Original research article

MOTOR ABILITIES OF STUDENTS AS PREDICTORS OF THEIR PERFORMANCE IN THE PULLING ROD

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Abstract. *The pulling rod is a traditional form of competition of people in the north-eastern Russian Republic Sakha, but also an international sport discipline known as mas-wrestling. The contact which contestants have through the rod represents a specific closed kinetic chain starting from the hand grip of the wooden rod, throughout the musculature of both hands, the shoulder area, back muscles, thigh and lower leg muscles, to the feet which are placed on the "board". The aim of the competition is to pull the opponent over the board or "take" the rod from the opponent. After the competition of 62 student Academy of Criminalistic and Police Studies in Belgrade (ACPS) in the pulling rod, three subsamples were determined according to the criterion of successful performance (completely ineffective - 13; partially successful - 38, and completely successful - 11). For all three subsamples the following information was obtained: Maximal isometric force of the non-dominant and dominant hand; maximal isometric force of back and knee extensors, obtained by the hardware-software system developed by the ACPS, as well the information on the vertical jump with an arm swing (the Abalakov test) and flexed arm hang, using standard test procedures. Statistically significant differences were determined between the first and the third group, for each studied variable, and in favor of the group of completely successful students (the third group). The results show justified use of the mentioned information in the function of predicting the performance of students in the pulling rod.*

Key words: *pulling rod, motor abilities, students, success*

INTRODUCTION

Often throughout history national games grew into sports competitions, even to the level of the Olympism. The best example are wrestling competitions. National sports and games were practiced during breaks, at harvest time, while tending to livestock, during the national assembly, but always in order to prove the strength and power of individuals or groups. Competitions in the form of a tug, given the simplicity of the organization, from ancient times, were represented in different areas of the globe. Such activities were highly represented in the former Yugoslavia, but also in other regions, especially those which were settled through migration. Our region is famous for the group of team competitions (pulling rope...), but also individual, direct contact (finger, hands) or indirectly through certain means (rod) (Wikipedia, n.d.).

The pulling rod is a traditional form of competition in north-eastern Russian republic Sakha (Yakutia), and now is even an international sporting discipline known as mas-wrestling. The World Championship in 2014, held in Yakutsk, was attended by around 180 competitors from 32 countries from all continents. The aim of the competition is to pull the opponent over the board or take the rod out of the opponent's hands in two out of three combats (IMF, 2014).

Contact between competitors is made through mutual grip of the rod (one hand is in an overgrip and the other in a counter grip). This relation represents a specific closed kinetic chain beginning from the hand gripping the rod (both competitors), all the way to the feet which are placed on a board. The biomechanical analysis of the competition shows the dominant muscle activity of both hands, forearms and upper arms of both hands, shoulders, back muscles and thigh muscles, and both lower legs (Philip, Zaharov, & Krivoshapkin, 2014). Pulling rod tactics and techniques are of no less importance for success in mas wrestling (Kudrin & Cherkashin, 2014; Borohinn & Feodorov, 2014). Given that this sporting discipline is relatively new, it offers many opportunities for scientific research[1]. Direct contact of the competitors through the rod significantly affects the rod itself (pulling one or the other hand, rotation ...). Possible research into using two rods that are connected in the middle (by rope, cable, chain ...) provides room for possible changes of the competition rules, time and techniques, tactics, with the goal of achieving a higher total value of this sports discipline (Zaharov, Pestryakov, Krivoshapkin, & Zaharova, 2014). Competitions are held at all age levels and for both sexes. Specifics of the body (Fedorova, 2014), as well as specific motor skills of females and their impact on the results of the pulling rod are also an important area of research interest (Arlov, Janković, & Javorac, 2016). On the territory of the Republic of Serbia, competitions in this kind of pulling rod (mas wrestling) are completely new[2]. The aim of this research is to quantify muscle strength and determine differences in muscle strength between ACPS students, divided into different groups according to their success in the pulling rod.

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[1] The first co-author was engaged as lecturer at the North-eastern Federal University in Yakutsk, as part of an international cooperation program.
[2] The World championship, held 2014 in Yakutsk, R. Saha, R. Serbia was represented by four competitors (Ervin Katona, Dalibor Zelenović, Alen Radošević, Saša Bulaja).

<center>METHODS</center>

The sample

The sample of participants consisted of 62 male students of the third year of undergraduate studies, at the Academy of Criminalistic and Police Studies (ACPS) in Belgrade. The sample was divided into three sub-samples according to the criteria of success in the pulling rod competition. The first sub-sample was represented by 13 students who lost every fight, the second by 38 students who had about the same number of wins and losses, and the third, by those who achieved victory in all their performances (11 of them).

Measuring instrument

By analyzing the structure of this competitive discipline it is possible to recognize the existence of a specific kinetic chain: hands, rod - board. Data regarding the studied variables were collected and analyzed, by using standard testing procedures described earlier in the literature (Garcia-Lopez et al., 2005; Bubanj, Bubanj, Stanković, & Petrović 2008; Obradović et al., 2011):

- maximal isometric force of the non-dominant hand[3] - FMAXNDH (expressed in decanewtons),
- maximal isometric force of the dominant hand - FMAXDH (expressed in decanewtons),
- maximal isometric force of back extensors - FMAXBACKEXT (expressed in decanewtons),
- maximal isometric force of knee extensors - FMAXKNEEEXT (expressed in decanewtons),
- two foot stand vertical jump with arm swing (Abalakov test) - VJ (expressed in centimeters), and
- flexed arm hang on a horizontal bar - ARMHANG (expressed in seconds).

The procedures

Sixty-two male students with approximate body mass voluntarily participated in the competitions, and realized 286 combats in total. Each student was involved in between 2-6 fights. The combat adhered to the terms and conditions defined by rules of competition (Wikipedia, n.d.), at the Academy of Criminalistic and Police Studies (ACPS) in Belgrade and did not negatively affect regular academic activities. Isometric muscle force was determined by a special hardware-software system for the determination of maximum muscle force, developed at ACPS. Leg power (in the Abalakov jump test) was determined by the use of a meter, while upper body strength and endurance were determined by a stopwatch.

As part of the analysis of the information contained within the defined database, basic descriptive parameters (mean, standard deviation, minimum and maximum values) were calculated for all the variables for each of the defined group of participants. A univariate analysis of variance (ANOVA method) tested the existence of differences between some groups for each of the applied variables, and the possible distinction in direction and significance was tested using the LSD Post Hoc test pairs of variables for the groups defined in

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[3]In the study sample, there was only three ACPS students with a dominant left hand (the information on maximal isometric hand grip force)

the study. For data processing , the statistical package SPSS version 20 was used. The level of significance was set at p<0,05.

RESULTS

After the realization of the planned analysis, the basic descriptive indicators were determined: mean (AS), standard deviation (SD), minimum (Min) and maximum (Max) value of the results in the sub-samples for all the studied variables. Table 1 shows the above mentioned statistics, as well as the results of the univariate analysis of variance.

Table 1 Descriptive indicators (Group 1- 3) and the results of the univariate analysis
of variance (ANOVA method)

Dependent variable	Group	N	Mean	SD	Min	Max	F	Sig
FMAXNDH (in daN)	1	13	53,06	7,16	40,9	66,0		
	2	38	55,97	7,83	39	74,5	2,681	0,077
	3	11	60,26	7,38	48,8	74,7		
FMAXDH (in daN)	1	13	56,35	5,98	49	68		
	2	38	59,46	6,75	49	77	2,121	0,129
	3	11	62,19	8,70	48	81		
FMAXBACKEXT (in daN)	1	13	156,5	20,12	133,9	197,6		
	2	38	160,93	15,14	132,5	196,6	3,977	**0,024**
	3	11	175,436	21,16	142,4	205,2		
FMAXKNEEEXT (in daN)	1	13	151,13	19,82	124,2	184,3		
	2	38	154,75	15,04	129,2	190,5	2,991	**0,048**
	3	11	167,96	24,51	132,2	207,6		
VJ (in cm)	1	13	44,52	5,27	35,9	53,7		
	2	38	41,42	5,43	33,9	56,8	1,269	0,289
	3	11	42,36	8,65	27,2	60,1		
ARMHANG (in s)	1	13	39,42	14,25	19,46	76,12		
	2	38	29,66	12,58	9,54	58,82	3,443	**0,039**
	3	11	28,59	7,62	19,79	43,29		

By analysing the results in table 1, the difference in mean values in almost all the variables is clear, and is in favour of the students in the group that was completely successful in competing in the pulling rod (group 3). This was determined by using a specially developed hardware-software system at the ACPS in Belgrade, as well as variables that were measured using standard testing procedures. Having established the equality of variance groups (Levene's test of homogeneity of variance), the conditions were created for the implementation of a univariate analysis of variance (ANOVA method). It is evident that there is a lack of statistically significant differentiation between the groups for the variable of maximum isometric force of the dominant hand (p=0,129), and vertical jump with arm swing (Abalakov test, p=0,289).

Table 2 LSD Post Hoc test group of 1-3 pairs of variables

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.
FMAXNDH (in daN)	1	3	-7,202	3,122	**0,025**
FMAXDH (in daN)	1	3	-5,84	2,857	**0,045**
FMAXBACKEXT (in daN)	1	3	-18,94	7,119	**0,01**
FMAXKNEEEXT (in daN)	1	3	-16,83	7,368	**0,026**
VJ (in cm)	1	3	-2,17	2,485	0,386
ARMHANG (in s)	1	3	-10,82	5,024	**0,035**

Table 2 shows the results of the LSD Post Hoc test for variable pairs where statistically significant differences were determined among these groups (Sig.), as well as their direction (negative values shown in the column Mean Diference (I-J) indicate a differentiation in favor of the third group). Statistically significant differences were found between the completely successful students (group 3) and completely unsuccessful students (group 1), in favor of the completely successful students in pulling rod, in almost all the variables. The difference between these two groups exists in favor of group 3, in the vertical jump with an arm swing, but not at a statistically significant level, according to the chosen level of significance (p<0,05).

DISCUSSION

The results of the implemented analysis indicate a distinction in all groups of students based on the studied variables as indicators of certain motor skills responsible for the outcome in the competition of the pulling rod (mas wrestling). A statistically significant difference was established for all the studied variables, between the first group (students who have lost all the fights) and the third group (students who won all the fights) in favor of the third group, except for the variable the vertical jump with arm swing (Abalakov test, p=0,386). The group of fully successful students in the pulling rod is defined by a statistically significantly higher level of reported maximal force of all the monitored muscle groups than the group of unsuccessful students. Maximal isometric force in the grip of the non-dominant hand, as expected, "the weakest link" in this kinetic chain with regard to quality of contact with the rod, contributes significantly to the performance of the students in the pulling rod. The information obtained for the maximal forces of the dominant and non-dominant hand, using a defined and proven system for the measurement of muscle force (Arlov & Obradović, 2002) refers to a concentric contraction of the fingers of both hands. The results of the dominant hand (64,03 daN) of the ACPS students, in the research on the impact of three teaching programs (three generations of students in 1995, 2005 and 2010) on their physical abilities (Dimitrijević, Koropanovski, Dopsaj, Vučković, & Janković, 2014), are approximate to the results of the most successful group (third group) in this paper (monitored in 2015). The same goes for the maximal isometric force of the back-dead lift with the results of 174,8 daN for students of earlier generations, and 175,4 daN for the most successful students in this study. In the study by Arlov et al. (2016) which focused on the origin of success of ACPS student in performance of the pulling rod, a statistically significant difference wasfound (maximal isometric force for the non-dominant hand (p=0,016), for back extensors (p=0,001) and for knee extensors (p=0,012)

between successful and unsuccessful female students, for variables which were measured with a defined hardware-software system for measurement of muscle force and in favor of the successful students. For variables measured by standard methods, differences were also determined, but were not statistically significant (the Abalakov test, p=0,167 and the flexed arm hang, p=0,228).

CONCLUSION

The results of the research point to the possibility and justification of using the information on maximal isometric force of ACPS students as an indicator of certain motor abilities (strength, endurance...) in the prediction of success in the pulling rod. An advantage could be provided by information obtained by the hardware-software system for measuring muscle strength (Maximal isometric contraction), in relation to information obtained by standard procedures (the Abalakov test, flexed arm hang endurance). Maximal isometric force of the non-dominant hand grip, as the "weakest link" in the specific kinetic chain, contributes significantly to the prediction of success of students in the pulling rod (mas wrestling). Information on the eccentric contraction of the dominant and non-dominant hand of the students would affect the performance of the pulling rod (especially in taking the rod from the opponent's hand, as the outcome of the fight), as well as the prediction of this performance. This results could contribute to the development of the mas wrestling as a sport discipline in this region.

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MOTORIČKE SPOSOBNOSTI STUDENATA U FUNKCIJI PREDIKCIJE NJIHOVE USPEŠNOSTI U VUČENJU PALICE

Vučenje palice je tradicionalni oblik takmičenja naroda severo-istočne ruske republike Sahe, sada već i medjunarodna sportska diciplina poznata kao mas-wrestling. Kontakt takmičara preko palice za vučenje predstavlja specifičan zatvoreni kinetički lanac od hvata šakama za palicu, preko muskulature obe ruke, ramenog pojasa, ledjne muskulature, muskulature natkolena i potkolena, pa sve do stopala, koja kontaktiraju sa „daskom" kao drugim rekvizitom. Cilj nadmetanja je prevlačenje protivnika ili „otimanje" palice. Nakon realizovanog takmičenja u vučenju palice 62 studenta Kriminalističko-policijske akademije u Beogradu (KPA), definisana su tri subuzorka po kriterijumu uspešnosti (potpuno neuspešni – 13; delimično uspešni – 38, i potpuno uspešni – 11). Za sva tri subuzorka, dobijene su informacije o maksimalnoj sili prilikom stiska nedominantne i dominantne šake; maskimalnoj sili ledjno-slabinske muskulature i opružača u zglobovima kolena, dobijene primenom hardversko-softverskog sistema razvijenog na KPA, kao i informacije o vertikalnom skoku sa uzmahom rukama (Abalakov test) i izdržaju na vratilu u poziciji zgiba, primenom standardnih postupaka pri testiranju. Utvrđene su statistički značajne razlike između prve i treće grupe, u prostoru praćenih sposobnosti, a u korist (treće) grupe potpuno uspešnih studenata. Rezultati ukazuju na opravdanost korišćenja navedenih informacija u funkciji predikcije uspešnosti studenata u vučenju palice.

Ključne reči: *vučenje palice, motoričke stosobnosti, studenti, uspešnost*