

Secular Trend of Body Dimensions in Highly Qualified Wrestlers

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ABSTRACT

The purpose of the paper was to study the physique of highly qualified martial art athletes engaged in different types of wrestling, and to perform a retrospective analysis of the morphological characteristics of wrestlers examined since the early 1920s. The materials of the anthropometric survey of 48 athletes engaged in different types of wrestling with qualification from the candidate for master of sports and above were used for this purpose and compared to the "control group" of young men (N = 97) who were not engaged in sports (similar to the group of athletes by age, ethnicity and percentage of individuals with different weight categories). A set of morphological traits was established that contributed to the successful achievements in sports. When comparing the physique of modern athletes with that of the wrestlers surveyed in the early and mid-20th century (the 1920s and 1960s), it has been shown that the secular trend towards increase in height typical for modern population, was expressed in athletes to a much lesser extent. Striking similarities were revealed for absolute and relative dimensions characterizing the skeletal body proportions of the wrestlers, which pointed to the secular stability of this sports morphotype. The obtained results can be used as additional morphological criteria for sports selection, professional orientation and prediction of competitive success.

Key words: *wrestlers, martial art, morphological characteristics, body proportions, secular trend, sports selection*

Introduction

The literature on secular trends and secular changes in different populations and in various groups of people is enormous. Hundreds if not thousands of papers are dedicated to this subject. Many authors wrote about the intergenerational increase in height and weight as well as the changes in body shape as part of the general trend.^{1–7} The studies of such trends in athletes are of considerable interest but not numerous.^{8–11} The main research question that should be addressed in such studies, relates to the direction and patterns of secular changes in general population and in a specific group of athletes. Are they similar to each other, or do not correspond at all? The present paper tries to answer to those questions.

The aim of the research was to study the physique of highly qualified athletes engaged in various types of wrestling, and to perform a retrospective analysis of secular changes in the morphological characteristics of wrestlers examined since the early 1920s.

Material and Methods

Anthropometric data of 48 male athletes who were engaged in martial arts (different types of wrestling) for many years and reached high qualifications (from a candidate for master of sports and above) were used in this study. Athletes were 18–31 years old (mean age – 20.62 ± 0.43), almost all of the Russian ethnicity, permanent residents of Moscow. For comparative analysis, the materials of the anthropometric survey of young men – students of different Moscow universities were taken (N = 97). The students were not involved in sports, were of the same age (20.19 ± 0.29), of Russian ethnicity and represented with different weight categories. They were used as a "control group".

In all examined subjects (athletes and the representatives of the "control group") more than 20 indicators of physique were measured: height and weight; lengths of corpus, arms and legs; shoulders, pelvis, elbow and knee widths; corpus and limbs circumferences; skinfolds thick-

ness at different locations – subscapular, abdominal, triceps and calf. Additionally, indices characterizing body proportions were calculated: the Livy index (chest circumference at rest / height, assesses the strength of chest development), the ratio of arm and leg length to height (characterizes the relative length of the limbs); skeletal robusticity indices (elbow width/height; knee width/height) and the ratio of shoulder and pelvic widths to height, as well as pelvic width/shoulder width index to assess the morphotype.

For a retrospective analysis of secular changes in highly qualified wrestlers' physique, data obtained from literary sources were used.^{12–14} They presented data accumulated in different decades for almost 100 years (since the early 1920s) for groups of athletes similar in age, sports specialization and qualification level. To conduct such analysis, it was also necessary to comply with the comparability of weight categories of the athletes.

Statistical processing of materials was carried out in the package of programs "Statistica 10.0"¹⁵. The significance of the differences between mean values of the traits with normal distribution was established using the Student's t-test; in the case of non-normal distribution, the nonparametric Mann-Whitney test was used.

Results

Table 1 shows the average values of body dimensions in the surveyed martial arts athletes and in the control group of students, as well as the results of a comparative intergroup analysis.

Since in recent decades, in the anthropological scientific literature much attention has been paid to the processes of the secular trend – the intergenerational increase in height and weight in modern children, adolescents and youth^{2–7}, the study of these processes in highly qualified athletes is also of a significant interest. In particular, it is important to compare modern athletes of the 21st. century engaged in different types of wrestling, to the athletes surveyed more than half a century ago¹⁴ and almost 100 years ago.¹² Table 2 shows the average values of some total body dimensions of wrestlers of welterweight and medium weight categories (from 70 kg to 87 kg) according to the data of different surveys.

The figure 1 demonstrates secular changes in height of highly qualified athletes engaged in different types of wrestling, in comparison to boys and girls who do not go in for sports.

TABLE 1
RESULTS OF COMPARATIVE ANALYSIS OF PHYSIQUE INDICATORS IN MEN IN THE SURVEYED GROUPS

Traits	Wrestlers (M±m) N=48	Control group: non-athletes (M±m) N=97	Significance of differences (p)
Age	20.63 ± 0.44	20.79 ± 0.29	0.745
Weight, kg	76.60 ± 1.60	76.23 ± 1.00	0.839
Height, cm	174.88 ± 0.94**	177.91 ± 0.58	0.005
Leg length, cm	98.90 ± 0.86**	101.28 ± 0.45	0.008
Corpus length, cm	75.98 ± 0.42	76.62 ± 0.31	0.234
Arm length, cm	78.38 ± 0.55	78.61 ± 0.33	0.703
Elbow width, cm	6.85 ± 0.13**	7.15 ± 0.03	0.004
Knee width, cm	9.98 ± 0.10	9.88 ± 0.04	0.305
Chest circumference, cm	95.15 ± 0.88	93.63 ± 0.68	0.192
Subscapular skf., mm	9.47 ± 0.52**	13.17 ± 0.76	0.002
Triceps skf., mm	5.43 ± 0.43***	10.50 ± 0.59	0.000
Abdominal skf., mm	8.76 ± 0.59***	16.96 ± 1.06	0.000
Calf skf., mm	5.86 ± 0.48***	9.81 ± 0.44	0.000
Livy index, %	54.45 ± 0.45**	52.66 ± 0.40	0.007
Shoulder width/height, %	23.15 ± 0.18	22.84 ± 0.08	0.073
Pelvic width/height, %	16.01 ± 0.12	15.83 ± 0.09	0.241
Pelvic width/shoulder width, %	69.30 ± 0.60	69.37 ± 0.39	0.925
Arm length/height, %	44.82 ± 0.19**	44.19 ± 0.12	0.005
Leg length/height, %	56.52 ± 0.26	56.92 ± 0.14	0.144
Arm length/leg length, %	79.39 ± 0.55**	77.67 ± 0.26	0.002
Elbow width/height, %	3.92 ± 0.07	4.02 ± 0.02	0.075
Knee width/height, %	5.71 ± 0.06**	5.56 ± 0.02	0.004

Note: ** – p<0.01; *** – p<0.001

TABLE 2

AVERAGE VALUES OF TOTAL BODY DIMENSIONS OF WRESTLERS OF WELTERWEIGHT AND MIDDLE WEIGHT CATEGORIES (FROM 70 KG TO 87 KG) ACCORDING TO THE DATA OF DIFFERENT SURVEYS

Traits	Sources				
	Birzin, 1925 ¹²	Deshin, 1958	Geselevich, 1964 ¹⁴	Martirosov, 1968 ¹⁵	Our data, 2017–2018 survey
Height, cm	169.3	172.55	173.2	173.3	175.3
Weight, kg	75.8	79.2	78.75	81.81	78.39
Chest circumference, cm	100.55	102.45	103.8	100.13	96.01

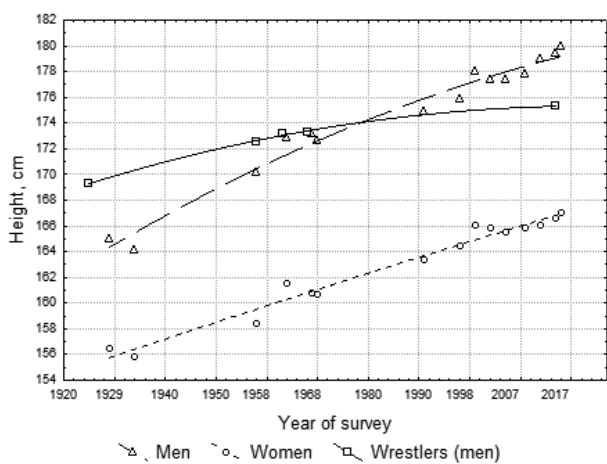


Figure 1. Secular changes in height of highly qualified athletes engaged in different types of wrestling, against the background of secular trend in height of boys and girls who do not go in for sports. The following data were used for this picture: Birzin¹², Aron¹³, Deshin, 1958, Geselevich¹⁴, Martirosov¹⁵, Vlastovskiy¹⁶, Solovyova, Godina, Miklashevskaya¹⁷, Godina et al.^{12–18}.

A more detailed study of secular changes in the morphological parameters of the physique is possible when comparing modern data with the results of a study by Martirosov (1968)¹⁵, which presents an analysis of a wide range of somatic traits for different weight categories of highly qualified wrestlers – from first-graders to Olympic champions (the age of wrestlers is 19–35 years, comparable with the age of the athletes examined by the present authors). Table 3 shows the average values of different somatic traits in wrestlers surveyed in the 1960s¹⁵ in comparison with our data. To make this comparison more reliable, the average values of morphological features only for the welterweight and middle weight categories of athletes are presented in the Table 3.

Discussion

According to the ANOVA results of the physique characteristics in the examined athletes (see Table 1), some differences in morphological traits compared with the control group of non-athletes were revealed. Along with the

expected minimal thickness of subcutaneous fat layer in the athletes, the following features of the physique were typical for the wrestlers: strong chest development (high values of the Livy index); broad shoulders; relatively short legs, both in absolute values and in those of the intermembral index (arm length/leg length); elongated arms (significantly higher ratio values: arm length/height and arm length/leg length), as well as relatively large robusticity of the lower body skeleton (high values of the ratio: knee width/height). The resulting complex of morphological traits, in general, is comparable with other researches and, most likely, contributes to professional success in this kind of sports.^{20–27}

The tasks of our study, due to the relatively small number of examined individuals, did not include an analysis of the constitutional characteristics of martial art athletes of different weight categories, but it should be noted that the values of skinfolds thickness in different parts of the body, the diameters of the distal epiphyses of the limbs (the elbow, wrist, knee and ankle width), as well as the values of body circumferences increased with increasing weight of the athletes, which could be expected for this type of comparison.^{28, 29} There are a lot of contradictory opinions when the role of arm length as an indicator associated with advantages in different types of wrestling is discussed by different authors. Some authors believe that athletes who are more successful in wrestling have relatively short arms, with longer upper arms, and the shorter forearms.^{15,30} Others point to long arms as an advantage in this kind of sports, since in fighting, a longer lever allows for greater strength.^{31,32} The inconsistency of such interpretations is explained by a large number of various techniques and their great diversity in various types of wrestling, which makes it possible for combatants with different morphological features to be equally effective through the use of different techniques corresponding to their individual characteristics, as well as functional compensations. Thus, the effectiveness of wrestlers (as well as athletes of other sports) is determined not only by specific body proportions, but also by the adequacy of the technique used, as well as by the level of physical, tactical and psychological training.

A retrospective comparison of the average values of total body dimensions in highly qualified wrestlers showed a very slight increase in height for almost 100 years (since

TABLE 3
 AVERAGE VALUES OF SOME PHYSIQUE TRAITS OF ATHLETES ENGAGED IN DIFFERENT TYPES OF WRESTLING
 (WELTERWEIGHT AND MEDIUM WEIGHT CATEGORIES: FROM 70 TO 87 KG), SURVEYED IN THE 1960S
 (MARTIROSOV, 1968) AND 2017–2018 (OUR DATA)

Traits	Martirosov, 1968 ¹⁵ (N=67)		Our data, 2017–2018 survey (N=27)	
	Mean	SD	Mean	SD
Height, cm	173.34	6.03	175.26	5.77
Leg length, cm	91.11*	4.44	93.48	5.30
Arm length, cm	76.78**	3.11	78.53	3.51
Shoulder width, cm	40.60	2.21	40.56	2.64
Pelvic width, cm	28.09	2.29	28.06	1.68
Elbow width, cm	7.06	Absent	6.87	0.86
Knee width, cm	9.75	Absent	10.05	0.50
Chest circumference, cm	100.13	Absent	96.01	4.18
Shoulder width/height, %	23.42	Absent	23.15	1.34
Pelvic width/height, %	16.21	Absent	16.01	0.81
Pelvic width/shoulder width, %	69.19	Absent	69.34	4.67
Arm length/height, %	44.29	Absent	44.81	1.44
Leg length/height, %	52.56	Absent	53.31	1.73
Arm length/leg length, %	84.27	Absent	84.17	4.24
Knee width/height, %	5.63	Absent	5.73	0.29
Subscapular skf., mm	8.34	Absent	9.43	3.10
Triceps skf., mm	3.18	Absent	5.38	2.42
Abdominal skf., mm	7.84	Absent	8.69	3.50
Calf skf., mm	8.06	Absent	6.05	2.96

Note: * – $p < 0.05$; ** – $p < 0.01$; the color highlights the features, with the average values as close as possible in the two groups surveyed in 2017-2018 and 1960s.

the early 1920s), practically no changes in body weight, and a slight decrease in chest circumference (see Table 2 and Figure 1).

As can be seen from Table 3, present-day wrestlers compared to those surveyed in the early 1960s have not changed much over the past fifty years. The average values of the indicators characterizing the main skeletal proportions (shoulder and pelvic diameters relative to height; arm length / leg length; skeletal robusticity index – knee width / height) are very similar in these two groups, the time distance being more than 50 years (2 generations), which indicates to a stable complex of morphological characteristics determining professional competitive success, which were formed in the process of enhanced training and sports selection.

Along with a slight secular increase in height (and, accordingly, a slight increase in arm length and leg length, closely related to height), highly qualified athletes engaged in different types of wrestling, both 50 years ago and now, were characterized with relatively broad shoulders and short legs.^{15,22–27,33} Such pattern of body morphology determines the stability of wrestlers in the ring and a large variability of punches (amplitude of movements).

The increase in subcutaneous fat layer in the modern group of athletes, compared with wrestlers surveyed several decades ago, is likely to be part of the global trend typical for modern human populations.^{34,35} However, in this case, we cannot exclude the possibility of technical errors in measuring the skinfold thickness due to more advanced measuring instruments (e.g., GPM calipers vs sliding calipers).

Conclusions

A complex of morphological features contributing to the achievement of high sports qualification and sports success in different types of wrestling was revealed in the examined group of athletes: minimal development of subcutaneous fat layer; well-developed chest (high values of the Livy index); broad shoulders; relatively short legs, both in absolute assessment and in the values of the intermembral index (arm length/leg length); elongated arms (significantly higher values of the ratios: arm length/height and arm length/leg length), as well as relatively high robusticity of the lower body skeleton (high index values: knee width/height).

When comparing the physique of modern wrestlers with those surveyed in the early and middle period of the last century (1920s and 1960s), against the trend in height typical for general population, it is evident that in athletes this trend is expressed to a much lesser extent. Maximal similarity in absolute and relative traits has been shown for the skeletal proportions of wrestlers, which indicates the stability of this sports morphotype. The obtained results can be used as additional morphological criteria for

sports selection, professional orientation and prediction of competitive success.

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SEKULARNI TREND TJELESNIH DIMENZIJA KOD VISOKOKVALIFICIRANIH HRVAČA

SAŽETAK

Svrha rada bila je proučiti građu visokokvalificiranih borilačkih sportaša koji se bave različitim vrstama hrvanja te izvršiti retrospektivnu analizu morfoloških karakteristika hrvača od ranih 1920-ih godina. U tu svrhu korišteni su podaci antropometrijskog istraživanja 48 sportaša koji se bave različitim vrstama hrvanja s kvalifikacijom kandidata za majstora sporta i više. Oni su uspoređeni s kontrolnom grupom mladića ($N = 97$) koji se ne bave sportom (slično odabrani kao i skupina sportaša prema dobi, etničkoj pripadnosti i postotku pojedinaca različitih težinskih kategorija). Utvrđen je skup morfoloških osobina koje su pridonijele uspješnim postignućima u sportu. Uspoređujući stas suvremenih sportaša s hrvačima ispitanim početkom i sredinom 20. stoljeća (20-ih i 60-ih godina 20. stoljeća), pokazalo se da je sekularni trend povećanja visine tipičan za modernu populaciju kod sportaša izražen u znatno manjoj mjeri. Uočljive su sličnosti u apsolutnim i relativnim dimenzijama koje karakteriziraju proporcije skeletnog tijela hrvača, što upućuje na sekularnu stabilnost ovog sportskog morfotipa. Dobiveni rezultati mogu se koristiti kao dodatni morfološki kriteriji za selekciju u sportu, profesionalnu orijentaciju i predviđanje natjecateljskog uspjeha.