Physical education and sport through the centuries
2022, 9(2), 130-141
ISSN 2335-0598

Original research article

DOI: 10.5937/spes2202132M

THE INFLUENCE OF MORPHOLOGICAL CHARACTERISTICS ON WRESTLERS' PREPAREDNESS

Milan Marković [1], Lazar Toskić [1,2], Filip Kukić [3], Ivan Zarić [4] and Milivoj Dopsaj [4,5]

[1]Faculty of Sport and Physical Education, University in Priština – Kosovska Mitrovica, Leposavić, Serbia.

[2]Faculty of Sport, University ''Union – Nikola Tesla'', Belgrade, Serbia.

[3]Physical Fitness Testing and Research, Police Sports Education Center, Abu Dhabi Police, UAE.

[4]Faculty of Sport and Physical Education, University of Belgrade, Belgrade, Serbia.

[5]Institute of Sport, Tourism and Service, South Ural State University, Chelyabinsk, Russia.

UDK 796.82:676.014.8

SUMMARY

In wrestling, weight categories are defined by rules, so the morphological composition of the body is an important factor in success. The subject of the paper is the morphological parameters of the examinees and the preparedness parameters on the Specific Wrestling Performance Test (SWPT). The aim of the research is to determine the influence of morphological characteristics on physical fitness, and the way of recovery of functional characteristics, as well as their interrelations and regularities. The sample consists of 26 wrestlers aged 20.2 ± 1.7 years, training experience 6.7 ± 3.2 years, number of weekly training 7.8 ± 1.9, body height 178.9 ± 5.6 cm, body weight 82.9 ± 7.4 kg, body mass index 25.9 ± 2.0 kg/m^2. From the aspect of morphological characteristics, the percentage of body fat - PBF, the percentage of muscle mass - SMM (InBody 720) were observed; as a parameter of preparedness, the total number of throws on the test was taken - TnThrows; while functional characteristics were defined as the percentage recovery of pulse frequency from the end of the test to the 1st and 3rd minute - ΔHR_{1min} and ΔHR_{3min}. Correlation statistics and linear regression analysis were used to determine the relations. Defined analyzes did not show a significant correlation between SMM and any other monitored variable, while PBF showed a highly statistically significant correlation with Tn^{Throws} ($r = -0.608$, $p = 0.001$), and a significant correlation with ΔHR_{3min} ($r = -0.429$; $p = 0.029$). Significant correlations were also determined between Tn^{Throws} and functional recovery characteristics (ΔHR_{1min}, $r = 0.522$, $p = 0.006$; ΔHR_{3min}, $r = 0.454$, $p = 0.020$).

Corresponding author
Milan Marković
milan.markovic@pr.ac.rs

In the homogeneous groups, such as actively trained wrestlers, the percentage of muscle component is uniform, while training is significantly different, which partially affects the different representation of fat component, and all this definitely affects the success and recovery of wrestlers.

Keywords: field testing, body fat percentage, muscle mass percentage, heart rate.

INTRODUCTION

The development of athletes in terms of physical, technical, tactical, and psychological preparedness is constantly adapted. When designing a physical training regimen, one should pay close attention to extraneous factors. Also, the adaptation of morphological characteristics is a natural outcome of sports training. Adaptation in sports is always triggered by training and training components, such as the type of intensity or training load, which is aimed at changing the morphological characteristics of the body to reach a typical body structure (Copic et al., 2014; Dopsaj et al., 2017; Dopsaj et al., 2018; Dopsaj et al., 2020). This phenomenon only occurs to those body tissues that are subjected to biological adaptation, such as fat and muscle tissue or even a bone tissue component (Dopsaj et al., 2018; Dopsaj et al., 2020).

When it comes to combat sports (wrestling, boxing, judo, karate, etc.), where weight categories are determined by rules, the morphological traits i.e., the body composition is one of the most significant success markers (Dopsai et al., 2013). Hence athletes strive for an optimal or even ideal body composition, and their strategy is to favor muscle over fat tissue. Through this approach, the fighters' contractility is increased, in terms of increased force, strength, and alacrity, which additionally greatly decreases the presence of fat in the body (Mirzaei & Akbarnezhad, 2008; Kim et al., 2011).

Previous research conducted in the area of the morphological state of wrestlers has determined that the somatotype of an elite wrestler is exceedingly mesomorphic (muscular, with a low fat percentage), whereas women possess strong endomorphic characteristics often bordering on mesomorphic (Kasum & Dopsaj, 2012; Dopsaj et al., 2017). Karnincic, et al., (2009) note that in highly developed conditions, wrestlers' body fat percentage typically ranges from 3% to 13%. The ideal wrestler's body fat percentage will be 7-10% developed through a synergy of training and adequate nutrition, with the sole exception of the highest weight category (Kasum & Dopsaj, 2012). Vardar et al., (2007) conclude that the percentage of body fat for world champions must be less than 10%. Mirzaei at al., (2009) recommend that coaches consider the physical composition of their wrestlers during the coaching process. In this way, Hübner-Wozniak et al., (2004) have found that the practice of wrestling techniques varies by competitive weight

category, and some studies point to significant differences in physical fitness and body composition among the ten weight categories of young wrestlers (Barbas et al., 2011). In this regard, Kraemer et al (2001) have noted the importance of specific anthropometric parameters to improve wrestling performance, such as the minimum body fat level. In wrestling, body mass control plays one of the most crucial roles during training and competition. Oftentimes, athletes are forced to subject themselves to accelerated processes of emaciation which can have adverse effects on health or diminish athletic capabilities, i.e., success rate (Cirkovic i sar., 2011).

This paper's subject will be to assess morphological parameters of the examinees, the displayed parameters of preparedness as evaluated by the Specific Wrestling Performance Test (SWPT). The aim of the research will be to determine the influence of morphological characteristics on physical preparedness, the manner of recovery of key functional characteristics, as well as their correlation and the postulates they follow.

METHODS

Participants

The sampling consisted of 26 wrestlers aged 20.2±1.7, with 6.7±3.2 years of experience, weekly training workload of 7.8±1.9, body height of 178.9±5.6cm, body mass of 82.9±7.4kg, body mass index of 25.9±2.0kg/m^2. All the examinees were familiarized with the testing procedures. They volunteered for participation and signed a written consent. The research was conducted in accordance with the terms of the Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects (World Medical Association, 2013), and with the approval and authorization of the Ethics Committee of the Faculty of Sports and Physical Education, University of Belgrade (02 No.484-2).

Design and Procedures

The data gathering process was conducted by using standardized measurement procedures, both in terms of a morphological body-structure analysis (Gibson et al. 2008; Sillanpaa et al. 2014), and field tests (Marković et al., 2017; Marković et al., 2018; Marković et al., 2021; Marković et al., 2022). The body composition measurement procedure was realized by utilizing an InBody 270, in the morning hours; the examinees had been instructed not to eat before the tests, and they were provided with a meal after the test and had at the very minimum a two-hour break before the continuation of testing. Subsequently, the examinees underwent a final procedure of theoretical and practical familiarization with the test. The test was preceded by a general warm-up in the duration of 10 minutes,

with an additional 10 minutes of the sport-specific warm-up in the form of throwing a partner or a wrestling dummy, followed by 5 minutes of rest. During the test, the participants threw a wrestling dummy (Suples, Ltd. ID, USA) by performing a Suplex techinque. The participants with a BM lower than 74.99 kg threw a 22kg dummy; the participants who weighed between 75.00kg and 89.9kg threw a 27kg dummy; and the participants with more than 90.00kg threw a 32kg dummy (Marković et al., 2017). In this manner, the relative load of the dummy was applied uniformly in terms of their respective weight categories. Prior to the commencement of testing, H7 Polar sensors were secured over the participants' chests (Polar, Inc., Lake Success, NI, USA) which monitored the hearth frequency. At the end of the test, the wrestlers rested actively for 1 minute by walking on the mat, after which they assumed a sitting position.

Specific Wrestling Performance Test

The test consisted of two three-minute rounds which emulated a wrestling match. The three-minute rounds were separated by a 30-secund cessation. In short, the participants were tasked with performing one throw of the dummy every 10 seconds in the 30 second time period. In the next phase, they performed a maximum number of throws within 20 seconds, which was followed by 10 seconds of passive rest. The same sequence was repeated in the second minute, and then in the third minute the duration for the maximum number of throws was changed from 20 to 30 seconds. Thereafter, the participants were given 30 seconds of passive rest. The second three-minute round was identical to the first one (Table 1). The final score of the test was calculated by factoring in the total number of throws completed in the phases for performing the maximum number of throws during the whole test, i.e., in both rounds (Marković et al., 2017; Marković et al., 2018; Marković et al., 2021; Marković et al., 2022).

Considering the specificity and complexity of the techniques used in the aforementioned test, one tester was assigned to monitor the correctness of each participant's actions in said test so as to avoid discrepancies. A second examiner monitored time and provided instructions regarding the active and passive phases of the test. A third tester ensured each partaker's heart rate was recorded promptly and precisely. The examiners provided verbal support to the participants in order to maximize the level of motivation and ensure the topmost success.

Table 1. Structure of the SWPT. (Marković et al., 2022).

Minutes:	Rounds				
	FIRST		Rest (s)	SECOND	
	Time intervals (s)	Number of throws		Time intervals (s)	Number of throws
1st minute	10	1		10	1
	10	1		10	1
	10	1		10	1
	20	**Max.***		**20**	**Max.***
	10	Rest		10	Rest
2nd minute	10	1		10	1
	10	1		10	1
	10	1		10	1
	20	**Max.***	30	**20**	**Max.***
	10	Rest		10	Rest
3rd minute	10	1		10	1
	10	1		10	1
	10	1		10	1
	30	**Max.***		**30**	**Max.***

* - Throws which count for the test result .

Variables

With the goal of the research in mind, the following morphological characteristics were observed: the percentage of body fat – PBF (%), the percentage of skeleton muscle mass – PSMM (%) (InBody 720). The test score was used as the main parameter of preparedness, although the ability of the cardiovascular system to recover in as short amount of time as possible is also relevant. The performance shown was defined as the total number of throws (Tn^{Throw}), i.e., the number of throws completed within the segments of the test that were dedicated to measuring the maximum number of throws in a given time frame. Functional characteristics (HR) were recorded at the end of the test (HR_{0min} (bpm)) and during the recovery period, based on which the relative (%) alteration was calculated in the first minute (ΔHR_{1min}), and again after a three-minute recovery period (ΔHR_{3min}) from the moment the test was completed (Astrand et al., 2003).

Statistical Analyses

All analyses were performed using the Statistical Package for the Social Science (IBM, SPSS 20.0). For all results, the following were provided: mean, the standard deviation (SD), the standard error (Std. Error), minimum (Min.), and maximum (Max.). Correlation statistics and linear regression analysis were used to establish interdependence. The significance level was set at $p < 0,05$ (Hair et al., 1998).

RESULTS

Descriptive statistics of morphological, functional, and success parameters are shown in Table 2. Determined degrees of interconnectedness between the analyzed variables and their statistical significance are displayed in Table 3.

Table 4 presents the statistical significance of the regression analysis of the most notable parameters, on the basis of which the regression models for the fat percentage's influence on the preparedness of wrestlers are defined in Figure 1.

Table 2. Descriptive statistics

Varijable	Mean	Std. Error	SD	Min.	Max.
PBF(%)	13.73	0.85	4.35	4.7	22.8
SMM(%)	48.98	0.49	2.50	44.1	54.8
Tn^{Throws} (n)	35.50	1.51	7.69	24.0	47.0
HR_{MAX} (bpm)	185.88	1.11	5.65	175.0	196.0
ΔHR_{1min} (%)	8.10	0.41	2.11	4.4	12.6
ΔHR_{3min} (%)	32.85	0.90	4.60	24.5	41.7

Table 3. Correlations statistics

	PBF	SMM	Tn^{Throws}	HR_{1min}	HR_{3min}
PBF	1	**-0.905****	**-0.608****	-0.116	**-0.429***
SMM		1	0.347	-0.119	0.282
Tn^{Throws}			1	**0.522****	**0.454***

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4. Regression analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
PBF	**Tn^{Throws}**	174.575	1	174.575	14.080	**0.001**
	ΔHR_{3min}	87.087	1	87.087	5.428	**0.029**

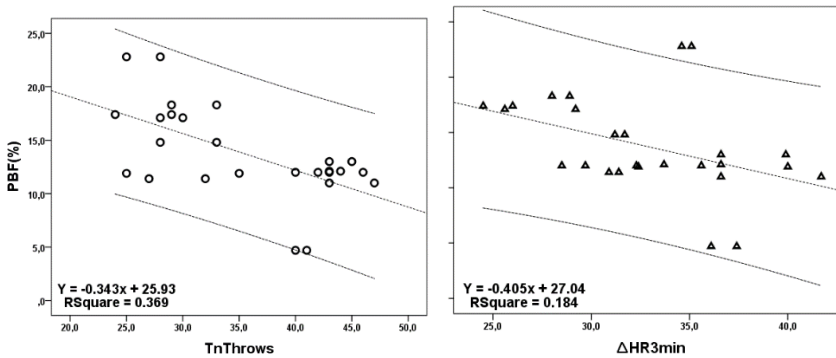

Figure 1. Linearna regresija i njeni modeli predikcije

DISCUSSION

Morphology or body composition is a term that describes the relative proportions of all main components of the body, including fat, bone, muscle, and water mass (Ratamess, 2012). Morphological characteristics are primarily influenced by genetic and environmental factors and one should pay a close attention to a well known fact that different morphological dimensions incur different genetic influence (Nikitjuk, 1998; Malacko et al., 2015). When it comes to morphological characteristics, the heritability coefficient, based on Holtziger's ratio, has a value of approximately 0.98 for the dimensionality of the skeleton, body voluminosity 0.80–0.90, and adipose tissue 0.50. Accordingly, the greatest transformation under the influence of exogenic factors (the process of sports training and the diet) is only possible in the case of adipose tissue. It is a known fact that muscle volume has a direct influence on the ability to develop strength, and thus to define the possibility of greater or less effective movement, overcoming resistance or obstacles, and that adipose tissue in the motor manifestations of athletes represents a 'disruptive factor' (Ostojic, 2005).

Wrestling is a kind of sport in which competitions are organized with weight-related restrictions, i.e., by categories which are defined based on the contestants' body mass. Body mass is defined by anthropometric and morphological

characteristics, while the ratio between the fat component and fat free mass in the body manifests efficiency. Fat free mass is constituted by bones, organs, and muscles which are the first thing that springs to mind when we talk about physical activities (Dopsaj et al., 2017).

Although athletes tend to lose body mass rapidly by means of dehydration techniques when preparing for competitions across all weight categories, through continuous training and optimal nutrition they benefit from a greatly improved interrelation between the active (muscles) and passive (fat tissue) components in the body (Dopsaj et al., 2013). Improving the relation between these two components basically means a surge in muscle mass and its contractile and energetic capabilities, as well as a decrease in adipose tissue in the body to a statistical minimum.

A strong negative correlation between the percentage of fat and muscle at the level of -0.905 (Table 3) confirms the aforementioned. Moreover, there is significant evidence that fat reduction contributes to muscular and cardio-respiratory endurance as well as to the development of speed and agility (Ratamess, 2012).

Necessary in the process of balancing hormones and providing an energy source, which are its basic functions in the body, any increase to the fat component may concomitantly lead to a decrease in athletes' performances (Houston et al., 1983; Kraemer et al., 2001). It can of course be safely surmised that physical preparation, in which the fat component represents a significant factor, is of paramount importance when it comes to the success of athletes, much like the levels of technical and tactical skills. The direct influence of the fat component on the lowering of success chances (preparedness) comes from the adverse effect the additional load has on the athlete's body, because this component possesses no active-contractile capacity (Dopsaj et al., 2017).

On the other hand, if we consider the active component from a quantitative point of view, muscle mass, depending on the level of training, may or may not affect the success and recovery of the cardiovascular system (SMM – Tn^{Throws}: 0.347; SMM – ΔHR_{1min}: -0.119; SMM – ΔHR_{3min}: 0.282; Table 3).

This researh's results have confirmed the rule that an increase in the body's fat percentage has a disadvantageous effect on success rate (Kasum and Dopsaj, 2012), more specifically, in this case the number of completed throws in the test (PBF – Tn^{Throws}: -0.608^{**}). It should also be noted that the rules which govern the recovery of the cardiovascular system are already well known, that is, after physical activities ceases, the pulse frequency will decrease, and the speed of recovery is directly linked to the levels of physical fitness of the athlete, or more precisely to the parameters affecting said fitness levels (PBF – ΔHR_{3min}: -0.429^{*}), as well as to the overall success rate in the test (Tn^{Throws} – ΔHR_{1min}: 0.522^{**}; Tn^{Throws} – ΔHR_{3min}: 0.454^{*}) (Table 3).

CONCLUSIONS

Due to the specificities related to their own unique physical activities, all sports develop athletes with certain characteristic morphological traits. As we have already mentione, wrestlers are denoted by a pronounced mesomorphism. The synergy of an optimal training regimen and adequte nutrition strives to reach an ideal wrestler's physique and entails constant supervision of body weight. Any changes to the balance between training and nutrition, i.e., their quantity and quality, will affect the interrelation between the active and passive components.

A favorable relation between training and nutrition will lead to a reduction of the fat percentage, and depending on the periodization and type of said training, an increase in muscle mass, preparedness, and inescapably the success rate and recovery speed.

A counteractive relation between training and nutrition leads to a decrease in the level of preparedness, increases the fat percentage, and changes the body mass which can even alter one's weight category which in turn utterly upsets probabilities of success.

Overall, the body composition control in international wrestlers should be a valuable system of supervision of the efficiency of body adaptation on training process aimed at optimizing competitive performance potential.

Acknowledgements

This research is part of the National Scientific Project “Effects of Applied Physical Activity on Locomotor, Metabolic, Psychological, Social and Educational Status of the Population of the Republic of Serbia”, No. ID III 47015, and it is financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia. The results of this study do not endorse any product of the manuscript’s authors nor the product of the NSCA.

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Physical education and sport through the centuries
2022, 9(2), 130-141
ISSN 2335-0598

УТИЦАЈ МОРФОЛОШКИХ КАРАКТЕРИСТИКА НА ПРИПРЕМЉЕНОСТ РВАЧА

САЖЕТАК

У рвању су правилима дефинисане тежинске категорије, самим тим морфолошки састав тела представља битан фактор успеха. Предмет рада су морфолошки параметри испитаника, и испољени параметри припремљености на Специфиц Wрестлинг Перформанце Тест-у (СWПТ). Циљ истраживања је да се утврди утицај морфолошких карактеристика на физичку припремљеност, и начин опоравка функционалних карактеристика, као и њихове међурелације и законитости. Узорак чини 26 рвача узраста 20.2±1.7 година, тренажног стажа 6.7±3.2 година, бројем недељних тренинга 7.8±1.9, телесном висином 178.9±5.6 цм, телесном масом 82.9±7.4 кг, индексом телесне масе 25.9±2.0 кг/м2. Са аспекта морфолошких карактеристика посматрани су проценат телесне масти – ПБФ, проценат мишићне масе – СММ (ИнБоду 720); као параметар припремљености узет је укупан број бацања на тесту – ТнТхроwс; док су функционалне карактеристике дефинисане као проценат опоравка фреквенције пулса од завршетка теста до 1. и 3. минута – ΔХР1мин и ΔХР3мин. За потребе утврђивања релација употребљена је корелациона статистика и линеарна регресиона анализа. Дефинисаним анализама није утврђена значајна корелација између СММ и било које друге праћене варијабле, док је ПБФ показао високо статистички значајну корелацију са ТнТхроwс (р = -0.608, п = 0.001), и значајну корелацију са ΔХР3мин (р = -0.429; п = 0.029). Анализом ТнТхроwс и карактеристика функционалног опоравка такође су утврђене значајне корелације (ΔХР1мин р = 0.522, п = 0.006; ΔХР3мин р = 0.454, п = 0.020). У хомогеним групама, као сто су активно тренирани рвачи процентуална заступљеност мишићне компоненте је уједначена, док је утренираност исте знатно различита, што делимично утиче на различиту заступљеност масне компоненте, а све то дефинитивно утиче на успех и опоравак рвача.

Кључне речи: теренско тестирање, проценат телесне масти, проценат мишићне масе, срчана фреквенција.

Reccived on 20.11.2022.
Accepted on 21.12.2022.