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## SOMATIC BUILD VS SPORTS RESULT OF POLE VAULT CONTESTANTS AGED 16-17

### BUDOWA SOMATYCZNA VS WYNIKI SPORTOWE ZAWODNIKÓW SKACZĄCYCH O TYCZCE W WIEKU 16-17 LAT

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#### Summary

Experimental researches conducted between 2005 and 2009 included 20 sportsmen aged 16-17 pole vaulting at the sports club 'Zawisza' Bydgoszcz, TS 'Olimpia' Poznań, pole vault centre Gdańsk, 'Gwardia' Piła, 'Śląsk' Wrocław.

The aim of the thesis was to define the relation between somatic parameters and sports results of pole vaulters of junior category (aged 16-17).

The following methods and research tools were used in the thesis: evaluation of physical development, testing physical dexterity, recording sports results and statistical description.

The analysis of the researches showed great diversity of somatic features and physical dexterity results of particular athletes.

The relation which occurs between sports result of the pole vault and the body height (0.66), the length of upper limb and lower limb (0.64, 0.54, respectively) are interesting.

On the basis of the above analysis with regard to, among many, small number of the examined, it is not possible to draw far-reaching conclusions concerning the relation which occurs between somatic build and physical dexterity attempts and pole vault result.

#### Streszczenie

Badania eksperymentalne prowadzono w latach 2005-2009, którymi objęto 20 sportowców w wieku 16-17 lat uprawiających skok o tyczce w klubie sportowym „Zawisza” Bydgoszcz, TS „Olimpia” Poznań, Ośrodek skoku o tyczce Gdańsk, „Gwardia” Piła, „Śląsk” Wrocław.

Celem pracy było określenie zależności między parametrami somatycznymi, a wynikiem sportowym w skoku o tyczce, tyczkarzy w kategorii junior młodszy (16-17 lat).

W pracy wykorzystano następujące metody i narzędzia badań: ocena rozwoju fizycznego, testowanie sprawności fizycznej, rejestracja wyników sportowych i metody statystycznego opracowania.

Analiza badań wykazała duże zróżnicowanie cech somatycznych i wyników sprawności fizycznej u poszczególnych ćwiczących.

Interesująco przedstawia się zależność, jaka występuje pomiędzy wynikiem sportowym skoku o tyczce, a wysokością ciała (0,66), długością kończyny górnej i dolnej (odpowiednio 0,64, 0,54).

Na podstawie powyżej przeprowadzonej analizy ze względu na między innymi małą liczbę badanych nie można wysunąć daleko idące wnioski dotyczące relacji, jaka zachodzi pomiędzy budową somatyczną, a próbami sprawności fizycznej i wynikiem w skoku o tyczce.

**Key words:** somatic features, sports result, correlation

**Słowa kluczowe:** cechy somatyczne, wynik sportowy, korelacja

## INTRODUCTION

The history of men's pole vault shows that the biggest sports achievements of this spectacular and complex athletic sports event are achieved by the contestants of diverse somatic build [1]. The achievement of the best results by the contestant depends, among many, on: level, physical dexterity, somatic build, technical skills and other conditions [2]. Numerous publications describe research results which show that the body type of every human being is their biological, to a high degree, determined genetically feature, i.e. the feature with a great immutability in the period of life [3, 4, 5, 6]. That is why an accurate choice in the aspect of children's body build to the proper sports events contributes to beneficial prognosis that these individuals will meet, in the future, the somatic requirements making sports competition on the highest world level reachable for them.

The external manifestation of the development of a particular person is their body build and the predispositions to execute particular physical activity. Because of that, somatic build and, most of all, some of its proportions which have their own development course, are of great importance in the pole vault [4, 7]. So far we have not been able to clearly state which of the parameters of somatic build are an exponent or rather a criterion for particular age categories of pole vault contestants.

**The aim of the thesis** was to define the relation between the somatic parameters and sports results of the pole vault jumpers of junior category (16 – 17).

## MATERIALS AND METHODS

Cognitive tests were conducted between 2005 and 2009 and they included 20 sportsmen aged 16 – 17 pole vaulting at the sports club 'Zawisza' Bydgoszcz, TS 'Olimpia' Poznań, pole vault centre Gdańsk, 'Gwardia' Piła, 'Śląsk' Wrocław.

The contestants participated in training classes at the club 4-6 times a week. The training unit lasts for 60-90 min., while at school they were following Physical Education programme in the amount of 3-4 45-minute units a week, with the emphasis on education of general physical dexterity.

## METHODS OF RESEARCH

The following methods and research tools were used in the thesis:

- evaluation of physical development,
- testing physical dexterity,
- recording sports results,
- methods of statistical description.

In order to conduct the evaluation of physical development, somatic build measurements including the following indexes were used.

- body height (basis-vertex),
- weight,
- torso length (suprasternale-symphysiom),
- lower limb length (basis-symphysion),
- upper limb length (acromion-daktylion III),
- shoulder width (acromion-acromion),
- pelvis width (iliocristale-iriocristale),
- thigh circumference,
- shank circumference,
- arm circumference,
- volume of the chest during inhalation,
- volume of the chest during exhalation,
- chest breadth (the difference of the chest volume during inhalation and exhalation).

Using the above parameters, somatic build index according to Rohrer was calculated using the following relation:

$$\frac{\text{Body weight (g)} \times 100}{\text{Body height (cm)}^3}$$

During the research a pair of large bow compasses, scales and measuring tape were used.

During the construction of physical dexterity attempts the system of control indexes suitable for competition requirements of pole vault was taken into account [8]:

- running speed for 30-m distance - high start position (s),
- running speed for 15-m distance with a 20-meter run-up,
- running speed for 15-m distance with a 20-meter run-up with a pole (s),
- running speed for 15-m distance with a 20-meter run-up with setting a pole (s),
- strength – measured by the long jump with a 20-meter run-up (cm),

- explosive strength – measured by the long jump with a 20-meter run-up,
- strength of back muscles and shoulder girdle – measured by lifting feet to the horizontal bar from straight arm overhang 5 times (time measured) (s),
- strength of back muscles and shoulder girdle – measured by lifting feet to the horizontal bar from straight arm overhang (quantity),
- strength of shoulder girdle and shoulders' muscles – measured by climbing 3-meter rope (s),
- strength of shoulder girdle and shoulders' muscles, horizontal pull-ups (quantity),
- strength of shoulder girdle and shoulders' muscles, 5 horizontal pull-ups (time measured) (s),
- pole vault test (cm),
- coordination and explosive strength measured by “flying” over the crossbeam from back somersault through a handstand (from the mattress) (cm),
- strength – measured by 4-kg shot put thrown back over the head (m).

The execution of the planned attempts was preceded by a detailed instruction on a way of their execution and before their performance the coach conducted a 15-minute warm-up.

To conduct the analysis of sports results the official competition protocols were included. The collected material was analysed statistically using the minimum, maximum and average value, the variations of the examined parameters and Pearson's correlation factors were considered as statistically significant for  $p < 0.05$ .

#### THE ANALYSIS OF TEST RESULTS

The conducted analysis of physical development of pole vault jumpers showed that the value of the standard deviation of particular parameters oscillates from 1.27 (pelvis width) to 6.24 (weight) (table 1). The average body height of the contestants aged 16-17 was 181.3 cm - the tallest contestant was 190 cm high and the shortest contestant was 174 cm high. We could observe clear diversity in the sportsmen's weight (min. 53.5, max. 78 kg). The average values of shoulder and pelvis width were 38.91 cm, 28.95 cm, respectively. The average values of upper and lower limb length were 91.78cm, 78.54 cm and the difference between their minimum and maximum values was equal 12.5 cm (lower limb) and 12.2 cm (upper limb). The measurement of thigh, shank and arm circumference were equally interesting. The average value of these features was 48.15 cm, 35.56 cm and 26.82 cm,

respectively. Relatively big diversity can be observed between the maximum and minimum value of thigh circumference (15.5). The measurement of the chest volume during inhalation and exhalation indicated the average value on the level of 93.38 cm, 85.73 cm, respectively, and for the average value of chest breadth - on the level of 7.6 cm. The average value of torso length was 53.9 cm while the minimum value was 50 cm and the maximum value was 57.1 cm.

Table 1. *The results of somatic development of the contestants of the junior category (aged 16-17)*

Tabela 1. *Wyniki badań rozwoju somatycznego 16-17 letnich skoczków o tyczce*

No	Examined param etres	Statistical values	16-17 years old (n=20)
1.	body height (cm)	Average	181,30
		SD	4,62
		Min	174,00
		Max	190,00
2.	body weight (kg)	Average	67,86
		SD	6,24
		Min	53,50
		Max	78,00
3.	shoulder width (cm)	Average	38,91
		SD	2,09
		Min	36,00
		Max	43,90
4.	pelvis width (cm)	Average	28,95
		SD	1,27
		Min	27,20
		Max	32,50
5.	lower limb length (cm)	Average	91,78
		SD	3,29
		Min	84,00
		Max	96,50
6.	upper limb length (cm)	Average	78,54
		SD	3,34
		Min	72,00
		Max	84,20
7.	thigh circumference (cm)	Average	48,15
		SD	4,19
		Min	42,50
		Max	58,00
8.	shank circumference (cm)	Average	35,56
		SD	2,29
		Min	32,50
		Max	40,00
9.	arm circumference (cm)	Average	26,82
		SD	2,10
		Min	23,50
		Max	32,00
10.	volume of the chest inspiration (cm)	Average	93,38
		SD	4,65
		Min	86,00
		Max	101,50
11.	volume of the chest exhalation (cm)	Average	85,73
		SD	4,13
		Min	79,00
		Max	93,50
12.	chest breadth (cm)	Average	7,60
		SD	1,37
		Min	4,50
		Max	10,00
13.	torso length (cm)	Average	53,90
		SD	2,04
		Min	50,00
		Max	57,10

Comparing the body height of the examined pole vault jumpers to the tests' results of M. Napierała (2008), who conducted researches within kujawsko-pomorskie province, shows that the examined pole vault jumpers are taller than their peers (M. Napierała: 16.5 years old – 175.64 cm). The relation between the body height of the examined contestants and the body height of the boys in Polish national tests of R. Przewęda and J. Dobosz (2003) looks similar: (16.5 years old – 176.49 cm).

Comparing the body weight of pole vault jumpers with the tests' results of M. Napierała (2008) within kujawsko-pomorskie province and Polish national tests of R. Przewęda and J. Dobosz (2003) it is shown that the examined pole vault jumpers have greater average body weight. In the research of M. Napierała (2008) and R. Przewęda, J. Dobosz (2003) the results are following: M. Napierała 16,5 years old – 65,27 kg; R. Przewęda, J. Dobosz 16,5 years old – 66,49 kg.

The conducted analysis of biological development of pole vault jumpers contributed to showing the relations resulting from their above natural development and, most of all, from the process of organism's adaptation occurring because of implemented training factors used in their athletic sports discipline.

In table 1 the parameters of somatic build of pole vault jumpers of the junior category (aged 16-17) are presented.

The analysis of body slenderness, defined by Rohrer index showed, on the basis of comparison of tests' results of the above index with the author's previous tests of the younger contestants doing the pole vault [11], the tendency of growth. It can be an evidence of growth of their muscle mass caused by training loads and the period of biological development of the examined sportsmen, as well as shoulder width and smaller dynamic of body height. The above index achieved value of 1.14 (table 2)

Table 2. *Index of body built by Rohrer*

Tabela 2. *Wskaźnik budowy ciała wg. Rohrera*

Rohrer index	
No	Age
	16-17
1.	1,14

The conducted analysis of physical dexterity tests' results showed significant fluctuation of standard deviation from 0.03 (first /0-5m/ and second /5-10m/ stage of the run for 15-m distance with setting a pole) to 49.48 in the pole vault in particular attempts. In the run for 30-m distance the average value was 4.05 s, the minimum value 3.71 s and the maximum value 4.31 s. In the run for 15-m distance, for 15-m distance with a pole and for 15-m distance with setting a pole the average values of 1.79 s, 1.85 s and 1.95 s, respectively, were noted. The results of the long jump at state and with a run-up are interesting. In both attempts there is a great diversity of results (standard deviation 25.92 and 31.63). The average of results of the long jump at state and with a run-up was 265.5 cm and 577.35 cm. The shortest long jump was 162 cm and the longest was 292 cm. In the long jump with a run-up the worst score was 528 cm and the best 631 cm. The pole vault results present a greatest diversity and the difference between the worst and the best one - 150 cm. The rest of the results of physical dexterity attempts are presented in Table 3.

Correlative analysis of particular physical dexterity tests' results and somatic build of pole vault jumpers aged 16-17 showed numerous statistically significant relations (table 4). Body height has statistically significant relation with seven physical dexterity attempts; run for 15-m distance (0.46), climbing a rope (0.48), lifting feet to the horizontal bar 5 times (0.79), 5 pull-ups on the horizontal bar (0.57), "flying" over the crossbeam from back somersault (0.64), 4-kg shot put thrown back over the head (0.58) and pole vault (0.66). Statistically significant relations occur between body weight and run for 15-m distance (0.52), first stage (0-5m), run for 15 m distance with setting a pole (0.49), climbing a rope (0.47) and lifting feet to the horizontal bar 5 times (0.60). There is at least one statistically significant relation between shoulder width, pelvis width (adequately with lifting feet to the horizontal bar 5 times /0.52/ and the last stage /10-15m/ of the run for 15-m distance with setting a pole /0.45/). Interesting statistically significant relations occur between the length of lower and upper limb and lifting feet to the horizontal bar 5 times (0.68 and 0.72 respectively), 'flying' over the crossbeam, 4-kg shot put throw back over the head and pole vault (0.60, 0.52, 0.64 and 0.64 and 0.52, 0.54) and climbing a rope (0.52 and 0.52). We also found the relation between thigh circumference and 4-kg shot put thrown back over the head (0.59) and run for 15-m distance, shank circumference (0.52).

Table 3. *The results of physical dexterity of pole vault jumpers aged 16-17*Tabela 3. *Wyniki sprawności fizycznej 16-17 letnich skoczków o tyczce*

No	Dexterity tests	Statistical values	Age 16-17 (n=20)
	1	run for 30 m (s)	Average
SD			0,16
min			3,71
max			4,31
2	run for 15 m (s)	Average	1,79
		SD	0,07
		min	1,67
		max	1,98
3	run for 15 m with a pole (s)	Average	1,85
		SD	0,11
		min	1,69
		max	2,05
4	run for 15 m with setting a pole (s)	Average	1,98
		SD	0,09
		min	1,81
		max	2,18
5	0 - 5 m (s)	Average	0,64
		SD	0,03
		min	0,59
		max	0,73
6	5 - 10 m (s)	Average	0,65
		SD	0,03
		min	0,60
		max	0,72
7	10 - 15 m (s)	Average	0,70
		SD	0,04
		min	0,62
		max	0,77
8	long jump at state (cm)	Average	265,50
		SD	25,92
		min	162,00
		max	292,00
9	long jump with a Run-up (cm)	Average	577,35
		SD	31,63
		min	528,00
		max	631,00
10	climbing 3-m rope (s)	Average	5,84
		SD	1,19
		min	3,31
		max	8,02
11	Pull-ups on the horizontal bar (quantity)	Average	12,00
		SD	3,08
		min	7,00
		max	17,00
12	lifting feet to the crossbeam-training stimulator (quantity)	Average	4,70
		SD	2,13
		min	1,00
		max	10,00
13	lifting feet to the horizontal bar 5 times in good time (s)	Average	6,20
		SD	0,93
		min	4,42
		max	7,51
14	5 pull-ups on the horizontal bar in good time (s)	Average	6,11
		SD	1,01
		min	4,22
		max	7,54
15	„flying“ over the crossbeam from back somersault through a handstand from the mattress (cm)	Average	70,40
		SD	25,74
		min	35,00
		max	120,00
16	4-kg shot put thrown back over the head (m)	Average	14,73
		SD	1,06
		min	12,89
		max	16,25
17	pole vault result (cm)	Average	386,30
		SD	49,48
		min	330,00
		max	480,00

Also many statistically significant relations occur between arm circumference, volume of the chest during inhalation and exhalation and torso length and some physical dexterity tests. The most interesting relation occurs between arm circumference and climbing a rope, lifting feet to the horizontal bar 5 times and 5 pull-ups on the horizontal bar (0.51, 0.63, 0.60, respectively). Statistically significant relations of torso length and particular physical dexterity tests are on the level from 0.49 and 0.67. The chest breadth does not enter into statistically significant relations with any physical dexterity test. It is necessary to emphasise that most relations occur on the average and small level of significance.

In table 5 the relations of particular somatic features with pole vault result are presented. Statistically significant correlation occurs between five out of 13 somatic build features. The relations between sports result and body height (0.66), upper and lower limb length (0.64, 0.54 respectively) are also of interest. Interesting is that statistically significant relation of pole vault occurs with the chest volume during inhalation and exhalation (0.45, 0.46). However, the relations of low and average relation are the most common (table 5).

Table 4. Values of correlative analysis of the results of particular physical dexterity tests and somatic build of pole vault jumpers aged 16-17

Tabela 4. Wartości analizy korelacyjnej wyników poszczególnych testów sprawności fizycznej i budowy somatycznej 16-17 letnich skoczków o tyczce

Examined parameters	Examined features – somatic measurements													
	Body height (kg)	Body weight (kg)	Shoulder width (cm)	Pelvis width (cm)	Lower limb length (cm)	Upper limb length (cm)	Thigh circum. (cm)	Shank circum. (cm)	Arm circum. (cm)	Chest volume inspiration (cm)	Chest volume exhalation (cm)	Chest breadth (cm)	Torso length (cm)	
Results of physical dexterity attempts	No	A	B	C	D	E	F	G	H	I	J	K	L	Ł
run for 30 m (s)	1	0,16	-0,11	0,08	0,20	0,28	<b>0,50</b>	0,02	-0,20	0,15	0,29	0,30	0,09	-0,28
run for 15 m (s)	2	<b>-0,46</b>	<b>-0,52</b>	-0,34	0,24	-0,33	-0,23	-0,41	<b>-0,52</b>	<b>-0,47</b>	-0,31	-0,35	-0,19	<b>-0,59</b>
run for 15 m with a pole (s)	3	-0,30	-0,22	-0,36	0,19	-0,22	<b>-0,54</b>	-0,22	-0,13	<b>-0,57</b>	-0,44	<b>-0,45</b>	-0,30	-0,34
run for 15 m with setting a pole (s)	4	-0,35	-0,30	-0,27	0,25	-0,25	-0,39	-0,36	-0,25	-0,34	-0,29	-0,28	-0,10	<b>-0,49</b>
0 - 5 m (s)	5	<b>-0,42</b>	<b>-0,49</b>	-0,26	0,35	<b>-0,47</b>	-0,41	-0,08	-0,34	-0,26	-0,31	-0,42	-0,04	-0,07
5 - 10 m (s)	6	-0,41	-0,37	-0,37	0,21	-0,24	-0,43	-0,36	-0,24	<b>-0,48</b>	-0,39	-0,39	-0,29	<b>-0,54</b>
10 - 15 m (s)	7	-0,41	-0,21	-0,07	<b>0,45</b>	-0,37	-0,30	-0,18	-0,19	-0,09	-0,17	-0,20	0,03	-0,32
long jump at state (cm)	8	0,33	0,26	-0,10	0,07	0,12	0,00	0,10	0,15	0,09	0,09	0,08	-0,01	0,31
long jump with a run-up (cm)	9	0,09	0,01	-0,41	-0,35	0,21	-0,06	-0,31	-0,01	-0,01	-0,12	-0,10	-0,22	0,18
climbing 3-m rope (s)	10	<b>-0,48</b>	<b>-0,47</b>	-0,25	0,29	<b>0,52</b>	<b>-0,52</b>	-0,04	-0,18	<b>-0,51</b>	<b>-0,47</b>	<b>-0,55</b>	-0,16	-0,33
Pull-ups on horizontal bar (quantity)	11	0,41	0,39	0,34	-0,17	0,19	0,15	0,36	0,25	0,34	0,28	0,24	-0,14	<b>0,63</b>
Lifting-stimulator-feet to the crossbeam (quantity)	12	0,22	0,02	0,11	-0,06	0,15	0,34	0,12	-0,01	0,25	0,27	0,21	-0,05	0,33
lifting feet 5 times to the horizontal bar in good time (s)	13	<b>-0,79</b>	<b>-0,60</b>	<b>-0,52</b>	0,10	<b>-0,68</b>	<b>-0,72</b>	-0,42	-0,29	<b>-0,63</b>	<b>-0,70</b>	<b>-0,76</b>	-0,22	<b>-0,50</b>
5 pull-ups of the horizontal bar in good time (s)	14	<b>-0,57</b>	-0,35	-0,43	0,10	-0,38	<b>-0,49</b>	<b>-0,45</b>	-0,21	<b>-0,60</b>	<b>-0,54</b>	<b>-0,51</b>	-0,13	<b>-0,67</b>
‘flying’ over the crossbeam from back somersault	15	<b>0,64</b>	0,26	0,27	0,05	<b>0,60</b>	<b>0,64</b>	0,39	0,09	0,22	<b>0,56</b>	<b>0,54</b>	-0,12	0,30
4-kg shot put thrown back over the head (m)	16	<b>0,58</b>	0,28	0,29	0,16	<b>0,52</b>	<b>0,52</b>	<b>0,59</b>	0,32	<b>0,52</b>	<b>0,49</b>	<b>0,45</b>	0,03	<b>0,58</b>

p<0,05 bold

Table 5. The results of correlative analysis of somatic features with pole vault result of the jumpers aged 16-17

Tabela 5. Rezultaty analizy korelacyjnej cech somatycznych z wynikiem w skoku o tyczce 16-17 letnich tyczkarzy

No	Examined features	Age
		16-17
1	Body height (cm)	<b>0,66</b>
2	Body weight (kg)	0,22
3	Shoulder width (cm)	0,15
4	Pelvis width (cm)	0,09
5	Lower limb length (cm)	<b>0,64</b>
6	Upper limb length (cm)	<b>0,54</b>
7	Thigh circumference (cm)	0,24
8	Shank circumference (cm)	0,06
9	Arm circumference (cm)	0,08
10	Chest volume inspiration (cm)	<b>0,45</b>
11	Chest volume exhalation (cm)	<b>0,46</b>
12	Chest breadth (cm)	-0,21
13	Torso length (cm)	0,20

p<0.05 bold

## CONCLUSIONS

Analyzing the correlation of particular somatic feature with any parameter describing motor dexterity contributes to the presentation of the differences which occur in the examined group and also between particular sportsmen. In the opinion of prominent experts, this subject is extremely complex. The specialists take a position which excludes explicitness of the successive relations [12.13].

The value of the standard deviation (of somatic features) oscillating from 1.27 (pelvis width) to 6.24 (body weight) proves the diversity of the examined sportsmen in relation to somatic build.

Rohrer index defined the body slenderness of the group on the level of 1.14 confirming that the

examined sportsmen at the age of 16-17 experience greater growth of muscle tissue and smaller growth of their body.

The analysis of the results of physical dexterity attempts showed their great diversity, the standard deviation oscillates from 0.03 to 49.48. The biggest one relates to the pole vault. In this attempt the difference between the worst and the best score was 45.45%.

The analysis of correlation of the examined pole vault jumpers' results with their particular measurements of somatic features showed some interesting relations. For example, body height is subject to statistically significant correlation with seven physical dexterity attempts ( e. g. with ‘flying’ over the crossbeam from back somersault /0.64). The relation between shank circumference and 4-kg shot put thrown back over the head (0.59) is also interesting.

Sports results have statistically significant correlation with five somatic features. The relation which occurs between pole vault sports result and body height (0.66), the length of upper and lower limb (0.64 and 0.54, respectively) is also interesting.

However, on the basis of the above analysis with regard to (among many) a small number of the examined sportsmen, it is not possible to draw far-reaching conclusions concerning the relation which occurs between somatic build and physical dexterity attempts and pole vault result.

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Received: 12.07.2011

Accepted for publication: 6.12.2011