.7). BMI (kg.m^{-2}) was measured 21.35 (± 1.66), which is a higher value than average value of the parameter of finalists in 2003 World Championship – 18.77 Europeans, 16.73 Asians (Grasgruber & Cacek, 2008). Average amount of subcutaneous fat 13.33 % (± 2.81) was, on the contrary, lower than stated by Georgopoulos et al. (2012) in the study of 113 participants of European and World Championships in the past 15 years (16.4 %; ± 4.99). Regarding the low amount of subcutaneous fat we speculate that compared to elite world competition Czech female gymnasts will have higher relative values of skeletal muscles which may disadvantage them in some aspects.

Although multicontest is still a dominant gymnastic discipline, in our opinion, only gymnastic powers, such as the USA, China, Russia, and Romania may afford to have a multicontest female gymnasts with medal ambitions on a world competition. Smaller countries with far smaller base. Such as the Czech Republic, must focus on disciplines corresponding with their somatotypic predispositions for a given discipline.

Talent selection is also important as somatotype plays an important role here (Malina et al., 1997). It is very difficult to make this process more effective in conditions in the Czech Republic, as sports gymnastics, despite being historically the most successful Olympic sport, is not as popular as in the past. Only bigger centres can afford to select talented individuals and dedicate time for their preparation from an early childhood. However, also these centres face lack of qualified junior trainers. The biggest problem is wasted potential in smaller towns with limited conditions for quality training. This results in a fact that a talented individual with corresponding somatotopic parameters ends his carrier too early despite having more potential than competitors who are led by qualified trainers, but their somatotopic predispositions are so limiting that they cannot compare themselves with the best world gymnasts.

CONCLUSIONS

Due to a decreasing level of sports gymnastics in the Czech Republic in this work we focused on an analysis of one of the possible reasons of this state, and it was anthropometric characteristics of elite female gymnasts. We evaluated 20 values of 8 representatives of the Czech Republic. We compared the basic parameters, body height, weight and BMI, with available data. From the results it is obvious that none of the three characteristics of our gymnasts approaches the average values of gymnasts competing in world competitions, not even the finalist of these competitions. The reasons may be not only in dysfunctional talent selection, but also in wrong condition preparation during the training process. Excessive muscle gain noticed in our female gymnasts may result from wrongly chosen methods of development of strength abilities. We came to conclusion that Czech elite female gymnasts are, regarding their body composition, capable of being successful in vault.

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