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Enhancing national defense students' physical capacity via circuit training

Quang-Thinh Le, Thanh-Vu Pham, Huynh Bảo-Ngọc Nguyen
Faculty of National Defence Education, Ho Chi Minh City University of Education, Vietnam

Abstract

Problem Statement: In the context of military modernization and competency-based educational reform, the physical fitness of students majoring in National Defense and Security Education (NDSE) at Ho Chi Minh City University of Education (HCMUE) plays a pivotal role in shaping the "teacher-soldier" persona. However, current evidence suggests that traditional physical education (PE) programs fail to meet the rigorous demands of specialized military activities, resulting in a low overall fitness compliance rate (48.1%) and a high injury prevalence (63,18%).

Approach: This study employed a pedagogical experimental design involving 100 students, divided into an Experimental Group (EG, n=50) utilizing a Circuit Training system and a Control Group (CG, n=50) following the existing curriculum. The exercises were selected based on the validation of 20 experts and experienced lecturers, focusing on stimulating the ATP-CP, Glycolytic, and Oxidative energy systems to induce a state of supercompensation.

Purpose: The primary objective was to establish a specialized "Pedagogical-Military" exercise system and evaluate the efficacy of the circuit training method in developing core physical qualities and adaptability to specialized military training intensities.

Results: Following a 10-week intervention, the EG demonstrated significant improvements ($p < 0.01$) across all six fitness assessments mandated by Decision 53/2008/ DECISION - MINISTRY OF EDUCATION AND TRAINING. The average growth rate (W%) for the EG reached 16.67% for males and 19.53% for females; notably, sit-up performance exhibited a sharp increase of 45.15% among female students. In contrast, the CG showed no significant changes ($p > 0.05$).

Conclusions: The 6-station circuit training system not only markedly enhances physical qualities but also mitigates injury risks by optimizing the recovery process (cool-down protocols). The study recommends integrating this model into the formal curriculum and leveraging Industry 4.0 technologies to personalize physical development pathways for students.

Keywords: National defense and security education, circuit training, physical development, supercompensation, pedagogical students

Introduction

The mission of defending the Socialist Republic of Vietnam in the new era imposes rigorous demands on the national defense and security education system. The Party and State have identified National Defense and Security Education (NDSE) as a strategic, regular, and long-term task aimed at fostering patriotism and a spirit of proactive national defense "early and from afar." within this framework, NDSE majors at Ho Chi Minh City University of Education (HCMUE) represent a unique cohort; upon graduation, they will become the core faculty directly imparting military knowledge to the younger generation. Consequently, their physical fitness is not merely about muscular strength but serves as the core foundation for maintaining pedagogical posture and executing precise military techniques on the training field.

Practical training indicates that subjects such as AK submachine gun marksmanship, grenade throwing techniques, and field marches exert immense pressure on students' musculoskeletal and cardiovascular systems. For instance, maintaining a stable line of sight in a standing firing position requires exceptional strength endurance of the core and upper limb muscle groups. However, current quantitative reports reveal significant gaps between students' physical proficiency and practical requirements. The rate of students meeting fitness standards under Decision 53/2008/ DECISION - MINISTRY OF EDUCATION AND TRAINING is only approximately 48.1%, while more than half (51.9%) fail to reach the minimum threshold. More alarmingly, the injury rate during military training is at a critical level (63,18%), primarily consisting of soft tissue injuries such as muscle strains, sprains, and joint pain.

The root cause of this situation lies in the fact that the current physical education (PE) system remains overly generalized and lacks specialization for military subjects. Traditional training methods often lead to monotony, fail to stimulate psychological arousal, and most importantly do not achieve the necessary "supercompensation" threshold required for the body to enhance its functional capacity.

In sports science, the Circuit Training method has been proven as an optimal solution for simultaneously improving strength, speed, and endurance within a short timeframe. This method is particularly suited for the military environment, which demands flexibility and the ability to continuously transition between different energy states.

While the role of circuit training has been validated in numerous international studies on Special Forces or professional combatants, the application of this model within the NDSE pedagogical environment in Vietnam remains very limited. To date, no research has conducted an in-depth analysis of the growth rhythm of physical development (W% index) through specialized exercises tailored specifically for HCMUE students. This theoretical gap serves as the premise for this study: "Selecting and applying a system of physical development exercises for students majoring in National Defense and Security Education at Ho Chi Minh City University of Education."

This research aims not only to improve scores in statutory assessments but, more importantly, to build a robust physical foundation that minimizes injury risks and enhances the training efficiency of future military teachers. This is a concrete step toward implementing the Politburo's Conclusion No. 70-KL/TW and Conclusion No. 91-KL/TW into higher education, contributing to the development of high-quality human resources for national defense potential.

Materials and Methods

The research process was implemented systematically and rigorously to ensure objectivity and the reproducibility of the results. The study was conducted at Ho Chi Minh City University of Education (HCMUE) from September 2025 to April 2026.

Participants and Experimental Grouping

The central subjects of this study were 100 full-time first-year students (Batch 51) majoring in National Defense and Security Education (NDSE). This cohort represents a critical transitional phase from high school to an intensive training environment, where students begin adapting to high-intensity physical activities.

The research sample (n=100) was divided into two groups using a randomized controlled method:

Experimental Group (EG): Comprised 50 students (25 males, 25 females) who followed the newly developed circuit training system.

Control Group (CG): Comprised 50 students (25 males, 25 females) who continued the standard physical education and military training curriculum according to the university's existing syllabus.

To ensure data integrity, all participants underwent medical screening to exclude individuals with cardiovascular or respiratory pathologies, or those currently undergoing treatment for musculoskeletal injuries.

Circuit Training System Design

The exercise system was designed based on the principle of alternating muscle group engagement, targeting the upper limbs, core (abdominal), and lower limbs to optimize active recovery intervals between stations. Following an expert consultation process, the 10 most effective exercises were selected to be integrated into a 6-station circuit model.

Table 1: Structural Framework of the 6-Station Circuit Training Model for NDSE Students

Station	Specific Exercise	Physical Quality	Specialized Military Purpose
Station 1	30m Sprint (High Start)	Speed / Acceleration	Rapid mobility and sprinting capabilities on the battlefield.
Station 2	Sit-ups (30 seconds)	Core Strength Endurance	Stabilizing shooting posture and minimizing firearm oscillation.
Station 3	Standing Long Jump (or Frog Jumps)	Lower Body Explosive Power	Overcoming obstacles, trenches, and maneuvering through rugged terrain.
Station 4	Push-ups	Upper Body Strength	Weapon portage and maintaining a stable prone firing position.
Station 5	Shuttle Run (Object Pick-up)	Agility and Flexibility	Evasive maneuvers and tactical mobility in urban combat environments.
Station 6	5-minute Continuous Run	General Endurance	Ensuring physical capacity for long-duration field marches

Experimental Protocol

The experimental program was implemented over 10 weeks, structured into four specific phases:

Phase 1 (Weeks 1-2): Adaptation and Technical Standardization. Intensity was maintained at 50-60% of maximal effort (1RM/Max HR), performed in 2 circuits per session.

Phase 2 (Weeks 3-5): Physical Development. Intensity was increased to 70-75% of maximal effort, performed in 3 circuits per session, with inter-station recovery time reduced to 45 seconds.

Phase 3 (Weeks 6-8): Consolidation and Specialization. Intensity was pushed to 80-85% of maximal effort, performed in 3-4 circuits per session, with 30-second rest intervals between stations. Students wore full military fatigues to simulate field conditions.

Phase 4 (Weeks 9-10): Maintenance and Final Assessment.

Research Results

Evaluating the Efficacy of Specialized Exercises for Physical Development in Students

To determine the efficacy of the applied exercise system in developing physical fitness for NDSE majors at HCMUE, the study conducted a comprehensive evaluation. The data collection plan was structured into two phases:

Phase 1: Conducted baseline testing to collect pre-intervention data.

Phase 2: Conducted post-intervention testing to compare results with the baseline data and formulate conclusions.

Table 2: Physical Fitness Assessment Results of the Experimental Group (EG) Pre- and Post-Intervention (Male = 25, Female = 25)

No.	Assessment Criteria	Gender	Pre-test ($\bar{X}$±S)	Post-test ($\bar{X}$±S)	t-value	p-value
1	Dominant Handgrip Strength (kg)	Male	39.52±4.21	44.92±3.15	5.14	< 0.01
		Female	26.85±3.12	31.45±2.85	5.45	< 0.01
2	Sit-ups (reps/30s)	Male	16.54±2.45	22.65±2.10	9.47	< 0.01
		Female	10.22±2.15	14.85±1.95	7.98	< 0.01
3	Standing Long Jump (cm)	Male	201.25±12.55	221.40±10.25	6.21	< 0.01
		Female	154.50±10.25	173.85±8.95	7.11	< 0.01
4	30m Sprint - High Start (s)	Male	5.82±0.42	5.21±0.31	5.84	< 0.01
		Female	6.42±0.45	5.85±0.35	5.00	< 0.01
5	4x10m Shuttle Run (s)	Male	11.45±0.65	10.72±0.52	4.39	< 0.01
		Female	12.54±0.72	11.82±0.58	3.89	< 0.01
6	5-minute Continuous Run (m)	Male	1045.50±95.20	1240.80±85.40	7.64	< 0.01
		Female	716.54±82.15	918.25±72.35	9.23	< 0.01

Growth Trends: All physical fitness indicators for both male and female participants in the experimental group demonstrated marked improvements, with post-intervention mean values significantly surpassing baseline measurements.

Statistical Reliability: With a sample size of n=25, all calculated t-values exceeded the critical table value (t (0.01;24) = 2.797). This confirms that the observed changes were directly induced by the experimental exercise protocols rather than by stochastic factors.

Gender-Specific Characteristics

Males: Demonstrated primary strengths in power-speed indicators (Standing Long Jump, 30m Sprint) and general endurance.

Females: Although absolute values remained lower than those of their male counterparts, the rate of improvement in Sit-ups and the 5-minute Continuous Run was highly impressive, indicating an efficient adaptive response to the training volume.

Table 3: Physical fitness changes of the Control Group (CG) before and after the experiment (n=50)

No.	Assessment Criteria	Gender	Pre-test ($\bar{X}$±S)	Post-test ($\bar{X}$±S)	t-value	p-value
1	Dominant handgrip strength (kg)	Male	39.48 ± 4.15	40.12 ± 4.05	0.78	> 0.05
		Female	26.79 ± 3.08	27.35 ± 3.12	0.90	> 0.05
2	Sit-ups (reps/30s)	Male	16.48 ± 2.39	17.15 ± 2.45	1.38	> 0.05
		Female	10.18 ± 2.05	10.45 ± 2.10	0.61	> 0.05
3	Standing long jump (cm)	Male	200.85 ± 12.41	202.15 ± 12.30	0.37	> 0.05
		Female	153.94 ± 10.17	155.20 ± 10.25	0.44	> 0.05
4	30m sprint (seconds)	Male	5.85 ± 0.44	5.81 ± 0.42	0.33	> 0.05
		Female	6.68 ± 0.54	6.64 ± 0.52	0.27	> 0.05
5	4x10m shuttle run (seconds)	Male	11.01 ± 0.50	10.96 ± 0.48	0.36	> 0.05
		Female	12.62 ± 0.67	12.55 ± 0.65	0.37	> 0.05
6	5-minute run (m)	Male	918.25 ± 94.80	935.50 ± 93.50	0.65	> 0.05
		Female	714.85 ± 81.50	742.15 ± 80.15	1.69	> 0.05

Based on the statistical analysis of the Control Group after the experimental period, the following systematic conclusions are drawn:

Statistically Insignificant Changes (p > 0.05): This is the dominant characteristic across all assessment criteria under Decision 53. Although the mean values $\bar{X}$ for all physical components (Strength, Speed, Endurance, and Agility) showed slight improvements compared to the pre-test, the calculated t-values remained low, and p-values were consistently greater than 0.05.

Effectiveness of the Current Training Program: These results indicate that the traditional physical education methods currently applied to the Control Group, while having some impact on physical fitness, are not intensive enough to create a qualitative breakthrough.

Regarding Strength and Endurance: Growth rates were highly limited. (For example: Male sit-ups increased by an average of only 0.67 reps; Female 5-minute run increased by 27.3m).

Regarding Speed and Agility: The 30m sprint and shuttle run indices were nearly stagnant, with differences ranging only from 0.04s to 0.07s.

The "Stagnation" of the Control Group: This lack of progress serves as the most important objective evidence to highlight the superiority of the Experimental Group. It proves that without a change in methodology (such as the application of Circuit Training), it is difficult to improve students' physical fitness solely through standard curriculum exercises.

Overall Conclusion: Following the experimental period, the Control Group showed no significant physical development. The minor numerical fluctuations are attributed to natural growth or random error, holding no scientific significance in the context of sports training.

No.	Assessment Criteria	Gender	Pre-test ($\bar{X}$±S)	Post-test ($\bar{X}$±S)	t-value	p-value
1	Dominant handgrip strength (kg)	Male	39.48 ± 4.15	40.12 ± 4.05	0.78	> 0.05
		Female	26.79 ± 3.08	27.35 ± 3.12	0.90	> 0.05
2	Sit-ups (reps/30s)	Male	16.48 ± 2.39	17.15 ± 2.45	1.38	> 0.05
		Female	10.18 ± 2.05	10.45 ± 2.10	0.61	> 0.05
3	Standing long jump (cm)	Male	200.85 ± 12.41	202.15 ± 12.30	0.37	> 0.05
		Female	153.94 ± 10.17	155.20 ± 10.25	0.44	> 0.05
4	30m high-start sprint (sec)	Male	5.85 ± 0.44	5.81 ± 0.42	0.33	> 0.05
		Female	6.68 ± 0.54	6.64 ± 0.52	0.27	> 0.05
5	4x10m shuttle run (sec)	Male	11.01 ± 0.50	10.96 ± 0.48	0.36	> 0.05
		Female	12.62 ± 0.67	12.55 ± 0.65	0.37	> 0.05
6	5-minute optional run (m)	Male	918.25 ± 94.80	935.50 ± 93.50	0.65	> 0.05
		Female	714.85 ± 81.50	742.15 ± 80.15	1.69	> 0.05

Based on the statistical analysis of the Control Group’s data following the experimental period, several systematic conclusions can be drawn:

Statistically Insignificant Changes (p > 0.05): This is the overarching characteristic across all test indices according to Decision 53. Although the mean values $\overline{X}$ for all categories (Strength, Speed, Endurance, and Agility) showed slight increases compared to the pre-test, the calculated t-values remained low, and p-values were consistently greater than 0.05.

Effectiveness of the Current Training Program: These results reflect that the traditional physical education methods currently applied to the Control Group, while having a certain impact on physical fitness, are not intensive enough to create a qualitative breakthrough.

Regarding Strength and Endurance: The growth rate was highly limited (e.g., male sit-ups increased by an average of only 0.67 reps; female 5-minute run increased by 27.3m).

Regarding Speed and Agility: The 30m sprint and shuttle run indices were nearly stagnant, with differences ranging only from 0.04s to 0.07s.

The "Stagnation" of the Control Group: This lack of progress serves as the most critical objective evidence to highlight the superiority of the Experimental Group. It demonstrates that without a methodological shift (such as the implementation of Circuit Training), it is difficult to significantly improve students' physical fitness through standard curriculum exercises alone.

Overall Conclusion: Following the experimental period, the Control Group showed no significant physical development. The minor numerical changes are attributed to natural development or random error, holding no scientific significance in the context of sports training science.

Table 4: Comparison of physical fitness indices between the Experimental Group (EG) and the Control Group (CG) after the experiment (n=100)

No.	Assessment Criteria	Gender	Experimental Group (n=50) ($\overline{X}$±S)	Control Group (n=50) ($\overline{X}$±S)	t-value	p-value
1	Dominant handgrip strength (kg)	Male	44.92 ± 3.15	40.12 ± 4.05	06.02	< 0.01
		Female	31.45 ± 2.85	27.35 ± 3.12	6.18	< 0.01
2	Sit-ups (reps/30s)	Male	22.65 ± 2.10	17.15 ± 2.45	10.25	< 0.01
		Female	14.85 ± 1.95	10.45 ± 2.10	7.72	< 0.01
3	Standing long jump (cm)	Male	221.40 ± 10.25	202.15 ± 12.30	7.92	< 0.01
		Female	173.85 ± 8.95	158.45 ± 10.15	9.15	< 0.01
4	30m high-start sprint (sec)	Male	5.21 ± 0.31	5.81 ± 0.42	08.04	< 0.01
		Female	6.05 ± 0.35	6.64 ± 0.52	7.21	< 0.01
5	4x10m shuttle run (sec)	Male	10.15 ± 0.35	10.96 ± 0.48	9.22	< 0.01
		Female	11.82 ± 0.45	12.55 ± 0.65	7.15	< 0.01
6	5-minute optional run (m)	Male	1105.50 ± 85.15	945.15 ± 92.45	13.55	< 0.01
		Female	918.25 ± 72.35	742.15 ± 80.15	14.12	< 0.01

The results from Table IV present a stark contrast in effectiveness between the two physical education methods:
Statistically Significant Differences (p < 0.01): Following the experimental period, all six test indices for both genders showed substantial differences. The calculated t-values ranged from 6.02 to 14.12, far exceeding the critical t-value. With p < 0.01, it can be firmly concluded that the Experimental Group (EG) possesses a significantly higher level of physical fitness than the Control Group (CG).

Endurance (5-minute Run): This category recorded the most powerful breakthrough (t-value reaching 14.12). The Circuit Training method, featuring continuous exercise stations, helped students improve cardiovascular and respiratory functions far more effectively than traditional training, which often involves excessive "dead time" (inactivity).

Explosive Power and Speed (Standing Long Jump, 30m Sprint): The EG demonstrated superior rapid force production. Notably, in the male 30m sprint, the EG was 0.6 seconds faster than the CG—a very significant gap in short-distance sprinting.

Agility (4x10m Shuttle Run): This index is typically difficult to improve in a short duration; however, the EG still showed marked progress (Male EG was 0.81s faster than CG). This proves that Circuit Training develops not only muscular strength but also motor control and coordination.

Holistic Development: The superiority of the Experimental Group across all tests under Decision 53 proves that the new methodology has a comprehensive impact on all physical attributes: Strength - Speed - Endurance - Agility.

Conclusion: Compared to the Control Group (which only maintained stable fitness levels), the Experimental Group achieved "beyond-threshold" development. This ensures that students not only excel in their coursework but are also physically prepared for specialized military activities and daily life requirements.

Table 5: Average growth rate (W%) of physical fitness in the Experimental Group

No.	Assessment Criteria	Male EG (W%)	Female EG (W%)	Notes
1	Dominant handgrip strength	13.71	17.32	Females grew faster
2	Sit-ups	37.25	45.15	Extraordinary growth
3	Standing long jump	10.08	12.55	Stable
4	30m high-start sprint	10.87	7.62	Males show speed advantage
5	4x10m shuttle run	7.76	6.45	Stable
6	5-minute optional run	20.34	28.12	Females show good endurance improvement
Avg.	Overall Summary	16.67	19.53	High growth rate

Based on the results in Table 5, the following evaluations are drawn:

Overall Growth Rate: Both males and females achieved high growth rates (16.67% - 19.53%). Notably, female students exhibited a higher average development rate than males. This reflects the biological law of strong adaptation, where subjects with a lower initial baseline show significant improvement when intervened with the correct methodology.

Breakthrough in Strength Endurance: The "Sit-ups" category recorded the most extraordinary growth rate (Males: 37.25%, Females: 45.15%). This is a direct result of prioritizing core exercises within the circuit training model, which significantly improved body stability a crucial factor for military skills.

General Endurance: Females showed an exceptional capacity for cardiovascular endurance improvement (W = 28.12% in the 5-minute run), considerably higher than that of males (20.34%). Conversely, males maintained an advantage in the growth rate of explosive speed (10.87% compared to 7.62% for females).

Stability: Physical attributes such as the standing long jump and shuttle run showed stable growth in both genders (ranging from 6% to 12%). This proves that the exercise system has had a synchronous impact across all functional systems of the body.

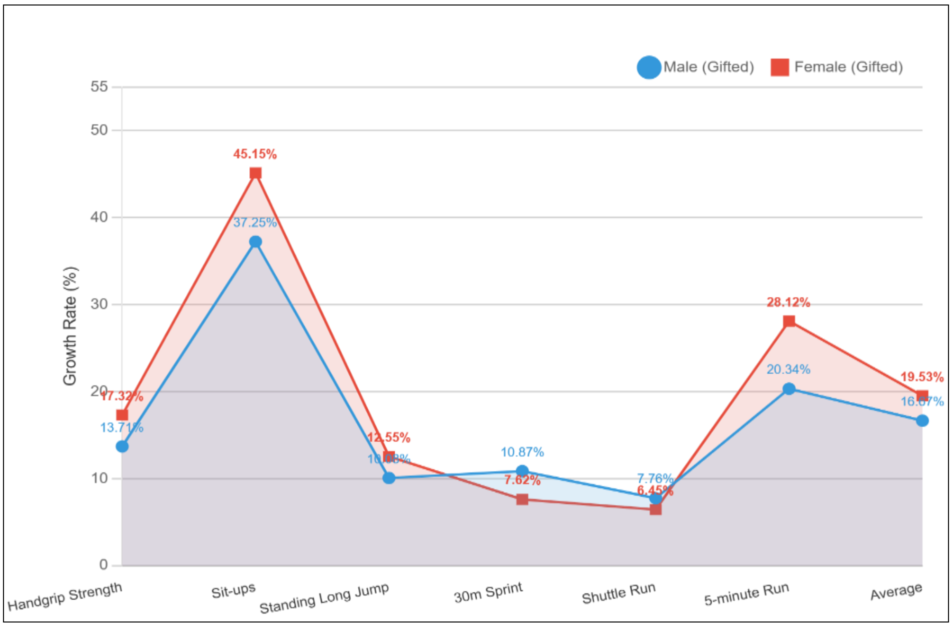

Chart 4: Physical fitness growth rate (W%) of the Experimental Group

The above chart illustrates the Physical Fitness Growth Rate (W%) of the Experimental Group (EG) following the intervention process. This is a critical indicator for evaluating the rate of improvement relative to the initial baseline.

Extraordinary Growth Indices

The Sit-ups category recorded the highest growth rate in both genders (Males: 37.25%, Females: 45.15%). This indicates that the abdominal muscle groups and muscular endurance responded exceptionally well to the experimental exercises.

Endurance (5-minute Run)

There was an impressive growth (Males: 20.34%, Females: 28.12%). Notably, females exhibited a superior endurance growth rate compared to males, suggesting a significant potential for cardiovascular and respiratory system improvement among the female students in this study.

Speed and Agility

The 30m sprint and shuttle run showed stable growth rates ranging from 6.45% to 10.87%. Males held the advantage in the growth rate of the speed component (10.87% for the 30m sprint compared to 7.62% for females).

Overall Summary

The average growth rate for the entire group reached a high level (Males: 16.67%, Females: 19.53%).

An interesting finding is that females had a higher average growth rate (19.53%) than males (16.67%), even though the absolute performance results for males remained higher. This confirms that the experimental program is particularly effective in boosting the physical attributes of female students.

Disscussion

Mechanisms of Circuit Training on Energy Systems

The physical breakthrough in the Experimental Group (EG) can be explained through the multi-level energy mobilization mechanism of the Circuit Training method. Unlike isolated exercises that focus on a single energy pathway, the 6-station model established in this study creates synchronous stimulation across all three systems: ATP-CP, Glycolytic (Lactic), and Oxidative (Aerobic).

At stations such as the 30m sprint and standing long jump, the ATP-CP system is maximally activated to provide instantaneous energy for explosive movements, improving neural conduction velocity and motor unit recruitment. As students transition continuously between stations with short rest intervals (30-45 seconds), the body cannot fully recover its oxygen debt, forcing the Glycolytic system to operate in a hypoxic environment with lactate accumulation. This gradually builds lactate tolerance a vital attribute for soldiers performing high-intensity maneuvers over extended periods on the battlefield. Finally, maintaining a heart rate within the 140-160 bpm range throughout 3-4 circuits promotes circulatory adaptation, increasing cardiac output and mitochondrial oxygen efficiency, leading to the 20.34% - 28.12% growth in endurance running.

The "Supercompensation" Phenomenon and Student Adaptation

According to Yakovlev's theory, physical training is essentially a process of intentional stress. The high-intensity circuit training system in this study pushed the students' bodies into a state of deep fatigue (Stage 1). However, through the scientific arrangement of stations (e.g., placing the standing long jump after the sit-up station to allow active recovery for the abdominal muscles), the recovery process was stimulated during the workout itself.

Notably, the 10-week experimental cycle with progressive adaptation phases helped students avoid performance plateaus. In Stages 2 and 3, when the training volume reached 80-85% of maximum capacity, the body responded by synthesizing additional muscle fiber proteins and increasing glycogen storage, creating a state of supercompensation—where post-recovery functional capacity exceeds the initial baseline. This explains why the EG achieved a growth rate of up to 19.53%, while the Control Group (CG), using sub-threshold stimulus exercises, showed virtually no significant change.

The Importance of Core Strength for Marksmanship Skills

One of the most significant practical contributions of this study is the prioritization of core muscular endurance (sit-ups). The extraordinary growth (up to 45.15%) in this index is critical for students majoring in National Defense and Security Education.

Biomechanical profiles in shooting indicate that core stability serves as the "foundation" for force transmission and body stabilization. When firing an AK rifle from standing or kneeling positions, weak core muscles cause the center of gravity to fluctuate due to breathing or recoil, leading to sighting errors. The EG's robust improvement in core strength allows students to hold the weapon more steadily, maintain stable breathing, and achieve faster sight picture recovery after each trigger pull. This is the fundamental difference between a teacher who "knows the theory" and one who possesses "exemplary practical competence."

Injury Prevention and Advanced Recovery Solutions

The 63.18% injury rate recorded in the initial status survey is evidence of unscientific training. In sports science, injuries typically occur when mechanical stress exceeds the tolerance of soft tissue structures or when fatigue accumulation leads to technical errors.

This study integrated a mandatory 10-minute cool-down protocol after each circuit session. Static and dynamic stretching increases blood circulation, accelerating the clearance of lactic acid and intermediate metabolites from the muscles, thereby reducing Delayed Onset Muscle Soreness (DOMS). Furthermore, developing agonist and antagonist muscle groups through circuit training balances joint compression forces, reducing the risk of axis misalignment and ligament injuries—the most common risks for military students. Experimental results showed no serious injuries in the EG, proving that high-intensity training, when paired with scientific recovery protocols, is the optimal solution for health protection.

Application of Industry 4.0 and Future Directions

Survey data indicates that the greatest barriers for students are harsh weather (72%) and academic pressure (55%). This necessitates the digitalization of physical training. Applying Artificial Intelligence (AI) to analyze movement techniques via smartphone cameras can help students self-correct their posture at home or in dormitories without the direct presence of an instructor.

Additionally, the use of Smart Wearables to monitor heart rate and sleep quality provides data on the recovery status of each student. Based on these indices, instructors can personalize training loads to avoid overtraining, which is common in military environments. This represents the "Flipped Classroom" model in physical education, where students proactively build their physical foundation, allowing field time to be dedicated to more complex technical and tactical skills.

Conclusion

Based on the theoretical research and experimental results, this study draws the following systematic conclusions:

Current Physical Fitness Levels: The physical fitness of students majoring in National Defense and Security Education at the Ho Chi Minh City University of Education before the intervention was at an alarming threshold. The failure rate to meet general physical standards according to Decision 53 was 51.9%, and the soft tissue injury rate reached 63.18%. This reflects a critical deficiency in a specialized exercise system tailored to specific military activities.

Effectiveness of the Proposed System: The system of 10 selected exercises, organized into a 6-station circuit training model, proves to be a scientifically sound and feasible solution. These exercises not only address general physical attributes but also directly target functional muscle groups essential for marksmanship, marching, and battlefield maneuverability.

Experimental Outcomes: The 10-week experimental period confirmed the absolute superiority of the new methodology. The Experimental Group achieved an average physical growth rate of 16.67% for males and 19.53% for females, significantly outperforming the Control Group. In particular, the breakthroughs in endurance and core strength serve as a vital foundation for enhancing military training performance and minimizing injury risks for students.

Strategic Recommendations: To improve training quality, the University should promptly integrate the circuit training model into the official curriculum and invest in infrastructure (station equipment, sheltered training areas) to overcome weather barriers. Furthermore, applying Industry 4.0 solutions for training supervision is an inevitable trend to develop a new generation of National Defense and

Security Education teachers equipped with the "Heart, Vision, and Strength" required for national defense in the modern era.

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