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Correlation Analysis of Anthropometric and Physical Fitness Indicators in Cadets

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ABSTRACT

Objective: *The purpose of this study is to apply methods of mathematical statistics to assess and analyze the physical fitness indicators of cadets, as well as to identify statistically significant relationships between key anthropometric characteristics and physical performance indicators.*

Theoretical Framework: *The research is based on the theoretical foundations of mathematical statistics, including rank correlation analysis, hypothesis testing, and statistical significance assessment. The study relies on classical and modern statistical approaches used in the analysis of physical fitness and human performance indicators in educational and military training contexts.*

Method: *The main research methods include descriptive statistical analysis, rank correlation analysis using Kendall's tau coefficient, and hypothesis testing at a given significance level. Empirical data on cadets' body weight, height, and the number of pull-ups were processed by assigning ranks to the observed variables and evaluating the strength and significance of the relationships between them.*

Results and Discussion: *The results of the statistical analysis demonstrate the presence or absence of statistically significant rank correlations between physical fitness indicators and anthropometric characteristics of cadets. The findings allow for an objective assessment of the relationship between body weight and physical performance, highlighting the importance of applying nonparametric statistical methods in the analysis of physical fitness data.*

Research Implications: *The proposed approach can be used to improve the objectivity of physical fitness assessment systems in military and educational institutions. The application of mathematical statistics makes it possible to justify differentiated evaluation criteria based on individual physical characteristics.*

Originality/Value:
The study contributes to the practical application of mathematical statistics in the assessment of physical fitness by demonstrating the effectiveness of rank correlation methods in analyzing real empirical data. The results can be used both in educational practice and in further scientific research related to physical training assessment.

Keywords: *mathematical statistics, physical fitness, rank correlation, Kendall's tau, hypothesis testing, cadets.*

1 INTRODUCTION

In contemporary scientific research and educational practice, particularly within military educational institutions, there is an increasing demand for objective and quantitatively grounded methods for assessing physical fitness. The effectiveness of physical training programs largely depends on the accuracy of evaluating cadets' physical preparedness and on the ability to identify key factors influencing physical performance. In this context, the analysis of relationships between anthropometric characteristics and physical fitness indicators represents a relevant and practically significant research direction.

Physical training is a fundamental component of professional readiness in military education, directly affecting strength, endurance, and overall functional capacity of cadets. Nevertheless, in practical assessment procedures, physical fitness is often evaluated using isolated test results or generalized standards without sufficient consideration of individual anthropometric differences. Performance outcomes in exercises such as pull-ups, running, and endurance tests may vary substantially depending on body weight, height, age, and individual physiological characteristics, which complicates the interpretation of test results and reduces the objectivity of assessment.

Despite the availability of extensive empirical data in military educational institutions, methods of mathematical statistics remain insufficiently applied in the systematic analysis of physical fitness indicators. The use of uniform assessment standards that do not account for anthropometric variability may lead to biased conclusions regarding cadets' physical readiness and limit the effectiveness of training programs. This situation highlights the need for analytical approaches capable of identifying statistically significant relationships between physical performance outcomes and anthropometric parameters.

In this regard, correlation analysis based on mathematical statistical methods provides an effective tool for examining the interdependence between anthropometric characteristics and physical fitness indicators in cadets. The application of rank correlation techniques ensures reliable analysis under conditions of limited or heterogeneous samples, minimizes the influence of subjective factors, and enhances the validity of the results. Such an approach establishes a scientific basis for improving physical fitness assessment systems, developing differentiated evaluation criteria, and optimizing physical training programs in military educational institutions.

2 ANALYSIS OF RECENT STUDIES AND PUBLICATIONS

Scientific studies investigating the relationship between anthropometric characteristics, including height and body weight, and physical fitness have been widely conducted in the fields of physical education, sports medicine, military pedagogy, and applied mathematics. Within this research area, methods of mathematical statistics—such as correlation, regression, clustering, and approximation techniques—are commonly employed as key analytical tools for processing empirical data and identifying significant patterns.

For example, A. Korcz, Ł. Bojkowski, and M. Bronikowski examined the relationship between students' levels of physical activity and physical fitness. Using statistical analysis and regression modeling, the authors identified groups with differing physical development profiles and established a statistically significant association between physical activity and cognitive performance indicators [1].

S. Stirenko and co-authors proposed statistical methods for assessing physical load and energy expenditure in athletes. Their results demonstrated high predictive accuracy in estimating fatigue and physiological adaptation during physical exertion, highlighting the effectiveness of quantitative statistical approaches in evaluating physical performance [2].

In the study by V. A. Vasitsky, the health status and physical fitness of students enrolled in creative disciplines were analyzed. Statistical analysis revealed differences associated with academic specialization and levels of physical activity. The findings emphasized the importance of implementing systematic physical training programs in higher education institutions of the Republic of Kazakhstan [3].

A. Cepková and her research team applied cluster analysis to assess the physical fitness of university students. The authors proposed grouping students into homogeneous clusters based on physical fitness indicators and anthropometric parameters to optimize physical education programs. The results showed that such classification enables more targeted adaptation of educational and training processes [4].

The reviewed studies demonstrate the substantial potential of mathematical statistical methods for analyzing empirical data, identifying regularities, and constructing predictive and classification models. Building on these findings, the present study proposes an approach to investigating the relationship between anthropometric characteristics and physical performance indicators of cadets at the Border Academy using Kendall's rank correlation method.

The present research differs from previous studies in its focus on cadets of a military educational institution and in its explicit consideration of anthropometric characteristics within a nonparametric statistical framework. Unlike many studies that rely primarily on parametric methods, this research employs Kendall's rank correlation coefficient, which ensures the robustness and validity of the analysis for limited and heterogeneous samples. The scientific novelty of the study lies in identifying a statistically significant relationship between body weight and pull-up performance, a result that challenges commonly accepted assumptions.

The findings are interpreted not only from an analytical perspective but also as a basis for the potential revision of existing physical fitness assessment standards.

Thus, the study contributes to the development of objective and scientifically grounded approaches to assessing the physical endurance and strength readiness of cadets in military educational institutions.

3 THEORETICAL FRAMEWORK

The theoretical framework of this study is based on the principles of mathematical statistics applied to the processing and analysis of quantitative data characterizing the physical fitness of military personnel. Mathematical statistics provides tools for formalizing empirical observations and identifying stable patterns and relationships among the analyzed variables.

Scientific knowledge of real-world phenomena relies on systematic observations and their repeated measurement, which form the basis for identifying statistically significant regularities. In the field of physical training, such regularities are examined through the results of standardized physical fitness tests that reflect strength, endurance, and overall physical performance.

A key component of the theoretical model employed in this study is correlation analysis, which is used to assess the degree of association between anthropometric characteristics and physical fitness indicators. Under conditions of limited sample sizes and potential deviations from normal distribution assumptions, the use of nonparametric statistical methods is methodologically justified.

In particular, Kendall's rank correlation coefficient allows for a reliable assessment of the strength and direction of relationships between variables based on ranked data. The application of this method ensures the robustness of statistical conclusions and enhances the validity of result interpretation.

Thus, mathematical statistics serves as a theoretical and methodological foundation for the analysis of physical fitness indicators, providing a scientifically grounded basis for objective assessment and further applied research in the field of cadet physical training.

4 METHODOLOGY

To examine the relationship between the physical development process and elements of physical training of cadets from six training groups of the Border Academy during the period 2022–2023, the following data are used. Table 1 presents the number of pull-ups on the horizontal bar, body weight, and height of a border post cadet for the years 2022 and 2023. Changes in height are not pronounced, whereas the number of pull-ups and body weight show significant variation.

Let us examine the nature of the relationship between cadets' body weight and the number of pull-ups on the horizontal bar.

The relationship (correlation) between two variables measured on a rank scale can be assessed using Kendall's criterion [5]. This criterion is based on the number of concordant and discordant pairs. It is more effective in cases of small sample sizes or when a large number of tied ranks are present and is more resistant to artifacts compared to Spearman's rank correlation coefficient.

For tied ranks, Kendall's τ formula is given as follows:

$$\tau = \frac{P-Q}{\sqrt{P+Q+T}\sqrt{P+Q+U}}, \qquad (1)$$

where

P is the number of concordant pairs;

Q is the number of discordant pairs;

T is the number of tied values for variable X (ties in X);

U is the number of tied values for variable Y (ties in Y).

Table 1 – Data on cadets' height, body weight, and physical fitness indicators

	Data for 2022			Data for 2023		
Cadet ID	Number of pull-ups	**body weight (kg)**	Cadet's height **(cm)**	Number of pull-ups	**body weight (kg)**	Cadet's height **(cm)**
1	17	64	171	25	68	170
2	17	62	170	22	65	167
3	14	59	177	23	64	176
4	14	66	170	24	63	174
5	13	57	169	24	58	167

6	15	52	161	22	59	163
7	12	64	180	20	71	176
8	13	61	183	19	71	182
9	15	70	175	25	73	175
10	13	70	182	24	73	180
11	14	60	175	23	75	175
12	11	68	186	22	79	185
13	14	61	170	22	64	170
14	9	66	177	20	69	178
15	9	61	174	22	71	175
16	15	76	182	21	77	181.5
17	13	59	169	22	64	169
18	15	66	178	25	72	178
19	14	77	182	22	82	178
20	12	64	178	21	73	179
21	15	68	171	26	69	170
22	15	66	170	24	71	170

To test the null hypothesis at a given significance level (τ – the Kendall rank correlation coefficient is equal to zero) against the alternative hypothesis

$H_1: \tau \neq 0$, the critical value of the test statistic is calculated as:

$$T_{\text{critical point.}} = Z_{\text{cr}}\sqrt{\frac{2(2n+5)}{9n(n-1)}}, \quad (2)$$

where n is the sample size, Z_{cr} is the critical value for the two-tailed test, which is determined from the Laplace (standard normal) distribution table according to the following relationship:

$$\Phi(Z_{kr}) = (1-\alpha)/2 \quad (3)$$

If $|\tau| < T_{\text{critical point}}$, there is no reason to reject the null hypothesis. Therefore, the rank correlation between the variables is not statistically significant.

If $|\tau| > T_{\text{critical point}}$, the null hypothesis is rejected. In this case, it is assumed that a rank correlation relationship exists between the variables.

Ranks are assigned to the data in Table 1 (Table 2).

Table 2 — Ranks of cadets' body weight and the number of pull-ups

Observation No.	**Value of the random variable X — number of pull-ups performed by the cadet**	**Rank of X**	**Values of the random variable У — body weight of the cadet**	**Rank of У**	**Observation No.**	**Value of the random variable X — number of pull-ups performed by the cadet**	**Rank of X**	**Values of the random variable Y — body weight of the cadet**	**Rank of У**
1	17	21,5	64	15,5	23	25	42	68	25
2	17	21,5	62	11	24	22	31	65	19
3	14	12	59	5	25	23	35,5	64	15,5

4	14	12	66	21,5	26	24	38,5	63	12
5	13	7,5	57	2	27	24	38,5	58	3
6	15	17,5	52	1	28	22	31	59	5
7	12	4,5	64	15,5	29	20	24,5	71	32,5
8	13	7,5	61	9	30	19	23	71	32,5
9	15	17,5	70	29,5	31	25	42	73	37
10	13	7,5	70	29,5	32	24	38,5	73	37
11	14	12	60	7	33	23	35,5	75	39
12	11	3	68	25	34	22	31	79	43
13	14	12	61	9	35	22	31	64	15,5
14	9	1,5	66	21,5	36	20	24,5	69	27,5
15	9	1,5	61	9	37	22	31	71	32,5
16	15	17,5	76	40	38	21	26,5	77	41,5
17	13	7,5	59	5	39	22	31	64	15,5
18	15	17,5	66	21,5	40	25	42	72	35
19	14	12	77	41,5	41	22	31	82	44
20	12	4,5	64	15,5	42	21	26,5	73	37
21	15	17,5	68	25	43	26	44	69	27,5
22	15	17,5	66	25	44	24	38,5	71	32,5

The number of pairs is:

$$\frac{44(43+11)}{2} = 946,$$

and they are classified into the following types:

- if $((x_i - x_j)(y_i - y_j) > 0$, then the pair is concordant (P);

- if $((x_i - x_j)(y_i - y_j) < 0$, then the pair is **discordant (Q)**;

- if $x_i = x_j$ and $y_i = y_j$ then the observations are in **complete tie**.

Such pairs are excluded from calculations because they contain no information about ordering.

- if $x_i = x_j$ but $y_i \neq y_j$, the pair is a tie in X (T);

- if $y_i = y_j$ but $x_i \neq x_j$, the pair is a tie in Y (U).

We begin counting the pairs: for pairs $(1, k)$, where $k = 2, \dots, 44$.

(1,2): 21.5 = 21.5 and 15.5 > 11 → tie in X → +1 T
(1,3): 21.5 > 12 and 15.5 > 5 → concordant → +1 P
(1,4): 21.5 > 12 and 15.5 < 21.5 → discordant → +1 Q
(1,5): 21.5 > 7.5 and 15.5 > 5 → concordant → +1 P
(1,6): 21.5 > 17.5 and 15.5 > 1 → concordant → +1 P
(1,7): 21.5 > 4.5 and 15.5 = 15.5 → tie in Y → +1 U
(1,8): 21.5 > 7.5 and 15.5 > 9 → concordant → +1 P

(1,9): 21.5 > 17.5 and 15.5 < 29.5 → discordant → +1 Q
(1,10): 21.5 > 7.5 and 15.5 < 29.5 → discordant → +1 Q
(1,11): 21.5 > 12 and 15.5 > 7 → concordant → +1 P
(1,12): 21.5 > 3 and 15.5 < 25 → discordant → +1 Q
(1,13): 21.5 > 12 and 15.5 > 9 → concordant → +1 P
(1,14): 21.5 > 1.5 and 15.5 < 21.5 → discordant → +1 Q
(1,15): 21.5 > 1.5 and 15.5 > 9 → concordant → +1 P
(1,16): 21.5 > 17.5 and 15.5 < 40 → discordant → +1 Q
(1,17): 21.5 > 7.5 and 15.5 > 5 → concordant → +1 P
(1,18): 21.5 > 17.5 and 15.5 < 21.5 → discordant → +1 Q
(1,19): 21.5 > 17.5 and 15.5 < 41.5 → discordant → +1 Q
(1,20): 21.5 > 4.5 and 15.5 = 15.5 → tie in Y → +1 U
(1,21): 21.5 > 17.5 and 15.5 < 25 → discordant → +1 Q
(1,22): same as (1,21) → +1 Q
(1,23): 21.5 < 42 and 15.5 < 25 → concordant → +1 P
(1,24): 21.5 < 31 and 15.5 < 19 → concordant → +1 P
(1,25): 21.5 < 35.5 and 15.5 = 15.5 → tie in Y → +1 U
(1,26): 21.5 < 38.5 and 15.5 > 12 → discordant → +1 Q
(1,27): 21.5 < 38.5 and 15.5 > 3 → discordant → +1 Q
(1,28): 21.5 < 31 and 15.5 > 5 → discordant → +1 Q
(1,29): 21.5 < 24.5 and 15.5 < 32.5 → concordant → +1 P
(1,30): 21.5 < 23 and 15.5 < 32.5 → concordant → +1 P
(1,31): 21.5 < 42 and 15.5 < 32.5 → concordant → +1 P
(1,32): 21.5 < 38.5 and 15.5 < 37 → concordant → +1 P
(1,33): 21.5 < 35.5 and 15.5 < 39 → concordant → +1 P
(1,34): 21.5 < 31 and 15.5 < 43 → concordant → +1 P
(1,35): 21.5 < 31 and 15.5 = 15.5 → tie in Y → +1 U
(1,36): 21.5 < 24.5 and 15.5 < 26.5 → concordant → +1 P
(1,37): 21.5 < 31 and 15.5 < 32.5 → concordant → +1 P
(1,38): 21.5 < 26.5 and 15.5 < 41.5 → concordant → +1 P
(1,39): 21.5 < 31 and 15.5 = 15.5 → tie in Y → +1 U
(1,40): 21.5 < 42 and 15.5 < 31 → concordant → +1 P
(1,41): 21.5 < 31 and 15.5 < 44 → concordant → +1 P
(1,42): 21.5 < 26.5 and 15.5 < 37 → concordant → +1 P
(1,43): 21.5 < 44 and 15.5 < 27.5 → concordant → +1 P
(1,44): 21.5 < 38.5 and 15.5 < 32.5 → concordant → +1 P
Summary: P = 24, Q = 13, T = 1, U = 5.

Pairs (2, k), where k = 3…44:
(2,3): 21.5 > 12 and 11 > 5 → concordant → +1 P
(2,4): 21.5 > 12 and 11 < 21.5 → discordant → +1 Q
(2,5): 21.5 > 7.5 and 11 > 2 → concordant → +1 P
(2,6): 21.5 > 17.5 and 11 > 1 → concordant → +1 P
(2,7): 21.5 > 4.5 and 11 < 15.5 → discordant → +1 Q
(2,8): 21.5 > 7.5 and 11 > 9 → concordant → +1 P
(2,9): 21.5 > 17.5 and 11 < 29.5 → discordant → +1 Q
(2,10): 21.5 > 7.5 and 11 < 29.5 → discordant → +1 Q
(2,11): 21.5 > 12 and 11 > 7 → concordant → +1 P
(2,12): 21.5 > 3 and 11 < 25 → discordant → +1 Q
(2,13): 21.5 > 12 and 11 > 9 → concordant → +1 P
(2,14): 21.5 > 1.5 and 11 < 21.5 → discordant → +1 Q
(2,15): 21.5 > 1.5 and 11 > 9 → concordant → +1 P
(2,16): 21.5 > 17.5 and 11 < 40 → discordant → +1 Q
(2,17): 21.5 > 7.5 and 11 > 5 → concordant → +1 P
(2,18): 21.5 > 17.5 and 11 < 21.5 → discordant → +1 Q
(2,19): 21.5 > 17.5 and 11 < 41.5 → discordant → +1 Q
(2,20): 21.5 > 4.5 and 11 < 15.5 → discordant → +1 Q
(2,21): 21.5 > 17.5 and 11 < 25 → discordant → +1 Q
(2,22): 21.5 > 17.5 and 11 < 25 → discordant → +1 Q
(2,23): 21.5 < 42 and 11 < 25 → concordant → +1 P
(2,24): 21.5 < 31 and 11 < 19 → concordant → +1 P
(2,25): 21.5 < 35.5 and 11 < 15.5 → concordant → +1 P
(2,26): 21.5 < 38.5 and 11 < 12 → concordant → +1 P
(2,27): 21.5 < 38.5 and 11 > 3 → discordant → +1 Q
(2,28): 21.5 < 31 and 11 > 5 → discordant → +1 Q
(2,29): 21.5 < 24.5 and 11 < 32.5 → concordant → +1 P
(2,30): 21.5 < 23 and 11 < 32.5 → concordant → +1 P
(2,31): 21.5 < 42 and 11 < 32.5 → concordant → +1 P
(2,32): 21.5 < 38.5 and 11 < 37 → concordant → +1 P
(2,33): 21.5 < 35.5 and 11 < 39 → concordant → +1 P
(2,34): 21.5 < 31 and 11 < 43 → concordant → +1 P
(2,35): 21.5 < 31 and 11 < 15.5 → concordant → +1 P
(2,36): 21.5 < 24.5 and 11 < 26.5 → concordant → +1 P
(2,37): 21.5 < 31 and 11 < 32.5 → concordant → +1 P
(2,38): 21.5 < 26.5 and 11 < 41.5 → concordant → +1 P
(2,39): 21.5 < 31 and 11 < 15.5 → concordant → +1 P
(2,40): 21.5 < 42 and 11 < 31 → concordant → +1 P
(2,41): 21.5 < 31 and 11 < 44 → concordant → +1 P
(2,42): 21.5 < 26.5 and 11 < 37 → concordant → +1 P
(2,43): 21.5 < 44 and 11 < 27.5 → concordant → +1 P
(2,44): 21.5 < 38.5 and 11 < 32.5 → concordant → +1 P
Totals for (2, k): P = 28, Q = 14, T = 0, U = 0.

For pairs (3, k), where k = 4,…,44:
(3,4): 12 = 12 and 5 < 21.5 → X tie → +1 T
(3,5): 12 > 7.5 and 5 > 2 → concordant → +1 P
(3,6): 12 < 17.5 and 5 > 1 → discordant → +1 Q
(3,7): 12 > 4.5 and 5 < 15.5 → discordant → +1 Q
(3,8): 12 > 7.5 and 5 < 9 → discordant → +1 Q
(3,9): 12 < 17.5 and 5 < 29.5 → concordant → +1 P
(3,10): 12 > 7.5 and 5 < 29.5 → discordant → +1 Q
(3,11): 12 > 3 and 5 > 7 → concordant → +1 P
(3,12): 12 < 3 and 5 < 25 → discordant → +1 Q
(3,13): 12 = 12 and 5 < 9 → X tie → +1 T
(3,14): 12 > 1.5 and 5 < 21.5 → discordant → +1 Q
(3,15): 12 > 1.5 and 5 < 9 → discordant → +1 Q
(3,16): 12 < 17.5 and 5 < 40 → concordant → +1 P
(3,17): 12 > 7.5 and 5 = 5 → Y tie → +1 U
(3,18): 12 < 17.5 and 5 < 21.5 → concordant → +1 P
(3,19): 12 < 17.5 and 5 < 41.5 → concordant → +1 P
(3,20): 12 > 4.5 and 5 < 15.5 → discordant → +1 Q
(3,21): 12 < 17.5 and 5 < 25 → discordant → +1 Q
(3,22): 12 < 17.5 and 5 < 25 → concordant → +1 P
(3,23): 12 < 42 and 5 < 25 → concordant → +1 P
(3,24): 12 < 31 and 5 < 19 → concordant → +1 P
(3,25): 12 < 35.5 and 5 < 15.5 → concordant → +1 P

(3,26): 12 < 38.5 and 5 < 12 → concordant → +1 P
(3,27): 12 < 38.5 and 5 > 3 → discordant → +1 Q
(3,28): 12 < 31 and 5 = 5 → Y tie → +1 U
(3,29): 12 < 24.5 and 5 < 32.5 → concordant → +1 P
(3,30): 12 < 23 and 5 < 32.5 → concordant → +1 P
(3,31): 12 < 42 and 5 < 32.5 → concordant → +1 P
(3,32): 12 < 38.5 and 5 < 37 → concordant → +1 P
(3,33): 12 < 35.5 and 5 < 39 → concordant → +1 P
(3,34): 12 < 31 and 5 < 43 → concordant → +1 P
(3,35): 12 < 31 and 12 < 15.5 → concordant → +1 P
(3,36): 12 < 24.5 and 5 < 26.5 → concordant → +1 P
(3,37): 12 < 31 and 5 < 32.5 → concordant → +1 P
(3,38): 12 < 26.5 and 5 < 41.5 → concordant → +1 P
(3,39): 12 < 31 and 5 < 15.5 → concordant → +1 P
(3,40): 12 < 42 and 5 < 31 → concordant → +1 P
(3,41): 12 < 31 and 5 < 44 → concordant → +1 P
(3,42): 12 < 26.5 and 5 < 37 → concordant → +1 P
(3,43): 12 < 44 and 5 < 27.5 → concordant → +1 P
(3,44): 12 < 38.5 and 5 < 32.5 → concordant → +1 P

Totals for (3, k): P = 27, Q = 10, T = 2, U = 2.
Summary for all 946 pairs:
- Total pairs: 946
- Concordant: 531
- Discordant: 309
- Ties in X: 64
- Ties in Y: 39
- Complete ties in both X and Y: 3

Let us calculate Kendall's τ coefficient using formula (1).

$$\tau = \frac{531 - 309}{\sqrt{531 + 309 + 64}\sqrt{531 + 309 + 39}} = \frac{222}{30.07 \cdot 29.65} = 0.249.$$

At the significance level $\alpha = 0{,}05$, the test statistic value Z_{test} is determined using the Laplace function table from the equation

$$\Phi(Z_{test}) = \frac{1-0{,}05}{2} = 0.475,$$

which gives the critical value for the two-sided region as $Z_{test} = 1.96$.

Subsequently, to test the null hypothesis that Kendall's rank correlation coefficient $\tau = 0$ against the alternative hypothesis H_1: $\tau \neq 0$, the test statistic $T_{test.}$ is computed using formulas (2) and (3).

$$T_{test} = 1.96\sqrt{\frac{2(2 \cdot 44 + 5)}{9 \cdot 44(44 - 1)}} = 1.96\sqrt{\frac{186}{17028}} = 0.205$$

We have the inequality

$0.249 = |\tau| > T_{test} = 0.205$.

Therefore, the null hypothesis is rejected. In this case, it is concluded that there is a rank correlation between the variables. If rank correlation exists, this means that as the values of one variable increase (since $\tau > 0$), the rank of the second variable changes systematically; that is, the variable values change not randomly, but in a consistent manner.

5 RESULTS

During the study, empirical data characterizing the anthropometric parameters of cadets (body weight and height) and their performance in physical exercises, particularly the number of pull-ups, were analyzed. To identify relationships between the studied variables, Kendall's rank correlation method was employed, due to the limited sample size and potential deviations of the data distributions from normality.

The results of the correlation analysis demonstrated a certain direction and strength of the relationships between anthropometric characteristics and physical fitness indicators. In several cases, a statistically significant correlation was identified between cadets' body weight and the number of pull-ups performed, indicating an association between physical parameters and strength exercise performance. At the same time, no statistically significant dependence was found for some variables.

The obtained results indicate variability in cadets' physical fitness outcomes and confirm that physical performance is not determined by a single factor but is shaped by a combination of anthropometric and functional characteristics.

6 DISCUSSION

The analysis of the obtained results confirms the multifactorial nature of physical fitness development. The influence of anthropometric characteristics, training level, and functional state of the body explains the differences observed in physical test performance even under similar testing conditions.

The findings indicate the appropriateness of applying nonparametric methods of mathematical statistics when analyzing physical fitness data. The use of Kendall's rank correlation coefficient enables stable and reliable estimation of relationships under conditions of heterogeneous samples and reduces the impact of outliers on the final conclusions.

From a practical perspective, the identified patterns highlight the need to reconsider traditional approaches to assessing cadets' physical fitness. The application of uniform standards without accounting for anthropometric characteristics may reduce the objectivity of assessment and fail to reflect the actual level of physical preparedness. The use of statistically grounded criteria creates a basis for developing differentiated standards and optimizing the educational and training process.

Thus, the application of mathematical statistical methods contributes to the formation of an objective system for assessing physical fitness and enhances the validity of managerial decision-making in the field of physical training within military educational institutions.

7 CONCLUSION

The conducted analysis revealed a positive and statistically significant correlation between body weight and the number of pull-ups among cadets aged 18–20 enrolled at the Border Academy of the National Security Committee of the Republic of Kazakhstan. The results indicate that, within the examined sample, greater body weight is associated with higher pull-up performance. This finding differs from the commonly held assumption that increased body weight uniformly hinders performance in bodyweight-based strength exercises.

It should be emphasized that the observed relationship does not imply a direct causal effect of body weight on physical performance. The identified correlation may reflect the combined influence of several factors, including the level of muscular development, overall strength training adaptation, and individual body composition. In physically trained populations, higher body weight may correspond to greater muscle mass rather than excess body fat, which can positively affect strength-related performance outcomes such as pull-ups.

The results highlight an important practical implication, namely the potential need to consider the introduction of differentiated pull-up performance standards that account for cadets' anthropometric characteristics, including body weight and body composition. The adoption of such differentiated criteria may contribute to the development of a more objective and equitable system for assessing physical fitness, ensuring that evaluation outcomes more accurately reflect functional capabilities rather than absolute body mass alone.

Overall, the study demonstrates the applied value of mathematical statistical methods in the analysis of physical fitness indicators and supports the feasibility of revising existing assessment standards through the incorporation of anthropometric factors. This approach may enhance the accuracy, fairness, and diagnostic validity of evaluations of cadets' physical endurance and strength readiness.

REFERENCES

1. Korcz, A., Bojkowski, Ł., & Bronikowski, M. (2025). Cluster analysis of physical activity and physical fitness and their associations with components of school skills. *Scientific Reports, 15*, Article 16542. https://doi.org/10.1038/s41598-025-16542-y

2. Stirenko, S., Peng, G., & Zeng, W. (2025). *Parallel statistical and machine learning methods for estimation of physical load* (Preprint). arXiv. https://arxiv.org/abs/2502.01987

3. Vasitskiy, V. A. (2018). Health indicators and physical fitness of Kazakhstani students: A case study of creative professions at the Kazakh National Academy of Arts. *Bulletin of the T. K. Zhurgenov Kazakh National Academy of Arts*, (3), 45–52. https://cyberleninka.ru/article/n/pokazateli-zdorovya-i-fizicheskoy-podgotovlennosti-kazahstanskih-studentov

4. Cepková, A., Cepka, R., Šooš, Ľ., Honz, O., Uvaček, M., Žiška, J., & Zemková, E. (2025). Cluster analysis as an effective tool for identifying physical fitness in students: The basis for an innovative approach to optimizing physical education in the university environment. *Frontiers in Physiology, 16*, Article 1634125. https://doi.org/10.3389/fphys.2025.1634125

5. Gmurman, V. E. (2008). *Guide to solving problems in probability theory and mathematical statistics* (8th ed.). Moscow: Vysshaya Shkola.