THE RELATIVE COMPOSITION OF THE BODY MASS OF HIGHLY SKILLED ROWERS AND THEIR RELATIONSHIP WITH SPORTS RESULTS

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Abstracts

Topicality. The definition of body composition is important in sports and is used by coaches and sports doctors in the selection and optimization of the training regime in the preparation for the competition. ***The purpose of the work*** is to study the components of the body weight of highly skilled kayak rowers and the relationship of measurement data with the results of performances. ***Materials and Methods.*** A total of 76 sportsmen were examined, including 44 men and 32 women. To determine fat, muscle and bone mass, the formulas of Y. Matejka and E. G. Martirosov. ***Results.*** When comparing the indicators, it was found that the group of MSMC and ZMS have better results than the group of MS and KMS, both in terms of the time of passage of the 200- meter distance, and in terms of body weight composition. The indices of relative muscle mass between a group of ZMS and MSIC and a group of MS and MMR differences are significantly significant (p<0,05). Reliably significant correlation coefficients between competition result women videocnet group of ZMS and MSIC. At the 500-meter distance, athletes of the group of PMS and MSMC showed significant differences between the relative muscle mass and sports results (p<0,05). At the same distance in female kayakers differences are statistically significant in terms of relative fat and muscle mass (p<0,05). At a distance of 1000 m athletes of the group of ZMS and MSMC on all indicators exceed the group of MS and KMS, but the differences are not reliable (p>0,05). A similar trend is in men, performing at a distance of 5000 m, where athletes of the group of ZMS and MSMC in all indicators exceed the group of MS and KMS, but the differences are not significant (p>0,05). At a distance of 5000 m, there were differences in the relative body fat, muscle and bone mass of women of both groups, but no statistically significant differences were found (p>0,05). ***Conclusions.*** It is noted that the group of MSMC and ZMS, both in men and women at a distance of 200 m, in all components of the body mass composition exceed the group of MS and CMC. Statistically significant correlation coefficient was revealed. It is revealed that at a distance of 500 m the best indicators are athletes of msmk group and ZMS, both in men and women. Correlation coefficients are reliable between the sports result and bone mass index in the same group. At a distance of 1000 m the best values have athletes group msmk and ZMS, but the values are not statistically reliable. The correlation coefficient is reliable only between the sports result and the fat mass index. It is revealed that the group of MSMC and ZMS, both in men and women, have better results than the group of MS and KMS, both in terms of the passage of the 5000-meter distance and in terms of body weight composition. The differences are not reliable.

Key words: rowing, kayak, fat and muscle mass, distance.

Володимир Давидов, Володимир Шантарович, Дмитро Пригодич. Відносні показники складу маси тіла висококваліфікованих веслярів на байдарках і їх взаємозв'язок зі спортивним результатом. *Актуальність.* Визначення складу тіла має важливе значення в спорті й використовується тренерами та спортивними лікарями під час відбору та для оптимізації тренувального режиму в процесі підготовки до змагань. *Мета роботи* – дослідити компоненти складу маси тіла висококваліфікованих веслярів на байдарках і взаємозв'язок цих вимірювань із результатами виступів. *Матеріали й методи дослідження.* Усього обстежено 76 спортсменів, із них 44 чоловіки та 32 жінки. Для визначення жирової, м'язової й кісткової мас використано формули Я. Матейки і Є. Г. Мартіросова. *Результати.* При зіставленні показників виявлено, що група МСМК

та ЗМС показує кращі результати, ніж МС і КМС, як за часом проходження 200-метрової дистанції, так і за показниками складу маси тіла. У показниках відносної м'язової маси між групами ЗМС та МСМК і МС та КМС відмінності достовірно значимі (р <0,05). Достовірно значимі коефіцієнти кореляції між змагальним результатом у жінок-байдарочниць групи ЗМС і МСМК. На 500-метровій дистанції в спортсменів групи ЗМС і МСМК відзначено достовірно значимі відмінності між показниками відносної м'язової маси й спортивним результатом (р <0,05). На цій же дистанції в жінок-байдарочниць відмінності статистично достовірні в показниках відносної жирової та м'язової маси тіла (р <0,05). На дистанції 1000 м спортсмени групи ЗМС і МСМК за всіма показниками перевершують групу МС і КМС, однак ці відмінності не достовірні (р> 0,05). Аналогічна тенденція й у чоловіків, які виступають на дистанції 5000 м, де спортсмени групи ЗМС і МСМК за всіма показниками кращі, порівняно з МС та КМС, але ці відмінності не достовірні (р> 0,05). На дистанції 5000 м у показниках відносної жирової, м'язової й кісткової маси тіла жінок обох груп простежено відмінності, проте статистично достовірної різниці не виявлено (р> 0,05). *Висновки.* Відзначено, що група МСМК і ЗМС, як чоловіки, так і жінки, на дистанції 200 м за всіма компонентами складу маси тіла перевершують групу МС та КМС. Виявлено статистично достовірний коефіцієнт кореляції. Установлено, що на дистанції 500 м кращими показниками володіють спортсмени групи МСМК і ЗМС як чоловіки, так і жінки. Коефіцієнти кореляції достовірні між спортивним результатом та показником кісткової маси в цій же групі. На дистанції 1000 м найкращими значеннями володіють спортсмени групи МСМК і ЗМС, але значення статистично не достовірні. Коефіцієнт кореляції достовірний лише між спортивним результатом та показником жирової маси. Виявлено, що група МСМК і ЗМС, як чоловіки, так і жінки, мають кращі результати, ніж МС та КМС, як за часом проходження 5000-метрової дистанції, так і за показниками складу маси тіла. Відмін- ності не достовірні.

Ключові слова: веслування, байдарка, жирова й м'язова маса, дистанція.

Владимир Давыдов, Владимир Шантарович, Дмитрий Пригодич. Относительные показатели состава массы тела высококвалифицированных гребцов на байдарках и их взаимосвязь со спортивным результатом. *Актуальность.* Определение состава тела имеет важное значение в спорте и используется тренерами и спортивными врачами при отборе и для оптимизации тренировочного режима в процессе подготовки к соревнованиям. *Цель работы* – исследовать компоненты состава массы тела высококвали- фицированных гребцов на байдарках и взаимосвязь данных измерений с результатами выступлений. *Материалы и методы исследования.* Всего обследовано 76 спортсменов, из них – 44 мужчин и 32 женщины. Для определения жировой, мышечной и костной масс использовались формулы Я. Матейки и Э. Г. Марти- росова. *Результаты.* При сопоставлении показателей наблюдалось, что группы МСМК и ЗМС имеют лучшие результаты, чем МС и КМС как по времени прохождения 200-метровой дистанции, так и по показателям состава массы тела. В показателях относительной мышечной массы между группами ЗМС и МСМК и МС и КМС различия достоверно значимы (р<0,05). Достоверно значимы коэффициенты корреляции между соревновательным результатом у женщин-байдарочниц группы ЗМС и МСМК. На 500-метровой дистанции у спортсменов группы ЗМС и МСМК отмечаются достоверно значимые различия между показателями относительной мышечной массы и спортивным результатом (р<0,05). На этой же дистанции у женщин- байдарочниц различия статистически достоверны в показателях относительной жировой и мышечной массы тела (р<0,05). На дистанции 1000 м спортсмены группы ЗМС и МСМК по всем показателям превосходят группу МС и КМС, однако различия не достоверны (р>0,05). Аналогичная тенденция и у мужчин, выступающих на дистанции 5000 м, где спортсмены группы ЗМС и МСМК по всем показателям превосходят группу МС и КМС, но эти различия недостоверны (р>0,05). На дистанции 5000 м в показателях относительной жировой, мышечной и костной массы тела женщин обеих групп имелись различия, однако статистически достоверных различий не наблюдали (р>0,05). *Выводы.* Отмечается, что группа МСМК и ЗМС как у мужчин, так и у женщин на дистанции 200 м, по всем компонентам состава массы тела превосходят группу МС и КМС. Выявлен статистически достоверный коэффициент корреляции. Определено, что на дистанции 500 м лучшими показателями обладают спортсмены группы МСМК и ЗМС, как мужчины, так и женщины. Коэффициенты корреляции достоверны между спортивным результатом и показателем костной массы в этой же группе. На дистанции 1000 м наилучшими значениями обладают спортсмены группы МСМК и ЗМС, но значения статистически не достоверны. Коэффициент корреляции достоверен лишь между спортивным результатом и показателем жировой массы. Установлено, что группа МСМК и ЗМС, как мужчины, так и женщины, показывает лучшие результаты, по сравнению с МС и КМС как по времени прохождения 5000-метровой дистанции, так и по показателям состава массы тела. Различия не достоверны.

Ключевые слова: гребля, байдарка, жировая и мышечная масса, дистанция.

Introduction. People have been interested in the studying of the body composition throughout the human history. As it is claimed by the archaeological discoveries of the Stone Age figurines, the prerequisites for the development of a scientific approach to the study of the body composition were created

in those distant times. The investigations of the composition of human body mass have importantly increased in the recent years [3; 4].

The results of some studies [1; 2] reveal that the body composition is essentially interconnected with indexes of a person's physical ability, with their adaptation to environmental conditions, as well as with professional and sports activities. In clinical, health and sports medicine, the significant issue is the monitoring of the body composition. The scope and possibilities of methods for determining body composition are constantly expanding.

Different ratios of body composition indexes are directly related to the state of athletes' physical ability [5; 6]; they closely correlate with the biochemical and functional indexes of the body, widely used in sport.

The purpose of the work is to investigate the body mass composition components of highly skilled kayakers and the interrelation of the measurement data with the performance results.

Methods and objects of study. Highly skilled kayakers of both sexes performing at different distances (200, 500, 1000, and 5000 meters) were examined. A total of 76 athletes were examined, among them there were 44 men and 32 women.

In order to determine the fat, muscle and bone mass, the formulas of J. Mateyka [1921] and E. G. Martirosov [1982] were used. The relation between body composition indexes and sports result was established by determining the correlation coefficient (r) by means of statistical processing [Buriakin, 2015].

The tables 1–7 present the correlation of measurement data with the results of highly skilled performances of athletes.

The tables contain average arithmetic values ($\overline{X}$) of selected characteristics for the two groups of highly skilled kayakers, absolute (σ) and relative (V%) indexes of variations and also correlation coefficients with sports result.

Results and their discussion. Table 1 presents the statistical results of the body composition of kayak rowers, majoring in a competitive distance of 200 meters.

Table 1

The indexes of body mass composition of kayak rowers and their interrelation with sports result (K–1, 200 m, men)

Indexes	Athlete qualification							
	HMS, WCA n=18				MS, CMS n=26			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass , %	7,70	2,61	4,72	0,783	9,69	2,57	4,94	-0,835
Muscle mass, %	54,92*	2,73	3,42	0,342	50,18*	2,26	7,31	-0,506
Bone mass, %	15,38	2,19	4,73	0,639	14,62	3,47	6,25	-0,738
Rowing 200 m, s	38,83*	2,35	5,61	-	42,84*	3,48	3,57	-

Note: t – Student's test, * - p<0,05; correlation coefficients are credible at r<0,390 for 5% of significance level

The analysis of the received data revealed better results of the group WCA and HMS than results of MS and CMS group (picture 1). 3,91s is an average difference of 200 m distance covering.

Herewith correlation coefficients of kayak rowers' body mass indexes are closely connected with the results of 200 m distance covering. The connection of muscle mass indexes with 200 m covering time is statistically significant, where correlation coefficient was 3,42, at r<0,390 for 5% of level significance.

According to the index of women' relative bone mass (Table 2), a statistically significant correlation coefficient was 0.368 with r <0.390 for the 5% level of significance. There were also certain differences between the results of the 200-meter distance covering (p <0.05) in single kayaks, where female kayakers of the first group were 5.38 seconds ahead of the second group kayakers (Fig. 2). Other correlation coefficients of the investigated indexes of the kayakers' body mass have a fairly strong connection with the result of the 200-meter competitive distance. However, this connection is not statistically significant (p> 0.05).
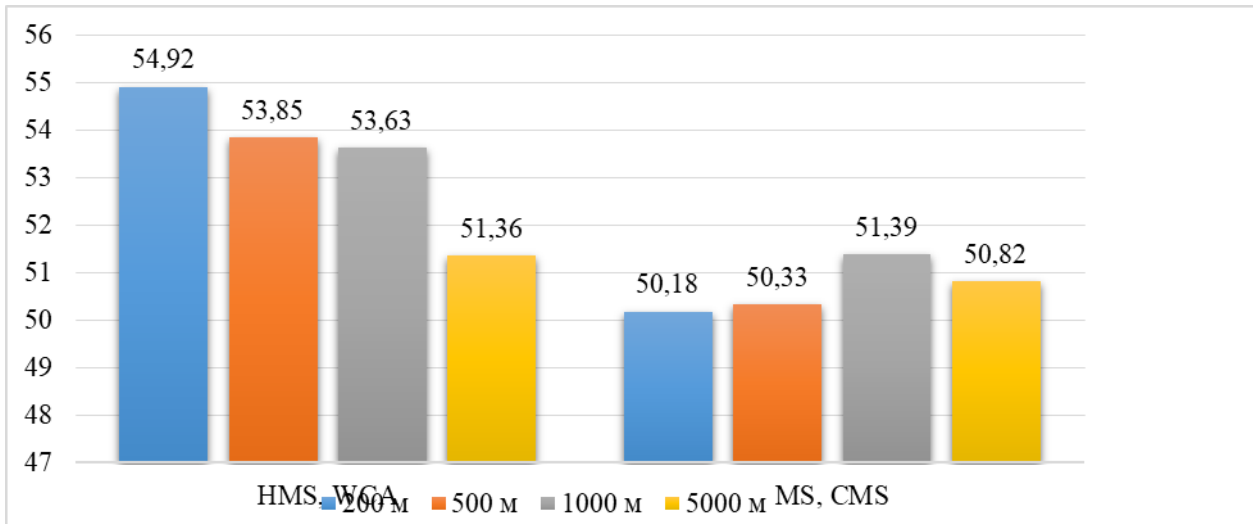
Fig. 1. *Relative muscle mass (%) of athletes of various qualifications majoring in rowing*

Table 2

The indexes of body mass composition of highly qualified kayak rowers and their interrelation with sports result (K – 1, 200 m, women)

Indexes	Athlete qualification							
	Honored Master of Sports, World-class athlete n=12				Master of Sports, Candidate Master of Sports n=20			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	11,27	2,31	5,71	0,649	16,04	2,51	6,84	-0,582
Muscle mass, %	53,62	2,73	6,42	0,542	48,23	1,87	5,65	-0,438
Bone mass, %	13,38	3,69	5,73	0,368*	14,56	4,52	6,74	-0,627
Rowing 200 m, s	41,56*	2,68	5,94	-	46,84*	3,83	5,68	-

Notes: t – Student's test, * - $p < 0,05$; correlation coefficients are statistically significant with r <0.390 for the 5% level of significance.
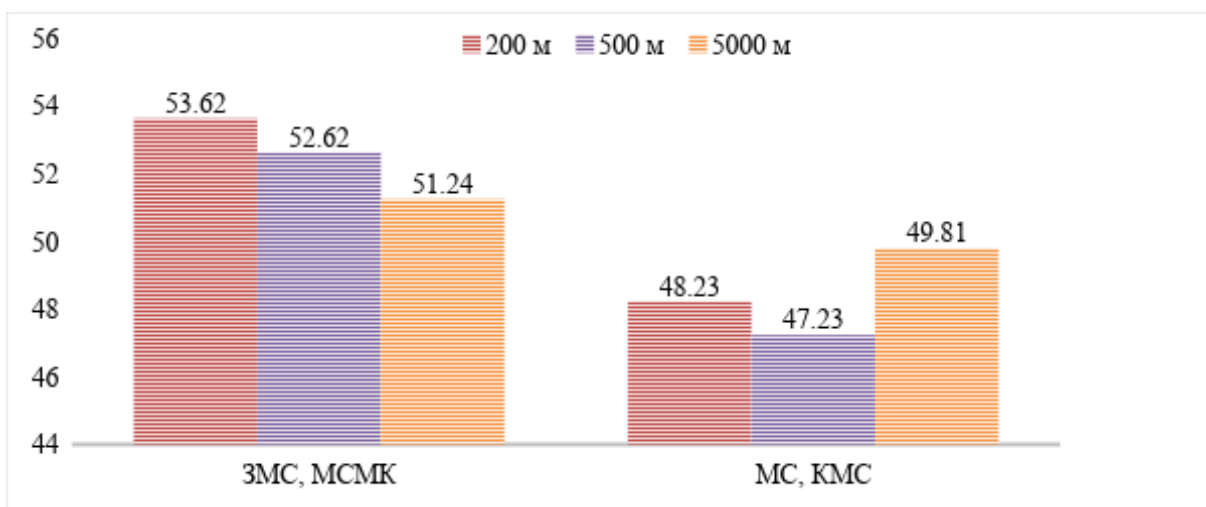

Fig. 2. *Relative muscle mass (%) of female athletes of various qualifications majoring in rowing*

Table 3 represents the results of kayakers specializing in 500-meter sprint rowing.

Table 3

The indexes of body mass composition of highly qualified kayak rowers and their interrelation with sports result (K – 1, 500 m, men)

Indexes	Athlete qualification							
	Honored Master of Sports, World-class athlete n=18				Master of Sports, Candidate Master of Sports n=26			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	6,70	2,61	4,72	0,479	10,85	2,57	4,94	-0,539
Muscle mass, %	53,85*	2,73	3,42	0,328	50,33*	2,26	7,31	-0,584
Bone mass, %	14,38	2,19	4,73	0,725	14,12	3,47	6,25	-0,673
Rowing 500 m, s	1:47,29	3,46	3,59	-	1:52,45	3,24	5,63	-

Notes: t – Student's test, * - $p<0,05$; correlation coefficients are statistically significant with r <0.390 for the 5% level of significance

Since we were interested only in the result of the covering of a competitive 500-meter distance by both groups and its correlation with the body mass composition, we will not repeat the analysis of body mass indexes, as it remained unchanged. From the table, we see that the male kayak rowers of the group WCA and HMS are ahead of the group MS, CMS on the average in 4.16 s. (Fig. 3).
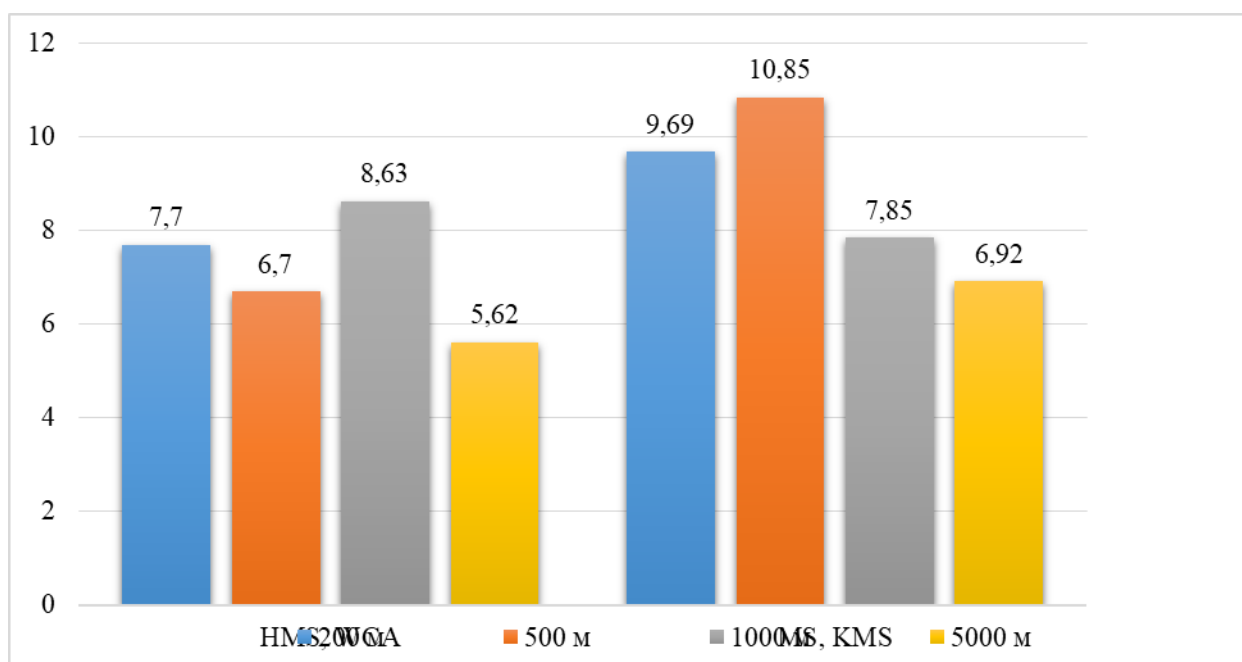

Fig. 3. *Relative fat mass (%) of athletes of various qualifications majoring in rowing*

There are statistical results of the indexes of body mass composition of female rowers in kayak singles specializing in the 500-meter competitive distance presented in Table 4. It is also revealed that the groups of HMS and WCA have better results than the MS and CMS groups, both in the time of the covering of 500-meter distance and in body mass composition. The differences between the results for all the investigated indexes of both groups of rowers are on the average: 5.47%, 4.67%, 1.12% and 4.65 seconds.

Table 4

The indexes of body mass composition of highly qualified kayak rowers and their interrelation with sports result (K – 1, 500 m, women)

Indexes	Athlete qualification							
	HMS, WCA n=12				MS, CMS n=20			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	10,27*	2,31	5,71	0,485	15,04*	2,51	6,84	-0,382
Muscle mass, %	52,62*	2,73	6,42	0,542	47,23*	1,87	5,65	-0,438
Bone mass, %	13,18	3,69	5,73	0,284	14,16	4,52	6,74	-0,572
Rowing 500 m, s	1:56,64	2,93	6,23	-	2:03,83	3,91	7,14	-

Notes: t – Student's test, * - p < 0.05; correlation coefficients are reliable at r< 0.390 for 5% significance level.

The correlation of body mass indexes with sports result is quite close. However, the correlation coefficients are reliable only between the sports result and the relative bone mass index in the HMS, WCA group, where r = 0.284.

Table 5 summarizes the statistical results of the body mass indexes of male rowers in single kayaks, specializing in a competitive distance of 1000 meters.

According to the findings, the examined groups have some differences, both in the time of the 1000-meter competition, and in the body mass indexes. The differences between the results of the indexes of fat, muscle and bone mass in rowers of both groups are on the average, respectively: 2.22%, 2.24%, 0.74% and 4.01 s. The differences between the body mass indexes are not statistically significant (p> 0.05). However, the correlation coefficients are reliable only between the sports result and the fat mass index in the HMS, WCA groups, with r = 0.352, r <0.390 for 5% of the significance level with respect to the Student's t-test.

Table 5

The body mass indexes of highly qualified kayak rowers and their interrelation with sports results (K – 1, 1000 m, men)

Indexes	Athlete qualification							
	HMS, WCA n=18				MS, CMS n=26			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	8,63	2,05	6,13	0,352	7,85	2,57	4,94	-0,469
Muscle mass, %	53,63	2,14	5,31	0,482	51,39	1,93	6,02	0,624
Bone mass, %	13,38	2,46	5,62	0,628	12,64	3,52	5,43	-0,462
Rowing 1000 m, min / s	3:31,82	3,65	5,67	-	3:35,83	4,38	3,58	-

Note: the correlation coefficients are reliable with r <0.390 for 5% level of significance with respect to the Student's t-test.

Table 6 summarizes the statistical results of the body mass indexes for men who specialize in 5000-meter competition distance rowing. When analyzing the obtained data, it is revealed that the groups of WCA and HMS have better results than the group of MS and CMS, both in the time of the 5000-meter distance, and in terms of the body mass indexes. The differences in the covering of the competitive distance of 5000 meters averaged 16.09 seconds. There were differences in the percentages of fat, muscle and bone mass of kayak rowers of both groups, but they were not statistically significant. At the same time, the

correlation coefficients of the rowers' body mass indexes has a strong connection with the result of covering the 5000-meter distance. And the relationship between body fat and bone mass of athletes and the time of the competitive distance is statistically significant, where the correlation coefficients were 0.379 and 0.268, respectively, with r <0.390 for 5% of the significance level with respect to the Student's t-test.

Table 6

The indexes of body mass composition of highly skilled kayak rowers and their interrelation with sports results (C–1, 5000 m, men)

Indexes	Athlete qualification							
	HMS, WCA n=18				MS, CMS n=26			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	5,62	2,59	3,46	0,379	6,92	2,49	3,42	0,736
Muscle mass, %	51,36	2,79	3,94	0,526	50,82	2,36	5,62	-0,349
Bone mass, %	13,41	3,14	5,89	0,268	12,36	2,41	4,82	-0,348
Rowing 5000 m, min/sec	20:58,51	10,8	5,63	-	21:14,53	12,2	3,53	-

Note: correlation coefficients are reliable at r <0.390 for 5% of the level of significance with respect to t – Student's test

The statistical results of the indexes of the body mass composition of women specializing in kayak rowing at a competitive distance of 5000 meters are shown in table 7.

When analyzing the obtained data, it was revealed that the group of HMS, WCA and the group of MS, CMS have differences both in the time of the covering of competitive distance and in the indexes of body mass composition (Fig. 4).

Differences during the covering of the competitive distance of 5000 meters by kayakers averaged 17.16 seconds.

Table 7

The indexes of body mass composition of highly skilled kayak rowers and their interrelation with sports results (C–1, 5000 m, women)

| Indexes	Athlete qualification							
	HMS, WCA n=18				MS, CMS n=26			
	Statistical results							
	$\overline{X}$	σ	V%	r	$\overline{X}$	σ	V%	r
Fat mass, %	9,76	2,89	4,93	0,638	13,87	2,38	5,84	-0,582
Muscle mass, %	51,24	2,53	3,64	0,346	49,81	3,47	4,36	-0,289
Bone mass, %	12,36	2,74	5,64	0,573	12,68	2,73	5,48	0,635
Rowing 5000 m, min/sec	23:29,42	4,62	5,46	-	23:46,26	4,73	3,47	-

Note: correlation coefficients are reliable at r <0.390 for 5% the level of significance with respect to t – Student's test

At the same time, the correlation coefficients of the body mass indexes of the rowers had a strong connection with the result of a 5000-meter distance covering.

And the relationship of muscle mass indexes with the performance time of the competitive distance was statistically significant, where the correlation coefficients were 0.346 and -0.289 at r <0.390 for 5% the level of the significance with respect to the t-Student's test.

Conclusions. It is noted that the group of MS, CMS, both among men and women at a distance of 200 m in all components of body mass composition are superior to the group of HMS, WCA. A statistically significant correlation coefficient was found.

It was revealed that at the distance of 500 m the athletes of the MS, CMS have the best performance, both among men and women. The correlation coefficients are reliable between the sporting result and the bone mass index in the same group.
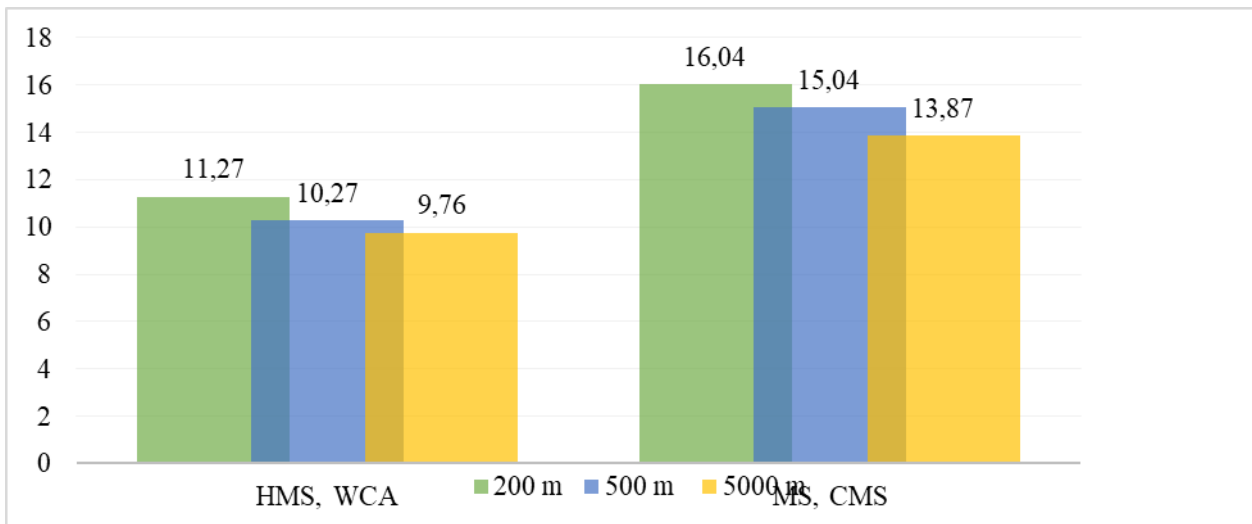
Fig. 4. *The relative fat mass (%) of female athletes of various qualifications majoring in rowing*

At a distance of 1000 m, the athletes of the MS, CMS have the best values, but the values are not statistically significant. The correlation coefficient is reliable only between the sports result and the index of fat mass.

It was revealed that the MS, CMS group, both among men and women, have better results than the HMS, WCA group, both in the time of covering the 5000-meter distance, and in terms of the body mass composition. Differences are not reliable. For men, a significant correlation coefficient between the indexes of adipose and bone body mass within the distance time is obvious. For women, the relationship is reliable in terms of muscle mass with the time of 5000 m.

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