Comparison of the motor abilities level of classical and free style wrestlers of Polish Junior National Team

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Summary

Introduction. Increasing the physical fitness level is the basic element of all types of physical fitness training of athletes prior to a competition. The importance of certain physical condition abilities for success in a wrestling bout varies in wrestlers of various wrestling styles and age. The aim of this research was to identify the differences between classical- and freestyle wrestlers in variables for the assessment of physical fitness.

Material and methods. The research was conducted on the sample comprised of 107 top-level classical- and freestyle wrestlers aged 17 to 20 years. There were 46 classical-style wrestlers and 61 freestyle wrestlers, and they were all Polish national team. The measuring instrument was comprised of 18 tests of the general and specific physical fitness level. Most of those 18 tests comprise the Polish set of tests for advanced wrestlers. The obtained results were processed by the canonical discriminant analysis and by the univariate analysis of variance (ANOVA).

Results and Conclusions. The discriminant factor defined as the muscular endurance of the trunk and upper extremities statistically significantly discriminated between junior classical- and freestyle wrestlers. It was found that the group of top-level junior freestyle wrestlers had statistically significantly more expressed muscular endurance of the trunk and upper extremities than the group of top-level junior classical-style wrestlers. The authors explained the obtained results by specific features of each wrestling style.

Introduction

Increasing the level of motor abilities is the basic part of all types of preparation of wrestlers for competition. It is also one of the extremely important segments of the training programme and a precondition of appropriate preparation for high performance in sport. An inappropriate basis of motor abilities at a lower level causes the decreased achievement range at a higher level of athlete's sport-specific development [1,2]. The importance of certain motor abilities for success in a bout is different in classical- and freestyle wrestlers.

However, the number of previous researches in which authors have dealt with differences in the physical fitness training of wrestlers in various types of wrestling is very small [3,4,5,6,7], and the obtained results point to the following conclusions. Relative strength of trunk extensors is more ex-pressed in freestyle wrestlers, whereas the relative strength of upper arm flexors and extensors is more expressed in classical-style wrestlers. The most important place in the physical fitness training of younger- and medium-school-age boys belongs to the development of movement coordination [5,6,8,9], whereas strength and endurance are more and more important in older-school-age boys and adolescents [5,6,10]. Apart from the small number of previous studies, the trend in the development of physical fitness training in wrestlers is evident in the last decade [11,12]. Nowadays, all the listed data affect the dilemmas regarding the execution of physical fitness training of wrestlers of various age categories and of various wrestling styles.

The problem increases in that most countries (and among them also Croatia) do not have either the necessary conditions or the sufficient number of European-quality-level high-performance wrestlers, which ultimately makes the realization

of this type of research impossible. That is the reason why the collaboration was started in this project with prof. Włodzimierz Starosta (Institute of Sport in Warsaw) whose focus for many years has been the diagnostics of the motor abilities level of high-performance wrestlers in Poland. This collaboration guaranteed a sample of high-performance wrestlers – national team members – that was large enough and whose number as regards their quality would be approximately equal in both wrestling styles (classical- and freestyle wrestling). Top-level Polish wrestlers belong to the highest rank of European and world wrestling, and they achieve significant results at all age categories (for example, five medals, in this number three gold at the Olympic Games in Atlanta in 1996). Such a research made on a large and a high-quality sample of wrestlers will make it possible to tell whether there were any differences, and if yes, then what the structure of those differences in the motor abilities level of classical and freestyle wrestlers was. The results would define the values of the motor abilities level that should be achieved by top-level junior wrestlers in accordance with the wrestling style of their choice.

Material and methods

The sample

The total number of subjects was 107 top-level classical- and freestyle wrestlers, aged between 17 and 20 years (juniors). All subjects were of the same quality class – they were members of the Polish national team. The first group of subjects was comprised of 61 top-level classical-style wrestlers (age – 18.31±0.91 years; years of sport participation – 6.84± 1.72 years; body weight – 74.75±14.80 kg; body height – 174.90±9.02 cm). The second group of subjects was comprised of 46 top-level freestyle wrestlers (age – 18.46±1.11 years; years of sport participation – 6.37±2.03 years; body weight – 74.5±14.06 kg; body height – 175.75±8.34 cm). All participants accepted the conditions of research as issued by the Ethical Board of the Institute for Sport (Warsaw) which approved the measurement protocol.

Variables

The battery of tests applied in this research was described in detail and illustrated in the battery of tests of general and specific preparedness for advanced wrestlers[1] written by Starosta and Tracewski [12], and Starosta [4,6]. Coordination was assessed by the *maximum turn in the jump* and the result was expressed in degrees (the greater the number of degrees, the higher level of the coordination). Agility was assessed by *zig-zag running (envelope)*, and by *run with turnover*. Absolute maximal strength was assessed by the 1 repetition maximum (1 RM) in *bench press*, *maximal load snatch*, *lifting maximum load onto the chest* and *back squat*. Muscular endurance was assessed by the number of *pull-ups*, *parallel bars dips* and *sit-ups with side twists and with load*. The *vertical jump* [4] served to assess explosive strength, *trunk bending (decline bench)* to assess flexibility and the *20 m run from the flying start* to assess speed. *Backward handsprings*, *the catch (snatch) from the neck, pirouettes, strive (merry-go-round)*, and *bridge from above upper*. The metric characteristics of the previously listed tests were described in many researches [4,6,13,14,15], and the research results point to the conclusion that the applied tests had very good metric characteristics.

Measurement protocol

Measurements were done in Poland during the training camp of the Polish national team in the years 1998 and 2000. The standardization of measurement conditions, described in detail by Starosta and Tracewski [12], had an important role in such years-long execution of this experiment. In three days the athletes did 18 tests. Eight were done on the first day (*maximal turn in the jump, zig-zag running, vertical jump, 20-m run from the flying start, bench press, pirouettes, strive (merry-go-round) and bridge from above upper*. On the second day the athletes did the following tests – *task-run with turnover, backward handsprings, maximal load snatch, lifting maximum load onto the chest, sit-ups with side twists and with load* and *back squats.* The tests *trunk bending, the catch (snatch) from the neck, pull-ups* and *parallel bars dips* were done on the third day. All measurements were carried out within the same training period (preparatory phase) under the supervision of the same principal researcher (W.S.).

Methods of data analysis

The data analysis was done by means of the statistical package *Statistica 5*. All the variables for the assessment of physical fitness level of athletes were expressed in terms of arithmetic means and standard deviations. The normality of distribution of results for the variables applied was tested by using the Kolmogorov-Smirnov test. The significance of differences in the variables for the assessment of physical fitness abilities (physical fitness level) between the classical- and freestyle wrestlers was assessed by the discriminants analysis. Upon confirming the significance, the univariate analysis of variance (ANOVA) was used to compute the statistical difference between each variable applied. The $p < .01$ level of statistical significance was selected. The calculation of arithmetic means (AM) into points on the basis of the 100-point T-scale [4,6] was later applied to graphically present the obtained results.

Results

Table 1 contains the differences between classical- and freestyle wrestlers in the variables for the assessment of physical fitness abilities.

Kolmogorov-Smirnov test was used to test the normality of distribution for all the variables listed. None of the variables were found to deviate significantly from normal distribution, so

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[1] Some tests from that battery was not used in this research (forward handspring, forward somersault in squat position, backward somersault in squat position, 1500 m – run and throwing the manikin applying the belly-to-back souplé).

that all variables were included into further research. The discriminant analysis was used to test the differences between the two groups of wrestlers – classical- and freestyle junior wrestlers – in the variables for the assessment of physical fitness abilities. The parameters presented in Table 1 were calculated within the discriminant analysis.

Upon confirming that the discriminant function statistically significantly differentiated between the two groups – classical- and freestyle wrestlers, the structure of the discriminant function was determined (Table 3).

The centroids (arithmetic means of all variables) of groups of wrestlers on the discriminant function were also calculated to be able to clearly and meaningfully interpret the obtained results (Table 4).

Upon confirming the statistical significance of the differences between classical- and freestyle wrestlers, each variable was tested for its significance (Table 5). The univariate analysis of variance (Table 5) helped to identify the differences between arithmetic means of twelve out of 18 variables for the assessment of the physical fitness level of athletes.

The average numerical results assessment (Table 1) by means of a 100-point T-scale [4] was used as the additional method for a detailed interpretation of the obtained results. A line plot was used (Figure 1) to present the obtained differences between the variables for the assessment of the physical fitness level of junior classical- and freestyle wrestlers.

Tab. 1. Differences between the classical- and freestyle junior wrestlers in variables for the assessment of physical fitness (mean±SD)

Variables	Classical-style wrestlers n=61	Freestyle wrestlers n=46
	Mean±SD	Mean±SD
Maximal turn in the jump (degrees)	808.39±137.94	733.24±117.26
Zig-zag running, the so-called *envelope* (s)	23.36±1.07	24.67±1.19
Run with turnover (s)	12.01±0.57	11.95±0.65
Pull-ups (number of repetition)	14.83±8.84	22.14±8.26
Parallel bars dips (number of repetitions)	26.271±10.21	36.80±11.18
Bench press (kg)	92.66±18.74	107.68±23.27
Sit-ups with side twists and with load (number of repetitions)	18.45±9.92	30.13±11.41
Maximal load snatch (kg)	58.33±8.17	63.14±12.74
Lifting maximum load onto the chest (kg)	82.56±12.42	85.84±17.29
Back squats (kg)	111.71±21.58	117.44±30.15
Vertical jump test (cm)	53.93±5.63	57.41±7.68
20-m run from the flying start (s)	2.64±0.09	2.66±0.14
Trunk bending (decline bench) (cm)	58.35±7.98	53.96±8.37
Backward handsprings (s)	2.99±0.61	2.65±0.50
Strive, the so-called merry-go-round (s)	12.17±1.82	12.09±1.88
Bridge from above upper (s)	2.12±0.31	1.91±0.23
The catch (snatch) from the neck (s)	7.35±1.16	6.50±0.83
Pirouettes (s)	5.56±0.90	5.42±0.77

Tab. 2. Results of the discriminant analysis for classical- and freestyle wrestlers – test of significance and of the power of the discriminant function (n=107)

Discriminant function	Eigenvalue	Canonical R	Wilks' Lambda	Targ %	χ²	df	p-level
I.	1.58	0.783	0.39	100	91.11	18	0.00

Legend: Eigenvalue – the variance of the discriminant function; Canonical R – canonical discrimination coefficient;
Wilks′ Lambda – inverse measure of intergroup variability; Targ % – the percentage of explained variance; χ² – chi-square;
df – degrees of freedom; p-level – probability of error

Tab. 3. Results of the discriminant analysis for classical- and freestyle wrestlers – correlation of variables for the assessment of physical fitness level with the discriminant function (n=107)

Variables	Discriminant function
Maximal turn in the jump (degrees)	0.23
Zig-zag running, the so-called *envelope* (s)	-0.21
Run with turnover (s)	0.04
Pull-ups (number of repetition)	-0.33
Parallel bars dips (number of repetition)	-0.39
Bench press (kg)	-0.28
Sit-ups with side twists and with load (number of repetitions)	-0.42
Maximal load snatch (kg)	-0.18
Lifting maximum load onto the chest (kg)	-0.09
Back squats (kg)	-0.09
Vertical jump test (cm)	-0.21
20-m run from the flying start (s)	-0.06
Trunk bending (decline bench) (cm)	0.21
Backward handsprings (s)	0.21
Strive, the so-called merry-go-round (s)	0.02
Bridge from above upper (s)	0.30
The catch (snatch) from the neck (s)	0.31
Pirouettes (s)	0.06

Tab. 4. Centroids of groups on the discriminant function

Junior wrestlers	Discriminant function
Freestyle	-1.435
Classical style	1.082

Discussion and Conclusions

Although previous research also dealt with the issue of physical fitness of classical- and freestyle wrestlers, no research was found that either analysed the differences among such a great number of junior wrestlers or applied such a complex battery of tests that covered a wide range of physical preparation of athletes.

The results of this research confirm the existence of the discriminant function (Table 2) that statistically significantly differentiated between classical- and freestyle wrestlers as regards the variables applied for the assessment of physical preparation of wrestlers. The highest correlations between the variables for the assessment of physical fitness abilities and the discriminant function (Table 3) were found in variables for the assessment of muscular endurance of the trunk – *sit-ups with side twists and with load*, and for the assess-

ment of muscular endurance of arms – *pull-ups* and *parallel bars dips*. Both on the basis of those correlations and on the basis of previous research [16] this discriminant function was defined as the muscular endurance of the trunk and upper extremities. The calculation of the centroids of groups (Table 4) helped to draw the discriminant function (Figure 2) that showed the top-level freestyle wrestlers to have a statistically more expressed muscular endurance of the trunk and upper extremities than the classical-style wrestlers.

The better results achieved by freestyle wrestlers in the tests assessing the muscular endurance of the trunk and arms may be explained by a greater complexity of this style of fighting [17,18]. In freestyle wrestling all techniques may be used that include leg locks either by using arms or legs. That is the reason why freestyle wrestling bouts end in a greater number of efficiently executed technical actions than in clas-

Tab. 5. Univariate analysis of variance for the variables for the assessment of the physical fitness level of classical- and freestyle junior wrestlers (n=107)

VARIABLE	SS Effect	Df Effect	MS Effect	SS Error	Df Error	MS Error	F	p-level
Maximal turn in the jump (degrees)	**145977.73**	**1**	**145977.73**	**1722288.40**	**103**	**16721.25**	**8.73**	**0.00**
Zig-zag running, the so-called *envelope* (s)	**17.23**	**1**	**17.23**	**82.03**	**69**	**1.19**	**14.49**	**0.00**
Run with turnover (s)	0.10	1	0.10	37.06	102	0.36	0.28	0.59
Pull-ups (number of repetition)	**1345.27**	**1**	**1345.27**	**7471.49**	**101**	**73.98**	**18.19**	**0.00**
Parallel bars dips (number of repetition)	**2867.73**	**1**	**2867.73**	**11668.90**	**103**	**113.29**	**25.31**	**0.00**
Bench press (kg)	**5728.97**	**1**	**5728.97**	**44006.52**	**102**	**431.44**	**13.28**	**0.00**
Sit-ups with side twists and with load (number of repetitions)	**3367.55**	**1**	**3367.55**	**11135.23**	**100**	**111.35**	**30.24**	**0.00**
Maximal load snatch (kg)	**559.36**	**1**	**559.36**	**10390.81**	**97**	**107.12**	**5.22**	**0.02**
Lifting maximum load onto the chest (kg)	262.08	1	262.08	21165.65	98	215.98	1.21	0.27
Back squats (kg)	811.83	1	811.83	64699.06	99	653.53	1.24	0.27
Vertical jump test (cm)	**313.18**	**1**	**313.18**	**4493.38**	**103**	**43.63**	**7.18**	**0.01**
20-m run from the flying start (s)	0.01	1	0.01	1.03	76	0.01	0.59	0.44
Trunk bending (decline bench) (cm)	**500.84**	**1**	**500.84**	**6906.72**	**104**	**66.41**	**7.54**	**0.01**
Backward handsprings (s)	**2.39**	**1**	**2.39**	**27.84**	**86**	**0.32**	**7.39**	**0.01**
Strive, the so-called merry-go-round (s)	0.14	1	0.14	347.11	102	3.40	0.04	0.84
Bridge from above upper (s)	**1.10**	**1**	**1.10**	**7.63**	**102**	**0.07**	**14.69**	**0.00**
The catch (snatch) from the neck (s)	**16.55**	**1**	**16.55**	**98.24**	**93**	**1.06**	**15.66**	**0.00**
Pirouettes (s)	0.47	1	0.47	71.20	100	0.71	0.66	0.42

Legend: SS Effect – the sum of square between groups; Df Effect – degrees of freedom between groups; MS Effect – mean squares between groups; SS Error – sum of squares within groups; Df Error – degrees of freedom within groups; MS Error – mean squares within groups; F – F approximation; p-level – probability of error; bold – statistically significant

sical-style wrestling. It can be said that in freestyle wrestling the *attack-oriented wrestling* in a standing position or on the floor has a far more important role for success in a bout, in contrast to the classical-style wrestling that is frequently characterized as *passive wrestling* in the standing position for the purpose of takedowns and completing the bout on the floor. Consequently, a good physical preparation of the trunk and upper extremities in freestyle wrestlers is gaining on importance which is also the result of the long-term drilling of technical-tactical elements during the training process, and their efficient and frequent execution in difficult competition conditions.

The analysis of the significance of differences for each variable (Table 5) helped to reach the conclusion that the variables *maximal turn in the jump, zig-zag running, undergrasp pull-ups on the horizontal bar, dips on parallel bars, maximal bench press, sit-ups with side twists and with load, maximal load snatch, vertical jump, trunk bending, backward handsprings, bridge from above upper* and *the catch (snatch) from*

the neck statistically significantly differentiated between junior classical- and freestyle wrestlers. On the basis of the values of differences that can be seen in Figure 2 the conclusions that follow can be drawn with great certainty.

Junior classical-style wrestlers have a better specific coordination – airborne dexterity in twisting around the longitudinal axis, agility – changing the direction of movement, and better flexibility of the lumbar spine.

Junior freestyle wrestlers have a better specific coordination – airborne dexterity in rotation around the medial axis, muscular endurance of the trunk and arms, absolute maximal strength of arm and trunk extensors, explosive strength in jumping and specific speed – assuming the bridge stance from the standing position.

Such results obtained by the univariate analysis of variance may be explained by the peculiarities of each wrestling style. When executing a great number of classical-style wrestling techniques, very complex coordination-specific requirements
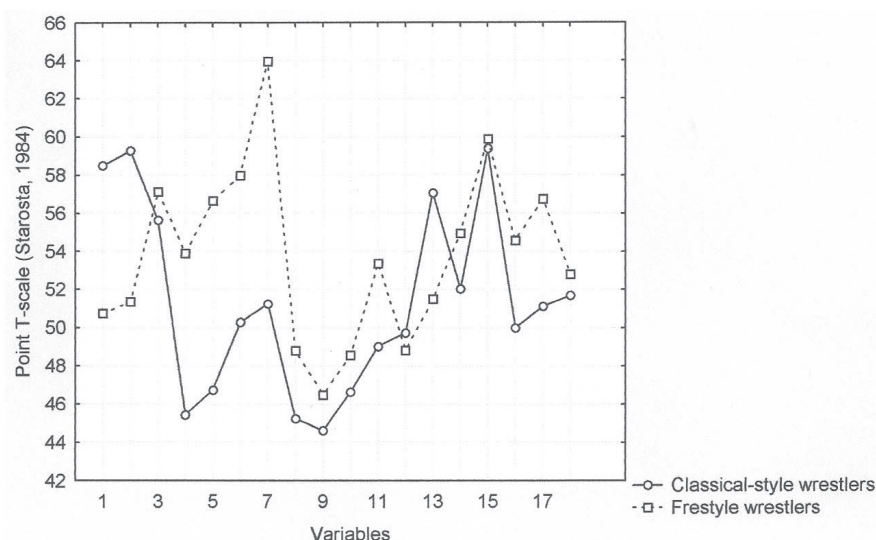
(1 = Maximal turn in the jump, 2 = Zig-zag running, 3 = Run with turnover, 4 = Pull-ups, 5 = Parallel bars dips, 6 = Bench press, 7 = Sit-ups with side twists and with load, 8 = Maximal load snatch, 9 = Lifting maximum load on to the chest, 10 = Back squats, 11 = Vertical jump test, 12 = 20-m run from the flying start, 13 = Trunk bending, 14 = Backward handsprings, 15 = Strive, 16 = Bridge from above upper, 17 = The catch (snatch) from the neck, 18 = Pirouettes)

Fig. 1. Differences between top-level Polish classical- and freestyle wrestlers (17-20 years of age) in the variables for the assessment of the physical fitness level
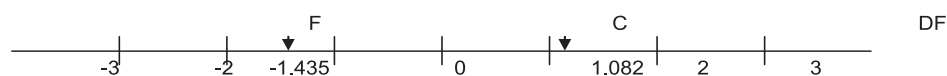
Legend: DF – discriminant function (muscular endurance of the trunk and of upper extremities); F – freestyle wrestlers, C – classical-style wrestlers

Fig. 2. Position of the centroids of the groups of junior classical- and freestyle wrestlers in the space of significant discriminant function (DF)

are set regarding the twist around the longitudinal axis, because a great number of takedowns are done by side twists and twists/rotations of the whole body. Likewise, agility (change of the direction of movement) has an important role in executing the techniques of bringing the opponent down onto the mat. Flexibility of the trunk, manifested as the mobility of the lumbar spine towards the back, is very important in the techniques of belly-to-back souplé and in various types of assuming the bridge stance. In contrast to the classical-style wrestling, the better results obtained by freestyle wrestlers in the tests for the assessment of muscular endurance, absolute and explosive strength, and specific speed can be explained by a greater complexity of that type of wrestling ([17,18]. In freestyle wrestling all techniques from classical-style wrestling can be used, as well as all the techniques that include leg locks executed by using either arms or legs. That is the reason why the specific coordination regarding the dexterity in twisting around the longitudinal axis is not so frequently manifested on the one hand, and the execution of movements that require the specific coordination (airborne dexterity in rotationg around the medial axis) on the other. Wrestling is executed at a larger distance, so that the explosive movements are the basis of the phase of entering the takedowns, and muscular endurance and absolute maximal strength are a precondition for the successful execution of this phase.

The obtained results will have a two-fold effect – they will make the selection of athletes for participation in one of the two styles of wrestling easier for the coaches, and they will also make the physical preparation of top-level junior classical- and freestyle wrestlers easier. This is of particular importance for wrestling in Croatia because the sample of quality classical-style wrestlers in Croatia is very small and the freestyle wrestling has only just started on its way.

The obtained results differ to some extent from previous research [3,4]. Such results may be the consequence of specific features of the population of wrestlers that has been tested and which is special as regards its utilization of motor abilities during the bout, which was also confirmed by a well known Russian coach [19].

The second reason for the differences from the previous researches may be explained to some extent by the differences between the training programmes and by the specific features of wrestling schools in which the aforementioned researches took place. Such a hypothesis could find its support in some previous research as well [20], however, such a thesis about the diversity of wrestling schools should be checked in further research, and thus help to accept or reject the expert opinion of some top-level wrestling coaches.

References

1. Starosta W, Tracewski J. An objective method of assessing the level of motor abilities in advanced wrestlers. [In:] Sadowski J, Starosta W (Eds.) Proceedings book of International Scientific Conference, Biała Podlaska "Movement Coordination in Team Sport Games and Martial Arts". Warsaw: Academy of Physical Education & Biała Podlaska: The Institute of Sport and Physical Education 1998; 249-254.
2. Baić M, Marić J, Valentić M. Bazične i specifične hrvačke vježbe u parovima za razvoj snage i fleksibilnosti trupa. Kondicijski Trening 2004; 2 (2): 34-43.
3. Rybalko BM. Fizičeskaja podgotovka borca (izučenie nekotoryh zakonomernostej skorostno – silovoj podgotovki borca). Na borcovskom kovre. Moskva: Fizkultura i sport 1966.
4. Starosta W. Sprawność ogólna i specjalna zaawansowanych zapaśników (styl klasyczny i wolny) w świetle badań prowadzonych w latach 1981-1984. Warszawa: Instytut Sportu – Zakład Selekcji Sportowej 1984.
5. Starosta W. Motor coordination abilities (significance, structure, conditions, development). International Association of Sport Kinetics. Institute of Sport, Warsaw 2003.
6. Starosta W. Global and local motor coordination in physical education and sport. International Association of Sport Kinetics. Warsaw 2006.
7. Rezasoltani A, Ahmadi A, Nehzate-Khoshroh M, Forohideh F, Ylinen J. Cervical muscle strength measurement in two groups of elite Greco-Roman and free style wrestlers and a group of non-athletic subjects. British Journal of Sports Medicine 2005; 39 (7): 440-443.
8. Sertić H. Utjecaj koordinacije i snage na uspješnost u judo borbi kod djece od 11 godina (Neobjavljeni magistarski rad). Zagreb: Fakultet za fizičku kulturu 1994.
9. Setić H, Kuleš. Odnos koordinacije i snage kod judaša starih 11 godina. U: Zbornik radova IV. konferencija o sportu Alpe – Jadran. Rovinj 23-26.06.1999. Zagreb 1999; 213-218.
10. Marić J, Baić M, Aračić M. (2003). Kondicijska priprema hrvača. U Dragan Milanović i Igor Jukić (ur.), Zbornik radova Međunarodnog znanstveno-stručnog skupa "Kondicijska priprema sportaša" <u sklopu> 12. zagrebačkog sajma sporta i nautike, Zagreb, 21. i 22. veljače 2003; 339-346.
11. Dinev P, Petrov K, Jankova R. Iskustva diferenciranog pristupa fizičkoj pripremi mladih hrvača. Sofija: Fizička kultura 1991.
12. Starosta W, Tracewski J. Zestaw prób sprawności ogólnej i specjalnej dla zaawansowanych zawodników zapasów (styl klasyczny i wolny). Warszawa: Instytut Sportu – Zakład Selekcji Sportowej 1981.
13. Starosta W, Baić M, Sertić H. Reliability of the chosen Polish test for evaluating specific training status in advanced wrestlers. [In:] Sadowski J (Ed.) Proceedings book of International Scientific Conference, Biała Podlaska "Coordination motor abilities in scientific research". Biała Podlaska: Józef Piłsudski Academy of Physical Education in Warsaw & Faculty of Physical Education in Biała Podlaska 2005; 144-149.
14. Marić J, Baić M, Sertić H, Vujnović I. Metric characteristics of selected tests for the evaluation of basic training status in top level wrestlers. [In:] Milanović D, Prot F (ur.), Proceedings Book of the 4rd International Scientific Conference "Kinesiology – New Perspectives". Zagreb: Faculty of Kinesiology 2005; 435-438.
15. Sertić H, Baić M, Segedi I. Metric characteristics of chosen acrobatic tests for advanced wrestlers. [In:] Sadowski J (Ed.) Proceedings book of International Scientific Conference, Biała Podlaska "Coordination motor abilities in scientific research". Biała Podlaska: Józef Piłsudski Academy of Physical Education in Warsaw & Faculty of Physical Education in Biała Podlaska 2005; 247-252.
16. Baić M. Razlike između vrhunskih poljskih i hrvatskih hrvača različitih stilova, dobi i težinskih skupina u prostoru varijabli za procjenu kondicijske pripremljenosti. [Differences between top-level Polish and Croatian wrestlers of different wrestling styles, age and weight categories in variables for the assessment of physical fitness. In Croatian] (Unpublished doctoral dissertation, University of Zagreb). Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu 2006.
17. Marić J. Rvanje slobodnim načinom. Zagreb: Fakultet za fizičku kulturu 1990.
18. Shahmuradov YA. Free style wrestling. Rome: FILA 1996.
19. Preobraženskij SA. Borba zanjatije mužskog. Moskva: Fizkultura i sport 1978.
20. Song T, Garvie G. Anthropometric, flexibility, strength, and physiological measures of Canadian wrestlers and comparison of Canadian and Japanese Olympic wrestlers. Canadian Journal of Applied Sport Science 1980; 5: 1-8.

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