

Comparative analysis of the specific motor skills of cadets by classes after the second year of education

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Abstract:

Introduction/purpose: Despite the era of digitization, the assessment of the combat readiness of modern army members has always been associated with good physical fitness. When it comes to the specific physical abilities of the Military Academy cadets, their previous tests indicate that the values are within the expected limits. The aim of this work is to compare the values of the results in the specific motor skills of cadets by classes (groups) after the second year of schooling. It is hypothesized that there are differences in the results of the cadets by groups.

Methods: The sample consisted of a total of 932 male cadets within nine groups, after the second year of study, starting from the 2012/2013 school year. Four variables related to specific motor skills were included: pull-ups on a bar for 2 minutes, crunches for 2 minutes, 3200 m running, and overcoming infantry obstacles. Using statistical programs, the results of these four variables were processed through central and dispersion parameters. The univariate analysis of variance (ANOVA) was used to determine the differences between the groups in the achieved results. The multivariate analysis of variance (MANOVA) determined the differences in the system of variables with spaces.

Results: The analysis of the results of the specific motor abilities by groups after the second year of study determined that there are statistically significant differences in the variables "pull-ups on a bar" and "crunches", while there are no statistically significant differences in the variables "3200 m running" and "overcoming infantry obstacles".

Conclusions: The values of the results of the cadets in these four specific motor abilities are obviously within the limits provided by the Instructions

and standards for evaluating cadets by age, so it was determined that there are no greater deviations than expected.

Key words: ANOVA, MANOVA, combat readiness, motor skills, pull-ups, crunches, infantry obstacles.

Introduction

The previous research studies on the specific physical abilities of the cadets of the Military Academy indicate that the results are within the expected limits. There are numerous worldwide studies related to motor abilities, morphological characteristics and functional abilities and they were conducted on a sample of respondents consisting of cadets of military academies or professional persons aged 18 to 24. The Military Academy in Norway performed testing on 260 male and 29 female cadets with the aim of examining changes in anthropometry and physical fitness during 3 years of schooling (Aandstad et al, 2020). The results showed that the most of the observed changes were very small. During the research of cadets (197 male cadets and 31 female cadets) of the Military Academy in Poland, in addition to somatic development, they were also tested in physical abilities (Jamro et al, 2021). A statistical difference was established, where male cadets showed better results in practical military subjects, while female cadets had better results in theoretical military subjects. The results of physical fitness indicate differences between the male and female sexes and point to the need for specialized training aimed at bridging large differences in physical fitness, especially in the development of muscle strength.

At the Military Academy in Romania (Melnykov et al, 2018), research was conducted on 112 cadets in physical preparation in the first two years of schooling. Eurofit tests for physical education and military training were used. The results indicate that the structure of changes in physical preparation in the experimental groups differs significantly in relation to the years of study. The obtained results should be aimed at developing the physical abilities of cadets.

Many studies indicate that good physical abilities of cadets or soldiers enable better execution of operational tasks as well as reduced musculoskeletal injuries (Vaara, 2017).

The analysis of the results of the motor skills of the cadets of the Military Academy in Belgrade during schooling shows that the best results were achieved after the second academic year (Marić, 2011). The exper-

imental treatment included the entire curriculum in the subject of Physical Education (PE) during the education at the Military Academy. The number of hours was 60+30 hours. The course content includes: wrestling, swimming, overcoming infantry obstacles with gymnastics, general physical preparation, skiing and theory. Based on the principle of systematicity and gradualness, each specialty goes from the known to the unknown and from the easier to the more difficult. "The best average results for the assessment of motor skills were achieved after the second year of study." (Marić et al, 2013).

The aim of this work is to compare the values of the results in the specific motor abilities of cadets by classes (groups) after the second year of study. It is hypothesized that there are differences in the results of (male) cadets by groups. The concept of experimental treatment is included in the entire curriculum in the subject of Physical Education (PE) related to the education of cadets in the Military Academy.

Results

Table 1 shows the descriptive parameters of the motor variable "pull-ups on a bar" for 2 minutes. Based on the minimum and maximum values of the results of the motor variable "pull-ups on a bar" by groups, it is observed that they range from a minimum of 5 (except in the 8th group, where the minimum value is 6 repetitions) to a maximum of 21. The coefficient of variation indicates a greater heterogeneity of the results by groups when the values are maximal. It is obvious that the subjects were prepared differently in mastering this motor task. Based on testing the symmetry of the curve, the skewness values indicate a negative curvature, while the kurtosis values show a certain heterogeneity of the results by groups.

Table 1 – Descriptive indicators of the variable "pull-ups on a bar" by groups

Group	No. cad.	Min	Max	Aver.	SD	COV. V. %	Skew.	Kurt.
I	121	5	21	11.26	3.68	32.7	-0.204	-1.015
II	107	5	15	12.63	3.07	24.3	-1.178	0.168
III	142	5	15	12.66	2.98	23.5	-1.039	-0.133
IV	99	5	20	13.03	3.25	24.9	-0.968	0.144
V	123	5	17	12.33	3.22	26.1	-0.783	-0.760
VI	94	5	15	12.02	3.21	26.7	-0.717	-0.803
VII	85	5	20	11.61	3.78	32.6	-0.370	-1.146
VIII	63	6	18	13.13	3.20	24.4	-0.679	-0.394
IX	98	5	16	12.57	3.28	26.1	-1.114	-0.051

The motoric variable “crunches for 2 minutes” by groups is shown in Table 2. From the descriptive parameters of this motor ability, it can be seen that the minimum values range mostly from 40 repetitions, except in the 8th group and the 6th group, where the minimum numbers of repetitions are 67 and 46, respectively.

Table 2 – Descriptive indicators in the variable “crunches for 2 min” by groups

Group	No. cad.	Min	Max	Aver.	SD	COV. V. %	Skew.	Kurt.
I	121	40	90	72.27	11.08	15.33	-1.209	0.861
II	107	40	91	72.08	10.38	14.40	-1.175	1.135
III	142	41	100	75.50	8.34	11.05	-1.633	3.382
IV	99	40	100	74.56	10.98	14.73	-0.982	1.178
V	123	44	90	73.74	8.43	8.44	-1.170	0.374
VI	94	46	100	76.65	10.84	14.14	-0.884	1.015
VII	85	40	115	70.74	14.15	20.00	-0.356	0.406
VIII	63	67	110	81.37	6.93	8.51	1.031	4.219
IX	98	40	90	70.49	12.10	17.16	-0.986	-0.122

The maximum values indicate that the best result was achieved in the seventh group with 115 crunches for 2 minutes. On the basis of the coefficient of variation, it was determined that the results in this motor ability are mostly homogeneous, which is mostly reflected in the 8th group (cov.v.= 8.44 %). The greatest heterogeneity is in the 7th group, where the values of the results of crunches for 2 minutes range from a minimum of 40 repetitions to a maximum of 115 repetitions (cov. v.= 20.00 %).

Based on the skewness value, the curvature of the curve is negative for all groups by years of education, except for the 8th group, which has a high degree of homogeneity.

In Table 3, the descriptive indicators in the variable “3200 meters running” by classes are shown in seconds. For some cadets, the maximum results are slightly higher than the limit based on the PE Instructions, but these are the results they achieved at the end of the school year in this discipline.

The worst result was achieved by a cadet in the 7th group, in the 3200 m running, with a time of 990 seconds, and the best time was achieved by some cadets from the 3rd and 5th groups with 678 seconds (11 min. and 18 sec.). On the basis of the coefficient of variation, one can observe a great homogeneity by classes. These values are possible, because the results are limited, according to the tables for the 3200 m running. In most cases,

Table 3 – Descriptive indicators in the variable “3200 meters running” by groups

Group	No. cad.	Min	Max	Aver.	SD	COV. V. %	Skew.	Kurt.
I	121	684	985	837.21	73.57	8.79	-0.041	-0.704
II	107	690	959	831.96	62.85	7.55	-0.013	-0.807
III	142	678	980	825.45	67.45	8.17	0.293	-0.471
IV	99	701	950	835.43	69.82	8.36	0.299	-0.462
V	123	678	980	826.07	68.63	8.30	0.301	-0.421
VI	94	722	980	828.34	73.31	8.62	0.274	-0.437
VII	85	699	990	861.33	71.02	8.24	-0.124	-0.675
VIII	63	690	938	815.71	61.67	7.56	-0.172	-0.699
IX	98	704	968	854.15	56.54	6.62	0.108	-0.566

the results by group move towards higher values, but the homogeneity is equally good, and the highest value is in the ninth group (cov.v.= 6.62 %).

Table 4 – Descriptive indicators in the variable “overcoming infantry obstacles” by groups

Group	No. cad.	Min	Max	Aver.	SD	COV. V. %	Skew.	Kurt.
I	121	98	176	141.72	21.28	15.0	-0.018	-0.921
II	107	96	176	140.38	18.77	13.4	0.144	-0.628
III	142	87	176	140.64	20.89	14.8	-0.177	-0.654
IV	99	92	176	139.92	19.73.82	14.1	-0.156	-0.728
V	123	101	176	144.45	21.47	14.9	-0.125	-1.197
VI	94	103	176	144.83	20.87	14.4	0.028	-0.678
VII	85	93	176	141.63	21.01	14.8	-0.412	-0.341
VIII	63	85	176	141.50	24.09	17.6	-0.003	-0.124
IX	98	95	176	142.21	19.46	13.7	-0.347	-0.377

Table 4 shows the descriptive parameters of the motor variable of overcoming infantry obstacles. For the assessment of the motor ability “overcoming infantry obstacles”, after the second year of studying and by analyzing the mean values, it can be said that the results are within the possibility limits, based on the minimum and maximum values of the results of the motor variable. It can be seen that the best time (result) was in the 8th group with 85 sec. (1 min. and 25 sec.) and in the 3rd group with 87 sec. (1 min. and 27 sec.), which means that some cadets had really outstanding results. Based on the coefficient of variation, it was determined that the results in this motor skill are mostly homogeneous and approximately equal. The maximum (worst) results are the same in all groups, because this is the result that is recognized for the grade that cadets should achieve based on the Physical Education instructions. Based on testing the symmetry of

the curve, the skewness values indicate mostly negative asymmetry and the curve is stretched towards higher scores.

Differences between the respondents in mastering the motor skills of cadets

During the analysis of the descriptive indicators in the mastery of the motor skills tested (pull-ups on a bar for 2 minutes, crunches for 2 minutes, 3200 m running, and overcoming infantry obstacles), numerical differences in the average results in certain variables for the assessment of motor skills were observed. The statistical significance of the observed differences between groups (classes) in relation to these four variables was determined by statistical analysis, the multivariate analysis of variance (MANOVA), and the univariate analysis of variance (ANOVA).

Regarding the pull-up test, from Table 5, it can be said that there are statistically significant differences in the results between the nine groups, based on the multivariate analysis of variance (MANOVA), where $p=0.012$.

Table 5 – Statistically significant differences between the groups in the variable “pull-ups on a bar”

MANOVA	n	F	p
	9	1.334	0.012

The analysis of the results obtained by the univariate analysis of variance (ANOVA), in Table 6, shows that, in the variable “pull-ups on a bar”, there are no statistically significant differences between the respondents by groups, except in the 4th group (.033), the 8th group (.004), and the 7th group (.079), but with an increased risk of inference.

The results achieved by the cadets by groups were as expected. However, there are cadets who achieved better results than expected, which may be the result of their greater commitment during the school year, apart from regular classes. In the variable “2-minute crunches”, by the MANOVA analysis (Table 7), within 9 different groups, it is observed that there are statistically significant differences, where $p=0.001$.

The univariate analysis of variance ANOVA, Table 8, showed that there are statistically significant differences in the 3st group (0.029), the 6th group (0.031), and the 8th group (0.037), which was not observed in other groups.

The results of this test indicate that even in these groups there is a different level of preparedness, but which can be influenced by practice. Regard-



Table 6 – Statistically significant differences between the groups in the variable “pull-ups on a bar”

Group	F	p
I	1.084	0.409
II	1.496	0.133
III	0.773	0.755
IV	1.952	0.033
V	0.887	0.625
VI	1.252	0.266
VII	1.669	0.079
VIII	2.635	0.004
IX	1.311	0.226

Table 7 – Statistically significant differences between the groups in the variable “crunches”

MANOVA	n	F	p
	9	1.591	0.001

ing the analysis of the statistically significant differences within 9 groups, the multivariate analysis of variance in the 3200 m running variable, Table 9, indicates that there are no differences, where $p=0.798$.

The univariate analysis of variance ANOVA, Table 10, showed no statistically significant differences by groups.

Having in mind that the cadets successfully mastered the teaching content after two years of studying, the obtained results are not surprising.

The analysis of the variable “overcoming infantry obstacles” based on the MANOVA (Table 11), shows that no statistically significant differences were found ($p=0.233$).

Table 8 – Statistically significant differences in the variable “2-minute crunches”

Group	F	p
I	2.473	0.029
II	0.939	0.587
III	1.272	0.314
IV	1.757	0.117
V	1.211	0.355
VI	2.451	0.031
VII	1.223	0.347
VIII	2.353	0.037
IX	1.594	0.163

Table 9 – Statistically significant differences between the groups in the 3200 m running variable

MANOVA	n	F	p
	9	0.660	0.798

Table 10 – Statistically significant differences in the 3200 m running variable

Group	F	p
I	2.453	0.333
II	0.331	0.943
III	3.803	0.230
IV	3.194	0.269
V	3.722	0.221
VI	4.931	0.258
VII	0.901	0.664
VIII	0.398	0.933
IX	1.067	0.603

Table 11 – Statistically significant differences between the classes in the variable “overcoming infantry obstacles”

MANOVA	n	F	p
	9	1.225	0.233

Based on the analysis of individual results (ANOVA) to determine statistically significant differences within 9 groups (Table 12), it can be observed that there are no differences here either.

Table 12 – Statistically significant differences in the variable “overcoming infantry obstacles”

Group	F	p
I	0.789	0.713
II	1.947	0.204
III	1.029	0.547
IV	1.571	0.299
V	1.006	0.562
VI	1.755	0.247
VII	0.903	0.630
VIII	0.911	0.624
IX	2.752	0.101

The achieved results are expected, because the cadets mastered these skills, which is mandatory during the evaluation within the Curriculum. Individual differences among cadets by groups in specific motor abilities may



be a consequence of different individual preparation. In these tests, motor skills are developed, mostly strength and endurance, and less speed, coordination, flexibility, etc. Cadets, with their extracurricular involvement, can achieve even better results during the schooling.

Conclusion

The achieved results in the motor skills of the cadets of the Military Academy are within the limits specified by the tables for checking physical abilities. The planned program corresponds to the set norms, but it is obvious that there is room to improve the results through afternoon physical activities - sections (Marić et al, 2015). A number of cadets are not sufficiently engaged in extracurricular physical activities, and it may also be a consequence of genetic predispositions, so they achieve minimal results. Depending on the period of development, certain factors that act on the body during exercise can cause different effects. Monitoring cadets by groups gives the opportunity to change and supplement the teaching process in military physical education.

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Análisis comparativo de las habilidades motoras específicas de los cadetes por clases a partir del segundo año de educación

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CAMPO: educación física

TIPO DE ARTÍCULO: artículo científico original

Resumen:

Introducción/objetivo: A pesar de la era de la digitalización, la evaluación de la preparación para el combate del ejército moderno siempre ha estado asociada con una buena condición física. En cuanto a las capacidades físicas específicas de los cadetes de la Academia Militar, sus pruebas previas, indican que los valores se encuentran dentro de los límites esperados. El objetivo de este trabajo es comparar los valores de los resultados en las habilidades motoras específicas de los cadetes por clases (grupos) después del segundo año de escolarización. Se hipotetiza que existen diferencias en los resultados de los cadetes por grupos.

Métodos: La muestra estuvo compuesta por un total de 932 cadetes varones dentro de nueve grupos, después del segundo año de estudio, a partir del año escolar 2012/2013. Se incluyeron cuatro variables relacionadas con habilidades motoras específicas: dominadas en barra durante 2 minutos, abdominales durante 2 minutos, carrera de 3200 m y superación de obstáculos de infantería. Mediante programas estadísticos se procesaron los resultados de estas cuatro variables a través de parámetros centrales y de dispersión. Se utilizó el análisis de la varianza (ANOVA) para determinar las diferencias entre los grupos en los resultados obtenidos. El análisis multivariado de varianza (MA-



NOVA) determinó las diferencias en el sistema de variables con espacios.

Resultados: El análisis de los resultados de las habilidades motoras específicas por grupos después del segundo año de estudio, determinó que existen diferencias estadísticamente significativas en las variables “dominadas en barra” y “abdominales”, mientras que no existen diferencias estadísticamente significativas en las variables “3200 m corriendo” y “superación de obstáculos de infantería”.

Conclusión: Los valores de los resultados de los cadetes en estas cuatro habilidades motoras específicas obviamente se encuentran dentro de los límites previstos por el Instructivo y estándares para la evaluación de cadetes por edades, por lo que se determinó que no existen desviaciones mayores a las esperadas.

Palabras claves: ANOVA, MANOVA, preparación para el combate, habilidades motoras, dominadas, abdominales, obstáculos de infantería.

Сравнительный анализ специфических двигательных навыков курсантов после второго курса обучения

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РУБРИКА ГРНТИ: 77.03.17 Профессионально-прикладная физическая подготовка

ВИД СТАТЬИ: оригинальная научная статья

Резюме:

Введение/цель: Оценка боеготовности современной армии всегда была связана с хорошей физической подготовленностью и, несмотря на цифровизацию, до сих пор является основой оценки боевой готовности армии. Ранние исследования специфических физических способностей курсантов Военной академии свидетельствуют о том, что значения их физической подготовки соответствуют норме. Целью данной статьи является сравнение значений результатов конкретной двигательной активности курсантов (по группам) после второго курса обучения. Выдви-

гається гіпотеза о наявності різниць в результатах курсантов в залежності від групи.

Методи: Виборка складалася з 932 курсантов чоловічого полу, закінчивших другий курс в дев'яти різних групах, починаючи з 2012/2013 навчального року. Були включені чотири змінні, пов'язані з конкретними двигательними навиками, а саме: підтягування на турніку - 2 хвилини, підйом корпусу від підлоги за 2 хвилини, біг на 3200 м і подолання смуги перешкодок. Використовуючи статистичні програми, результати цих чотирьох змінних були оброблені з допомогою центральних і дисперсійних параметрів. Для визначення різниць між групами в досягнутих результатах використовувався одномерний дисперсійний аналіз (ANOVA). Многомерний дисперсійний аналіз (MANOVA) виявив різниця в системі змінних по пространствам.

Результати: Аналізуючи результати окремих двигательних здатностей курсантов, закінчивших другий курс в різних групах, встановлено, що існують статистично значимі різниця по показателям підтягування на турніку і підйому корпусу від підлоги, в той час як статистично значимих різниць по змінним бігу на 3200 м і подолання перешкодок не виявлено.

Висновки: Значення результатів тестування курсантов по цим чотирьом конкретним двигательним здатностям знаходяться в межах, передбачених Інструкцією і стандартами оцінки курсантов по віку. Встановлено, що більших відхилень, ніж очікувалося, немає.

Ключові слова: ANOVA, MANOVA, фізична підготовка, моторика, підтягування, присідання, смуга перешкодок для піхоти.

Упоредна анализа специфичних моторичких способности кадета по класама после друге године школовања

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ОБЛАСТ: физичко васпитање

КАТЕГОРИЈА (ТИП) ЧЛАНКА: оригинални научни рад



Сажетак:

Увод/циљ: Процена борбене готовости савремене војске, упркос дигитализацији, одувек је била повезана са добром физичком оспособљеношћу и њена је основа. Досадашња истраживања специфичних физичких способности кадета Војне академије, указују на то да се вредности крећу у предвиђеним границама. Циљ овог рада јесте да се упореде вредности резултата који се односе на специфичне моторичке способности кадета по класама (групе) после друге године школовања. Поставља се хипотеза да постоје разлике у резултатима кадета по групама.

Методе: Узорак чине укупно 932 кадета мушког пола у оквиру девет група, након друге године школовања почевши од школске 2012/ 2013. године. Обухваћене су четири варијабле које се односе на специфичне моторичке способности: згибови на вратилу за 2 мин, подизање трупа са тла за 2 мин, трчање на 3200 м и савладавање пешадијских препрека. Применом статистичких програма обрађени су резултати ове четири варијабле кроз централне и дисперзионе параметре. За утврђивање разлика између група у постигнутим резултатима коришћена је униваријантна анализа варијансе (АНОВА). Мултиваријантном анализом варијансе (МАНОВА) утврђене су разлике у систему варијабли по простору.

Резултати: Анализирајући резултате специфичних моторичких способности кадета по групама после друге године школовања, утврђено је да статистички значајне разлике постоје у варијаблама згибови на вратилу и подизање трупа са тла, док у варијаблама трчање на 3200 м и савладавање пешадијских препрека нема статистички значајних разлика.

Закључак: Вредности резултата кадета у ове четири специфичне моторичке способности очигледно се крећу у границама предвиђеним Упутством и стандардима за оцењивање кадета по годинама, па је утврђено да не постоје већа одступања од предвиђених.

Кључне речи: АНОВА, МАНОВА, физичка оспособљеност, моторне способности, згибови, трбушњаци, полигон пешадијских препрека.

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