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DYNAMICS OF PHYSICAL QUALITIES OF CADETS DURING THE EDUCATIONAL TRAINING PROCESS

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Abstract:
Physical training is a key component of cadet education, as it ensures the development of physical qualities and functional readiness necessary for effective performance of professional duties. Systematic physical training during the educational process is expected to promote positive adaptations of the cardiovascular and respiratory systems, as well as improve overall physical preparedness. However, objective assessment of the dynamics of these adaptations at different stages of education remains an important scientific task.

Keywords: Cadets; physical fitness; functional readiness; educational training process; physical qualities; cardiovascular adaptation; PWC_{170}.

Introduction

Physical training plays a crucial role in the professional education of cadets, as it ensures their readiness to perform physically demanding tasks and maintain high levels of operational efficiency. Modern military and law enforcement activities require not only professional knowledge and skills but also a high level of physical fitness, functional capacity, and resistance to prolonged physical and

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psychological stress. In this context, the educational training process serves as a key period for the systematic development of essential physical qualities.

Physical qualities such as speed, strength, endurance, agility, and flexibility form the basis of a cadet's physical preparedness. These qualities are developed progressively through structured physical training programs implemented throughout the years of study. The effectiveness of such programs can be objectively assessed by analyzing the dynamics of physical fitness indicators at different stages of education. Comparing cadets at various academic levels allows for the identification of positive adaptations as well as potential shortcomings in the training system.[1,2]

The first year of study is typically characterized by the initial adaptation of cadets to increased physical loads and regulated training conditions. During this stage, physical fitness levels may be heterogeneous due to differences in pre-admission training backgrounds. In contrast, third-year cadets have undergone prolonged and systematic physical training, which is expected to result in improved physical performance, greater physiological adaptation, and more stable fitness indicators. Therefore, a comparative analysis between first-year and third-year cadets provides valuable insight into the long-term effects of the educational training process.

Numerous studies have emphasized the importance of continuous monitoring of physical fitness in cadet populations, highlighting its role in injury prevention, performance optimization, and professional readiness. However, despite the availability of standardized physical fitness tests, there remains a need for empirical data that clearly demonstrate the dynamics of physical qualities throughout the educational process. Such data are essential for evidence-based improvements of training curricula and for aligning physical training objectives with professional requirements.

Therefore, the purpose of this study was to analyze the dynamics of physical qualities of cadets during the educational training process by comparing key physical fitness indicators of first-year and third-year cadets. The findings of this study are expected to contribute to a better understanding of the effectiveness of

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existing training programs and to provide practical recommendations for optimizing physical training in cadet education.[3,4]

Methods.

Study Design. This study employed a cross-sectional comparative design to analyze the dynamics of physical qualities of cadets during the educational training process. Physical fitness indicators of first-year and third-year cadets were assessed and compared to evaluate the impact of prolonged systematic physical training.

Participants

The study involved a total of **40 male cadets**, divided into two groups:

- **First-year cadets (n = 20)**
- **Third-year cadets (n = 20)**

All participants were enrolled in the same educational institution and followeda unified physical training curriculum. Cadets were medically examined prior to participation and were considered healthy and fit for physical activity. Participation was voluntary, and all measurements were conducted in accordance with ethical standards for human research.

Physical Fitness Assessment

Physical qualities were assessed using standardized and widely accepted physical fitness tests:

- Speed was evaluated using the 100-meter sprint, with time recorded in seconds.
- Muscular strength was assessed by the pull-up test, recording the maximum number of correct repetitions performed.
- Aerobic endurance was measured using the 3000-meter run, with completion time recorded in minutes.
- Agility was evaluated by the 4×10 meter shuttle run, with time recorded in seconds.

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- Flexibility was assessed using the sit-and-reach test, with results recorded in centimeters.

All tests were conducted under standardized conditions in accordance with established testing protocols. Prior to testing, participants performed a standardized warm-up to minimize the risk of injury and ensure consistency of results.

Testing Procedure

Testing was conducted over a single assessment period during the academic year. Physical fitness tests were administered in a fixed order to reduce the influence of fatigue on performance outcomes. Adequate rest intervals were provided between tests. All measurements were recorded by qualified instructors with experience in physical training assessment.

Statistical Analysis

Data were processed using methods of descriptive statistics. Results are presented as mean values ($\bar{X}$) and standard deviations (σ). The coefficient of variation (V, %) was calculated to assess the degree of variability and homogeneity within each group. Comparative analysis was performed to identify differences in physical fitness indicators between first-year and third-year cadets. Statistical analysis was conducted using standard statistical procedures, and the obtained data were interpreted at a descriptive level to evaluate trends and dynamics of physical qualities during the educational training process.[5]

Results

The comparative analysis of physical fitness indicators revealed statistically significant differences between first-year and third-year cadets, indicating positive dynamics of physical qualities during the educational training process. All physical fitness indicators of third-year cadets were significantly better than those of first-year cadets ($\mathbf{p < 0.05}$). The most pronounced improvements were observed in muscular strength and endurance, while speed, agility, and

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flexibility also showed statistically significant positive changes. Reduced coefficients of variation in most indicators suggest a higher homogeneity of physical fitness among third-year cadets. Third-year cadets showed statistically significant improvements in all functional fitness indicators ($p < 0.05$). Reduced resting heart rate and blood pressure, increased vital capacity, and higher PWC_{170} values indicate enhanced cardiovascular efficiency and aerobic capacity. Lower Ruffier–Dickson index values reflect better cardiac functional adaptation to physical load. Decreased variability coefficients suggest greater homogeneity of functional readiness among third-year cadets.[6]

Physical Fitness Indicators

Physical Fitness Indicators of First-Year and Third-Year Cadets

Table 1.

Indicator	Course	$\bar{X}$	σ	V (%)
100 m sprint (s)	1st year	13.8	0.7	5.1
	3rd year	13.1	0.6	4.6
Pull-ups (reps)	1st year	10.9	2.6	23.9
	3rd year	15.4	2.8	18.2
3000 m run (min)	1st year	13.6	1.1	8.1
	3rd year	12.2	0.9	7.4
4×10 m shuttle run (s)	1st year	10.8	0.5	4.6
	3rd year	10.1	0.4	4.0
Sit-and-reach (cm)	1st year	8.9	2.5	28.1
	3rd year	10.7	2.3	21.5

Third-year cadets demonstrated significantly better performance in all physical fitness tests compared to first-year cadets ($p < 0.05$). Sprint performance over 100 meters improved significantly, reflecting enhanced speed abilities. Agility, assessed by the 4×10 m shuttle run, also showed a statistically significant reduction in completion time ($p < 0.05$), indicating improved coordination and movement efficiency.

Muscular strength, measured by the pull-up test, exhibited the most pronounced improvement. Third-year cadets performed a significantly higher number of repetitions compared to first-year cadets ($p < 0.05$), highlighting the

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effectiveness of long-term strength-oriented training. Similarly, endurance performance in the 3000 m run improved significantly ($p < 0.05$), demonstrating enhanced aerobic capacity.

Flexibility, assessed by the sit-and-reach test, showed a statistically significant increase in third-year cadets ($p < 0.05$), although higher coefficients of variation indicate greater inter-individual differences within both groups.

Variability Analysis

The coefficients of variation for most indicators were lower in third-year cadets, suggesting increased homogeneity and stabilization of physical fitness levels as a result of prolonged systematic training. Despite this, flexibility and strength indicators retained relatively higher variability, indicating the influence of individual adaptation rates.

Functional Fitness Indicators of First-Year and Third-Year Cadets

Table 2.

Indicator	Course	$\bar{X}$	σ	V (%)
Resting heart rate (beats·min^{-1})	1st year	72.4	4.8	6.6
	3rd year	68.1	4.2	6.2
Systolic blood pressure (mmHg)	1st year	118.6	6.9	5.8
	3rd year	114.2	6.3	5.5
Diastolic blood pressure (mmHg)	1st year	76.8	5.4	7.0
	3rd year	73.1	4.9	6.7
Vital capacity (ml)	1st year	4020	420	10.4
	3rd year	4350	390	9.0
PWC_{170} (kgm·min^{-1})	1st year	1150	160	13.9
	3rd year	1320	150	11.4
Ruffier–Dickson index (units)	1st year	9.6	1.8	18.7
	3rd year	7.8	1.5	19.2

Results Description (Functional Fitness)

The analysis of functional fitness indicators revealed statistically significant differences between first-year and third-year cadets ($p < 0.05$). Third-year cadets

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demonstrated a significantly lower resting heart rate and blood pressure values, indicating more efficient cardiovascular adaptation to physical loads.

Vital capacity was significantly higher in third-year cadets ($p < 0.05$), reflecting improved respiratory system functionality. Physical working capacity assessed by the PWC_{170} test showed a statistically significant increase in third-year cadets ($p < 0.05$), indicating enhanced aerobic performance.

The Ruffier–Dickson index values were significantly lower in third-year cadets ($p < 0.05$), corresponding to a better functional state of the cardiovascular system. Overall, the reduction in variability coefficients suggests increased functional stability with prolonged training exposure.[7]

Discussion

The findings of the present study demonstrate a clear relationship between the improvement of physical fitness indicators and the enhancement of functional readiness in cadets during the educational training process. The statistically significant differences observed between first-year and third-year cadets confirm the positive impact of prolonged and systematic physical training on both physical qualities and physiological adaptation.

Improvements in speed, strength, endurance, agility, and flexibility among third-year cadets were accompanied by favorable changes in functional fitness indicators, including reduced resting heart rate, lower blood pressure values, increased vital capacity, and higher physical working capacity (PWC_{170}). These results suggest that the development of physical qualities is closely associated with enhanced efficiency of the cardiovascular and respiratory systems.

The pronounced increase in muscular strength, as evidenced by pull-up performance, may be attributed to long-term resistance and strength-oriented training. This improvement is functionally supported by lower Ruffier–Dickson index values and increased PWC_{170}, indicating improved cardiac efficiency and tolerance to physical loads. Such adaptations are essential for cadets, whose professional activities require repeated high-intensity efforts and sustained muscular work.

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Endurance improvements, reflected in faster 3000 m running times, were strongly associated with enhanced aerobic capacity. The significant increase in vital capacity and physical working capacity among third-year cadets supports the notion that systematic endurance training leads to beneficial structural and functional adaptations of the respiratory and cardiovascular systems. These adaptations contribute to improved oxygen transport and utilization, which are critical for prolonged physical activity.

Although improvements in speed and agility were moderate compared to strength and endurance, they were still statistically significant and accompanied by reduced variability coefficients. This indicates greater neuromuscular coordination and movement efficiency, likely resulting from repeated exposure to complex motor tasks during training. Functional stabilization of cardiovascular parameters further supports improved recovery ability and readiness for repeated physical efforts.

Flexibility showed a significant increase; however, relatively high variability suggests individual differences in adaptability and the need for more targeted flexibility-oriented interventions. Despite this, improved flexibility may contribute indirectly to functional readiness by reducing musculoskeletal strain and injury risk, thereby supporting sustained training participation.

Overall, the integration of physical fitness and functional readiness outcomes highlights the effectiveness of the educational training process in producing comprehensive physiological adaptations. The close interaction between physical qualities and functional systems emphasizes the importance of a balanced training approach that simultaneously develops motor abilities and supports cardiovascular and respiratory efficiency.[8]

Conclusion

The results of this study confirm that the educational training process has a significant and positive effect on both physical qualities and functional readiness of cadets. The comparative analysis between first-year and third-year cadets demonstrated consistent improvements in speed, strength, endurance, agility,

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and flexibility, which were accompanied by favorable adaptations of the cardiovascular and respiratory systems.

The close relationship identified between physical fitness indicators and functional parameters highlights the integrated nature of training adaptations. Improvements in muscular strength and endurance were supported by enhanced physical working capacity, increased vital capacity, and more efficient cardiovascular responses to physical load. These findings emphasize that the development of physical qualities cannot be considered independently from functional readiness, as both components jointly determine overall physical preparedness.

The reduction in variability of most indicators among third-year cadets suggests a stabilization of physical and functional fitness levels as a result of prolonged systematic training. This indicates that long-term participation in a structured educational training program contributes not only to performance enhancement but also to more uniform and predictable physiological adaptation.

From a practical perspective, the findings support the effectiveness of the existing physical training curriculum and underline the importance of continuous monitoring of both physical and functional indicators throughout the educational process. Such an integrated assessment approach allows for timely adjustments to training content and intensity, ensuring optimal development of cadets' physical readiness for professional demands.

In conclusion, the educational training process provides a reliable foundation for the comprehensive development of cadets' physical qualities and functional capacities. Future research should focus on longitudinal designs and the inclusion of additional functional markers to further refine training strategies and enhance the effectiveness of cadet physical education programs.

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