SOMATOMETRIC CHARACTERISTICS OF HIGH JUMPERS

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The significance of somatic prerequisites for the high jump is evident. In the course of our evaluation, a significant dependence of the physique on performance was confirmed with all the groups of female and male high jumpers having high average performances, which were measured over the period from 1983 to 2005. All these groups were characterized by relatively large homogeneity in most somatic indicators.

The measurements we use as a base in the following parts of this paper were carried out over the course of more than two decades. They include single cross-section examinations of the groups of female and male high jumpers (n = 117) as well as longitudinal monitoring of selected individuals.

In accordance with the physical development of female and male high jumpers, it is obvious that the groups measured were chosen intentionally and can be designated as "partially selected groups" with respect to both performance and physique. In the course of our examination, changes in the physique, caused by selection and consequently by a specific training load as well as the demanding athletic event itself, can be observed with all the groups.

Keywords: Somatic prerequisites, anthropometric examination, typology, somatotype, predication, sporting performance.

INTRODUCTION

Performance demands in present day peak sports increase continuously and only individuals, with whom factors influencing performance are on a high level, can expect to succeed. Gualdi-Russo and Graziani (1993), Rienzi (2000), Kopecký, Přidalová et al. (2001) state that sports performance is determined in a differentiated way by somatic, functional, psychological and motor characteristics and capabilities. Therefore, the physique becomes a limiting factor of performance, i. e. a direct reflection of the level of movement activities. This knowledge is of great importance when suitable types for various sports branches or events are sought.

To measure somatic characters and to relate them to performance is necessary not only in ontogenic observation, but also within groups of, e. g. first rate sportspeople. The somatotype is a holistic expression of somatic character, on the basis of which, and some other somatic qualities, we can deduce morphological prerequisites for a selected sports event (Štěpnička et al., 1979).

Ulbrichová (1988) emphasized the significance of these studies: "...beside body height, weight and fat there are a number of other characteristics typical for individual kinds of sports – some parameters may be affected by specific loading even if they need not play a significant role in the structure of performance – e. g. the girth and shape of the chest, the ratio of shoulder width to pelvis width, etc.... The main goal of research work in the morphology of sportspeople is to clarify the significance of these characteristics for performance itself, to study the possibilities of selecting suitable somatic types and the possibilities for influencing them using specific training loading."

We note a certain similarity in the somatotypes of sporters in one branch of sport and, as a rule, an exclusion of types which are too different. Riegerová and Vodička (1992) state this as follows: "It is a well known fact that, based on the morphological state of an individual – morphophenotype we are able to predict, to some extent, his/her physical performance." And Tanner (1964) stated quite simply earlier on: "A deficiency in the physique may nearly prevent a sporter from achieving success."

Basic somatometric data can be found in various papers dealing with the general or special performance of sporters – often as an illustration of the complex characterization of the group concerned. It is indicative of the fact that most authors consider the physique to be one of the important characters affecting motor performance (Langer, 1989, 2004; Chytráčková, 1990; Riegerová & Vodička, 1992; Pavlík, 1999; Riegerová et al., 1995; Krawczyk, Sklad, & Jackiewicz, 1997; Susane et al., 1998; Carter & Ackland, 1998; Vařeková & Vařeka, 2005; Riegerová, Přidalová, & Ulbrichová, 2006; etc.).

Štěpnička (1972 and 1974) carried out the typological classification of an overwhelming majority of the Czechoslovak first rate sporters.

The research results are noteworthy – the research, aimed at the relationship of morphological character and performance in the high jump with a group of persons (n = 100) was carried out by Stawczyk (1965) and Moravec and Slamka (1983) who, analogous to Langer (1989), described first rate female and male high jumpers. Langer (1989, 2004) kept under review age regularities of the development of biomechanical parameters in the run up and the take off technique in the context of changes of anthropometric character.

Our long term observation of first rate female and male high jumpers in the course of more than 20 years is unique in the technical literature.

OBJECTIVE OF THE WORK

The long term objective of our work is to attempt to apply systematically the results of our research to the professional practice of physical education.

The main objective is to analyze the development of somatic prerequisites in the high jump globally, to describe the morphological character of high jumpers and to demonstrate the relationship between sports performance in this event and mutual interactions.

The summary of experimentally verified results should serve as a foundation for the optimization of training methods, forms and instruments as well as for the elimination of undesirable phenomena.

CHARACTERIZATION OF THE SET

The sets will be characterized in detail in the results part. Here, we will focus on the listing of the measured sets, the results of which are included in this paper:
1983–1984 a set of male high jumpers (n = 19) and female high jumpers (n = 14),
1985–1986 a set of male high jumpers (n = 21) and female high jumpers (n = 14),
1989–1991 a set of male high jumpers (n = 8) and female high jumpers (n = 8),
1995–1996 a set of male high jumpers (n = 11) and female high jumpers (n = 6),
2002–2005 a set of male high jumpers (n = 7) and female high jumpers (n = 9).

We carried out the basic anthropometry with the best Czech, Slovak and Danish female and male high jumpers in training camps in Nymburk, Prague, Otrokovice, Brno and Olomouc at the time of major races in Czechoslovakia and later in the Czech Republic. In the course of the athletic season of 1995–1996 we surveyed somatotypes within a group of French first rate male and female high jumpers in Rheims and in training camps at Dijon, Tours and Le Toucquet.

METHODS

The effort to establish objective criteria for typological classification needs led to some attempts at creating adequate measuring methods. Determination of the somatotype according to the Heath and Carter method (Heath & Carter, 1967; Carter & Heath, 1990) fits the anthropometric research in sport best. It was advantageous to use the method for the possibility of comparison as well as for the evaluation of the somatotypes of high jumpers.

According to Štěpnička (1983) and Chytráčková (1990), somatotypes can be matched to various categories based on the methodology we have followed. We divided the somatotypes based on the dominance of individual components and based on their mutual relationships.

The somatic parameters were measured by classic anthropometric instruments under standard conditions and the particular points were defined precisely (Martin & Saller, 1961; Fetter, Prokopec, Suchý, & Titelbachová, 1967). The selected anthropometric techniques were unified so that the findings are comparable with other published results.

All the measurements were carried out before the athletic racing season (April–May), mostly in the morning hours in warm, well-lit rooms or in sports halls.

The high jumpers were dressed in athletic trunks and T-shirts and were barefoot. They expressed assent to the measurements. In the course of the measurements we respected ethical rules.

The method for the assessment of individual component levels in reports is published by, e. g. Carter (1980), in the Czech Republic by Štěpnička (1972), etc. The somatometric data – the body height and weight, the girth of each contracted arm and the girth of the calf – were required. Further, we measured two bone measurements and four skin folds. Based on the measured parameters, the somatotype was defined according to Heath and Carter (Riegerová & Ulbrichová, 1993).

The admissible margin of error of measurements for the determination of body height was ±1 cm and for the assessment of width circumferential measurements it was ±1 cm. When defining the body weight we worked with an accuracy of 0.1 kg. We recorded the thickness of skin folds with an accuracy of 0.1 mm.

We recorded the measurements for defining the somatotype (body height, body weight, width of skin fold, bone measures, and the girths of arm and calf) in pre-prepared forms. The reports were completed with a preprinting to record the age, nationality and three components of the somatotype. After calculating the individual coordinates we assessed the somatotype using our own computer programs and recorded it in the somatograph. We have put all the values found into summary sheets and graphs.

RESULTS

We must first say that all the anthropometric measurements were performed by us with the sets of notable Czech as well as foreign male high jumpers (n = 66) and female high jumpers (n = 51) and were of an informative character. In the text part we aim mostly at the assessment and interpretation of results from an objective viewpoint.

The data on age and the measurements of the body height and body weight in the observed groups are presented in TABLE 1. The number of the measured athletes (n), the arithmetic mean (AM), the standard deviation (SD), the measured minimum and maximum values, i. e. the range of the age, body height and body weight (xmin; xmax), were recorded with every set.

For comparison the data on the age, body height and weight of the best male and female high jumpers in the world tables in the athletic seasons of 1989–1990 and 2002–2003 are presented in TABLE 2.

TABLE 1
Basic data on the age, body height and body weight with the measured sets of notable Czech as well as foreign male and female high jumpers in the period from 1983 to 2005

1983–1984	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Males	19	23.1	3220	19.0	29.0	1.924	4.460	1.85	2.02	80.5	4.770	70.0	86.5
Females	14	22.0	2.710	16.0	27.0	1.758	4.320	1.67	1.84	62.1	6.410	52.0	74.0

1985–1986	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Males	21	23.8	3.504	18.0	32.0	1.914	5.266	1.83	2.02	80.7	5.126	72.5	92.5
Females	14	21.7	2.491	19.0	27.0	1.784	2.887	1.74	1.84	66.1	4.194	61.0	75.0

1989–1991	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Males	8	22.5	2.646	18.0	26.0	1.939	4.729	1.86	2.02	80.4	4.601	72.5	86.5
Females	8	22.3	2.332	19.0	27.0	1.789	2.976	1.84	1.75	67.1	4.106	75.0	62.0

1995–1996	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Males	11	21.1	3.486	17.0	28.0	1.907	4.956	1.81	1.98	78.8	6.726	62.0	85.0
Females	6	20.7	2.545	17.0	25.0	1.775	2.435	1.72	1.80	64.7	8.065	50.0	74.0

2002–2005	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Males	7	23.6	1.990	21.0	27.0	1.910	7.764	1.83	2.05	80.1	3.932	73.0	86.0
Females	9	23.1	4.120	19.0	31.0	1.766	4.470	1.70	1.86	57.9	3.110	63.0	53.0

TABLE 2
Basic data on the age, body height and body weight with the sets of notable world male and female high jumpers in the athletic seasons of 1989 and 2002

WORLD	n	Age [years]				Body height [m]				Body weight [kg]			
		AM	SD	xmin	xmax	AM	SD	xmin	xmax	AM	SD	xmin	xmax
1989 (males)	9	24.0	3.032	19.0	30.0	1.92	0.208	1.82	2.02	81.0	4.812	71.0	86.5
1989 (females)	9	23.5	0.901	19.0	27.0	1.78	0.187	1.69	1.86	63.2	4.756	56.0	74.0
2002 (males)	10	24.1	2.807	20.0	28.0	1.93	0.049	1.83	2.02	79.7	5.715	67.0	85.0
2002 (females)	10	22.4	0.831	21.0	24.0	1.81	0.054	1.73	1.92	61.6	4.991	55.0	73.0

Our entire set was younger than the best world high jumpers (on average by 1.3 years with men and 1.5 years with women). The highest recorded age data with our groups of men were in 1986 (J. V., age 32, born in 1954; personal record 2.12 m), the lowest age data in 1996 (S. C., age 17, born in 1979; personal record 2.04 m and L. S., age 17, born in 1979; personal record 2.01 m). As for women there are extreme age values from 2002 (L. D., age 31, born in 1971; personal record 1.92 m) or from 1984 (I. V., age 16, born in 1968; personal record 1.84 m).

As for the data on average body height the high jumpers tested (h = 1.92 m) do not differ from world standards too much and are shorter only by 0.02 m. The body height range of the variation of our best high jumpers is, however, sizable (Rmin-max = 0.17 m). When we compare our set with the set of high jumpers measured in 1967 by Štěpnička (1972), then the difference in the average body height is, for our groups, +0.08 m.

Note: In general, the trend of increasing body height is well known with the normal population as well as with sporters (Matiegka, 1927; Novotný, 1964; Fetter & Suchý, 1966; Linz & Fleischman, 1965; Linz, 1971; Žára, 1968; Štěpnička, 1979; Bláha, 1986; Langer, 1989, etc.).

With women the body height range of variation is almost the same as with men (Rmin-max = 0.16 m). The female high jumpers we have measured are shorter than the set of the ten best female high jumpers in the world, on average by less than 0.03 m.

Note: According to Ballreich and Kuhlow (1986) a body height increase of a high jumper by 0.1 m results in augmentation of the vertical jump height +0.07 m.

We measured the highest body height 2.05 m with men (D. H., year of measurement 2002, age 27, body weight 79.0 kg; personal record 2.21 m) and 1.86 m with women – female high jumpers (I. S., year of measurement 2002, age 25, body weight 63 kg; personal record 1.96 m). We found the lowest value of the body height 1.81 m with the French junior (S. C., year of measurement 1996, age 17, body weight 62 kg; personal record 2.09 m) and 1.70 m among women (K. K., year of measurement 2002, age 29, body weight 58 kg; personal record 1.87 cm).

The dependence of absolute sports performance on body height was not substantiated with the tested female and male high jumpers having high average performances (xmales = 2.20 m; xfemales = 1.82 m). The correlation coefficient is very low (rM = 0.101) with men, with women it even has a negative value (rF = –0.407).

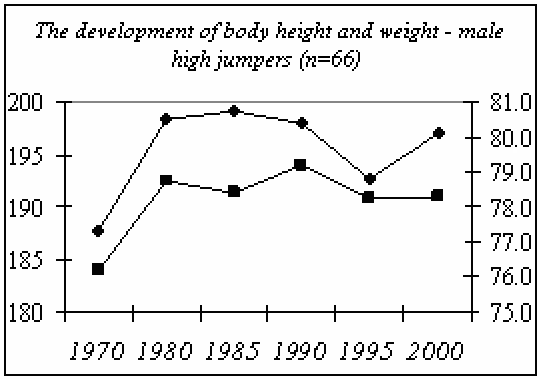
The body weight range of variation is relatively large in our groups (RMmin-max = 16.5 kg; RFmin-max = 22.0 kg). The highest and the lowest body heights always correspond to the highest and the lowest body weights with men and women. As for men – 86.5 kg and 2.02 m (M. M., born in 1963, year of measurement 1989; personal record 2.20 m) and 62 kg and 1.81 m (C. S., 1979, 1996; 2.19 m). As for women – 75 kg and 1.84 m (K. J., 1962; 1986; 1.82 m) and 50 kg and 1.72 m (L. E., 1976, 1996; 1.84 m). An extremely tall male high jumper having a very low body weight (D. H., body height 2.05 m, year of measurement 2002, age 27, body weight 79.0 kg; personal record 2.21 m) and a female high jumper having identical parameters (I. S., body height 1.86 m, year of measurement 2002, age 25, body weight 63 kg, personal record 1.96 m) are exceptions.

Average values of body weight with all the measured male and female high jumpers in the particular research stages are approximately the same. Our set differs from the best world male and female high jumpers on average by +2.5 kg with men and by +1 kg with women.

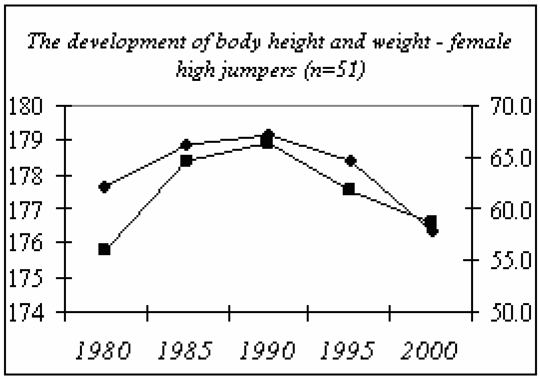
Note: In his research Štěpnička (1972) specifies the average weight of our best high jumpers as 77.3 kg (n = 15).

Fig. 1
The development of average body height (♦) and body weight (■) values in stages measured with male (a) and female (b) high jumpers in the CR

a)



b)



The summary findings of anthropometric measurements for determining a somatotype of male and female high jumpers have been processed using our own computer program and recorded together with the average values and standard deviations in TABLE 2.

TABLE 3
Average components of the male and female high jumpers' somatotypes in particular research stages

1983–1984	n	Components of somatotype														
		ENDOMORPH				MESOMORPH				ECTOMORPH				AM		
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX	ENDO	MESO	ECTO
Males	19	2.84	0.727	3.66	4.49	4.21	0.694	2.49	5.10	4.32	0.415	2.96	4.52	2.8	4.2	4.3
Females	14	3.43	0.829	2.61	4.88	4.96	0.458	2.38	3.22	4.04	0.603	3.91	4.48	3.5	5.0	4.0

1985–1986	n	Components of somatotype														
		ENDOMORPH				MESOMORPH				ECTOMORPH				AM		
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX	ENDO	MESO	ECTO
Males	21	3.94	0.381	3.47	4.56	3.64	1.033	1.15	5.12	4.04	0.552	2.96	5.19	3.9	3.6	4.0
Females	14	3.60	0.650	2.61	4.88	3.40	0.568	2.38	4.29	3.86	0.331	3.32	4.50	3.6	3.4	3.9

1989–1991	n	Components of somatotype														
		ENDOMORPH				MESOMORPH				ECTOMORPH				AM		
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX	ENDO	MESO	ECTO
Males	8	3.87	0.656	2.85	4.66	3.23	1.051	1.08	4.71	4.46	0.640	3.56	5.34	3.9	3.2	4.5
Females	8	3.78	0.627	2.83	4.88	3.35	0.464	2.58	4.29	3.82	0.336	3.32	4.50	3.8	3.4	3.8

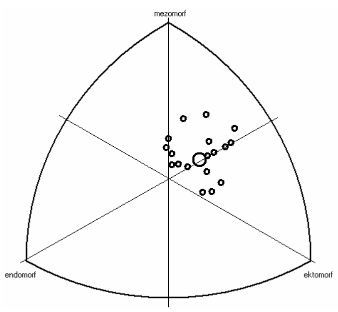
1995–1996	n	Components of somatotype														
		ENDOMORPH				MESOMORPH				ECTOMORPH				AM		
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX	ENDO	MESO	ECTO
Males	11	3.07	0.430	2.11	3.65	3.69	1.031	1.72	4.99	4.17	0.411	3.54	5.02	3.1	3.7	4.2
Females	6	3.50	0.356	3.13	4.19	3.16	1.505	1.22	5.40	4.07	1.097	2.82	5.70	3.5	3.2	4.1

2002–2005	n	Components of somatotype														
		ENDOMORPH				MESOMORPH				ECTOMORPH				AM		
		AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX	ENDO	MESO	ECTO
Males	7	2.40	0.669	1.50	3.44	3.75	1.376	1.33	5.33	4.03	1.311	2.16	6.47	2.4	3.2	4.0
Females	9	3.56	0.850	2.11	3.65	1.98	0.844	1.72	4.99	5.08	0.627	3.54	5.02	3.6	2.0	5.1

For clear and rapid orientation in the distribution of phenotypes in the sets of male (n = 66) and female (n = 51) high jumpers we have calculated components of somatotypes in five stages of measurements and entered them in the somatographs after computer processing. (Fig. 2–6).

Fig. 2
Somatographs of the best male (a; n = 19) and female (b; n = 14) high jumpers measured during the period 1983 to 1984

a)



b)

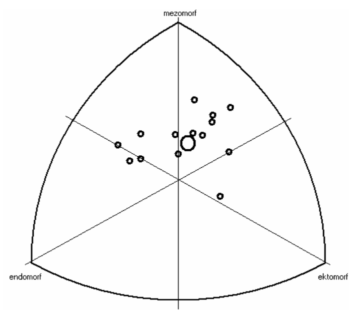
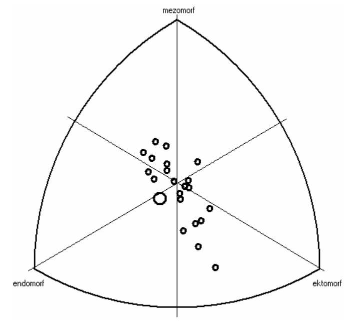


Fig. 3
Somatographs of the best male (a; n = 21) and female (b; n = 14) high jumpers measured during the period 1985 to 1986

a)



b)

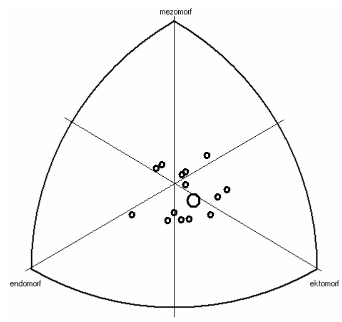
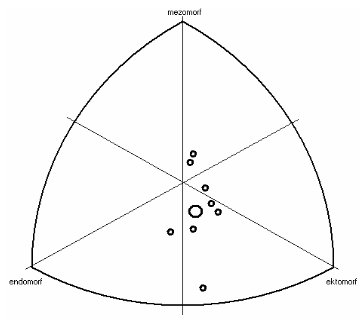


Fig. 4
Somatographs of the best male (a; n = 8) and female (b; n = 8) high jumpers measured during the period 1989 to 1991

a)



b)

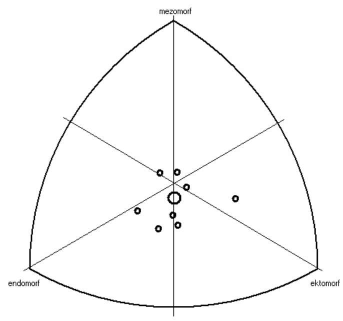
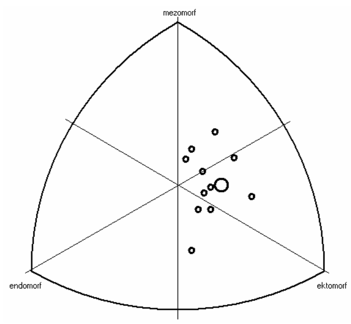


Fig. 5
Somatographs of the best male (a; n = 11) and females (b; n = 6) high jumpers measured during the period 1995 to 1996

a)



b)

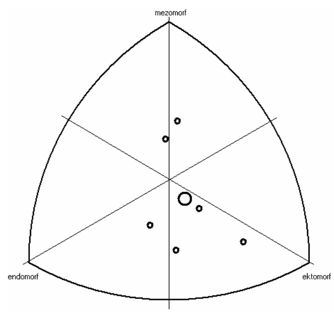
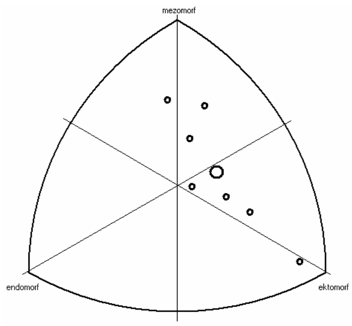
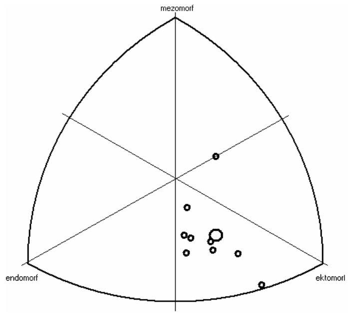


Fig. 6
Somatographs of the best male (a; n = 7) and female (b; n = 9) high jumpers measured during the period 2002 to 2005

a)



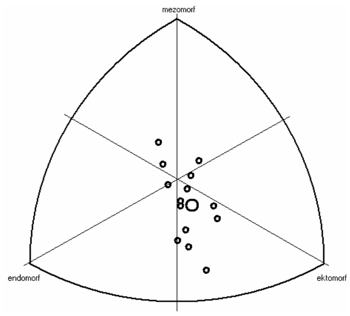
b)



It is interesting to compare the somatotypes of the male and female high jumpers from the viewpoint of the two techniques of getting over the bar – the straddle technique and the fosbury flop technique (Fig. 7 and 8).

Fig. 7
Somatographs comparing male high jumpers–floppers (a; n = 14) and male high jumpers–straddlers (b; n = 7) measured during the period 1986 to 1991

a)



b)

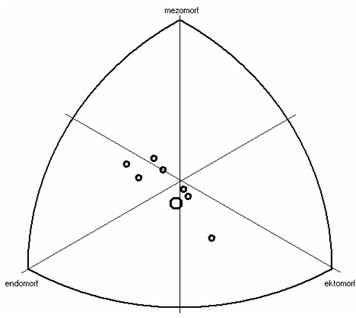
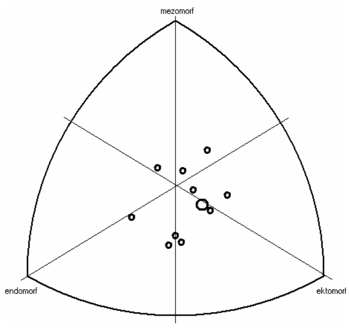


Fig. 8
Somatographs comparing female high jumpers–floppers (a; n = 10) and female high jumpers–straddlers (b; n = 4) measured during the period 1986 to 1991

a)



b)

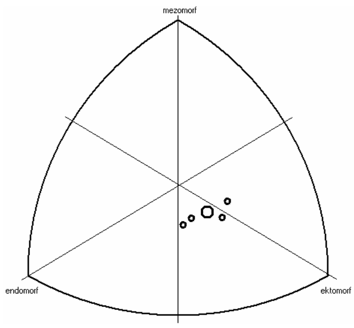
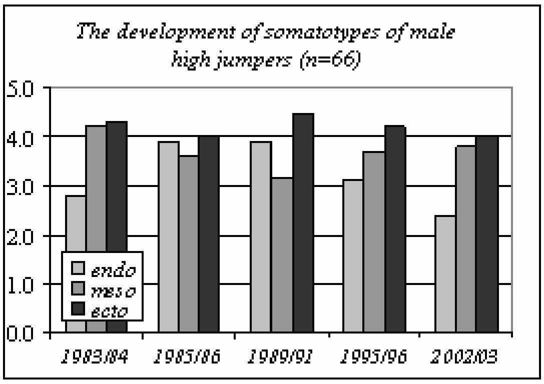
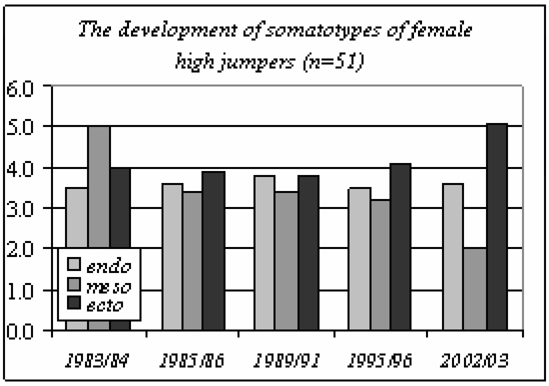


Fig. 9
The development of average somatotypes of male (a) and female (b) high jumpers during the period 1983 to 2003

a)


b)


In the overwhelming majority of measurements the particular components of somatotypes show a tendency to increase and the average somatotype of high jumpers is 3.4–3.7–4.2. On the basis of matching the somatotypes to categories according to Carter (Štěpnička, 1979), our set of male athletes can be described as falling into categories of mesomorphs and ectomorphs. Endomorphic ectomorphs (36.4%) occur in most cases. Endomorphic mesomorphs (16.7%), mesomorphic ectomorphs (15.2%) and ectomorphic mesomorphs (13.5%) are other frequent somatotypes. With the high jumpers we have kept under review there is an apparent dominance of the ectomorphic component (51%), especially in the last two measurement stages.

Note: Štěpnička (1967, 1974) specifies the somatotypes of the Czechoslovak high jumpers (n = 15) using the following values 1.5–5.5–3.0 (1967) or 1.6–5.5–2.8 (1974) and defines the groups having the ectomorphic mesomorphs designation. With the men the mesomorphic component (55%) dominates considerably, while the ectomorphic component is represented by only 33%.

With female high jumpers (n = 51) we have calculated the average somatotype 3.4–3.8–4.2. The third component is dominant and the second is higher than the first. Thus, according to Carter (Štěpnička, 1979) it is the same category as with the male high jumpers – ectomorphic mesomorphs. Endomorphic ectomorphs (43.8%), mesomorphic ectomorphs, ectomorphic endomorphs (identically 16.3%) and ectomorphic mesomorphs (15.2%) were the most frequent somatotypes of the female high jumpers measured.

Based on the characteristics resulting from the values of various indexes it is possible to claim that male and female high jumpers have, on an average, above average body height and length of the lower limbs as regards length dimensions.

DISCUSSION AND CONCLUSION

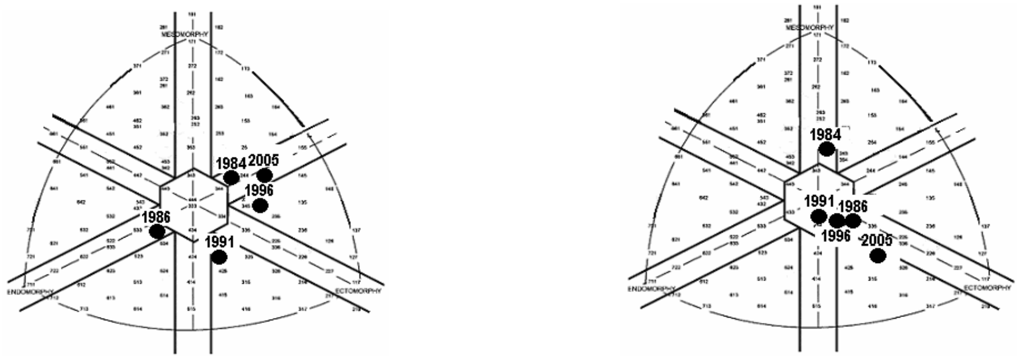
The anthropometric research that we carried out with Czech and foreign male and female high jumpers on a long term basis was especially informative.

As for the data about average body height, the tested male high jumpers ($\bar{h}$ = 1.92 m) do not differ much from the first ten world male jumpers and are shorter only by 0.02 m. The female high jumpers of our set are as tall as the best female high jumpers in the world tables ($\bar{h}$ = 1.78 m). The trend of body height that becomes evident with all the five sets of the best men and women in a period lasting more than 20 years is the most interesting in the above mentioned comparison. The increases in body height average values are slowing down gradually, nonetheless the differences are clearly evident with our choices over a 22 year period.

The body weight average values with the measured male and female high jumpers are approximately the same in some stages of the research. The last measurement of women (2002–2005) when the average body weight decreased considerably in comparison with the previous periods is an exception.

In the overwhelming majority of measurements, the particular somatotype components show a tendency to increase (3.4–3.7–4.2), which corresponds to the category of mesomorphs ectomorphs with groups of high jumpers. Particularly, in the last two stages of measurements the dominance of the ectomorphic component (51%) is evident. We have calculated the combination of components 3.4–3.8–4.2 for the female high jumpers. Thus, it is the same category as with men – mesomorphs ectomorphs. Most of the athletes do not show the extreme mesomorphy and are placed in the graph from mesomorphic ectomorphs through balanced mesomorphs up to endomorphic mesomorphs.

Fig. 10
The average values of male (a) and female (b) high jumpers somatotypes obtained in particular periods and their inclusion in categories of somatotypes



Based on the development of measured data relating to the physique of female and male high jumpers it is evident that the measured groups were selected intentionally and can be designated as partially selected groups, namely with respect to both performance and physique. In the course of the research, adaptation changes in the physique become evident with all the sets. These changes were caused by the selection and subsequently by the specific training load as well as by the execution of the demanding athletic event itself.

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SOMATOMETRICKÉ CHARAKTERISTIKY SKOKANŮ DO VÝŠKY

(Souhrn anglického textu)

Význam somatických předpokladů je u skoku do výšky zřejmý. V průběhu našeho hodnocení byla potvrzena významná závislost tělesné stavby a výkonu, a to u všech skupin žen a mužů věnujících se skoku do výšky s vysokými průměrnými výkony. Měření probíhalo v období od r. 1983 do r. 2005. Všechny tyto skupiny se vyznačovaly relativně velkou homogenností většiny somatických ukazatelů.

Měření, která používáme za základ v následujících částech příspěvku, probíhala v průběhu více než dvou desetiletí. Zahrnují jednoduchý průřezový průzkum skupin žen a mužů (n = 117) a také průběžné monitorování vybraných jednotlivců.

V souladu s tělesným vývojem žen a mužů věnujících se skoku do výšky byly měřené skupiny voleny samozřejmě záměrně a lze je označit za „částečně zvolené skupiny" s ohledem na výkon i tělesnou stavbu. V průběhu našeho průzkumu lze u všech skupin pozorovat změny v tělesné stavbě způsobené výběrem a následně specifickou tréninkovou zátěží a rovněž samotnou náročnou atletickou disciplínou.

Klíčová slova: somatické předpoklady, antropometrický průzkum, typologie, somatotyp, tvrzení, sportovní výkon.

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