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THE IMPORTANCE OF NEUROMOTOR TRAINING IN MILITARY PENTATHLON. AN ANALYSIS APPLIED TO THE PREPARATION OF THE CISM OBSTACLE COURSE

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ABSTRACT. ***Introduction***: neuromotor training, integrating balance, coordination, agility, and proprioceptive exercises alongside functional training, plays a key role in optimizing performance and preventing injuries in events that involve overcoming fixed obstacles. In military pentathlon, the CISM obstacle course requires an optimal combination of basic motor skills and their effective integration throughout the 20 obstacles. ***Objective:*** this study aimed to evaluate the impact of neuromotor training on obstacle run preparation, focusing on technical performance, movement efficiency, and injury risk reduction. ***Materials and methods***: a 12-week neuromotor training program was implemented during the pre-competition period (march–may) for nationally ranked military athletes. The program included targeted exercises to enhance coordination, balance, agility, and motor control. Performance was assessed through running times, while technical execution and injury incidence were monitored via video and photographic analysis. Equipment used included agility ladders, fit balls, balance boards, small trampolines, plyometric boxes, elastic bands, TRX systems, unstable surfaces (rubber, sand, synthetic turf), smartwatches, and video recording tools. ***Results:*** preliminary analysis showed significant improvements in technical execution, movement economy, and completion times, alongside a reduction in injury frequency among participants. ***Discussion:*** findings indicate that neuromotor training enhances motor control and rapid adaptability in the complex demands of the military obstacle run. Additionally, injury prevention benefits underscore its relevance in military sports preparation. ***Conclusions***: neuromotor training is a valuable complementary method in military pentathlon preparation, improving both performance and physical resilience. Further research with larger samples and varied competitive conditions is needed to validate these results.

Keyword: neuromotor; pentathlon; training; obstacles; military.

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INTRODUCTION

In competitive sports, the neuromotor (or neuromuscular) training method is commonly used. It generally involves combinations of physical exercises with increased mental control that do not necessarily involve sustained physical effort (Chen et al., 2023). The main goal is to improve communication between the brain and muscles to increase confidence, courage, agility, balance, coordination, and muscle strength by forming new synapses in the brain. Proprioception is defined as the body's ability to perceive its position in space and coordinate movements, allowing us to orient and stabilize our body movements without looking at our actions (Qin et al., 2024). It is a trained and developed sense that involves nerve receptors in muscles and tendons that transmit information to the brain, helping to prevent injuries by training balance and reaction speed. Neuromotor training in competitive sports that require overcoming obstacles or maintaining balance over time develops qualities that enable the brain to know exactly what signal to send to the muscles, which in turn can react automatically in situations of imbalance, turning reactions into reflexes, thus increasing the chances of exceptional success while reducing the possibility of injury (Peng et al., 2024). In military pentathlon competitions, the incidence of injuries during training or competitions is high. Starting with 1989, girls actively participate in military pentathlon competitions, thus eliminating gender-based discrimination (Mainenti et al., 2022).

Fig. 1. Aspects from CISM obstacle course training
Sources: the author's personal photo album

The CISM (Council International du Sport Militaries) obstacle course race is part of the military pentathlon competition and is considered the queen of military competitions (Cohal, 2019, pp. 234-239). The competition consists of running a 500-meter course with 20 distinct obstacles. The positioning and complexity of the 20 obstacles, the technique of approaching them, and the ability to maintain a constant running speed give the specificity of the event. The positioning of the obstacles and their difficulty have been designed to optimally test the soldier's speed running qualities and abilities in terms of strength, skill, and endurance, which are also necessary on the battlefield. Through neuromotor training, military athletes develop adequate spatial-temporal abilities, which significantly reduce the risk of injury during obstacle course running. Recent studies show that by increasing the proportion of neuromuscular training in the overall training program, athletic performance increases and, directly proportional to this, courage, self-confidence, and athletic longevity also increase (Akbar, 2022). In the case of the military pentathlon, which is a combined event, the percentages allocated to neuromotor training must take into account the specific multidisciplinary effort and the time allocated for the preparation of the five events. In general, training in the combined military pentathlon event must be customized for the individual athlete and must be optimized taking into account the multidisciplinary training that characterizes them. (Cohal, 2025, pp. 125-133).

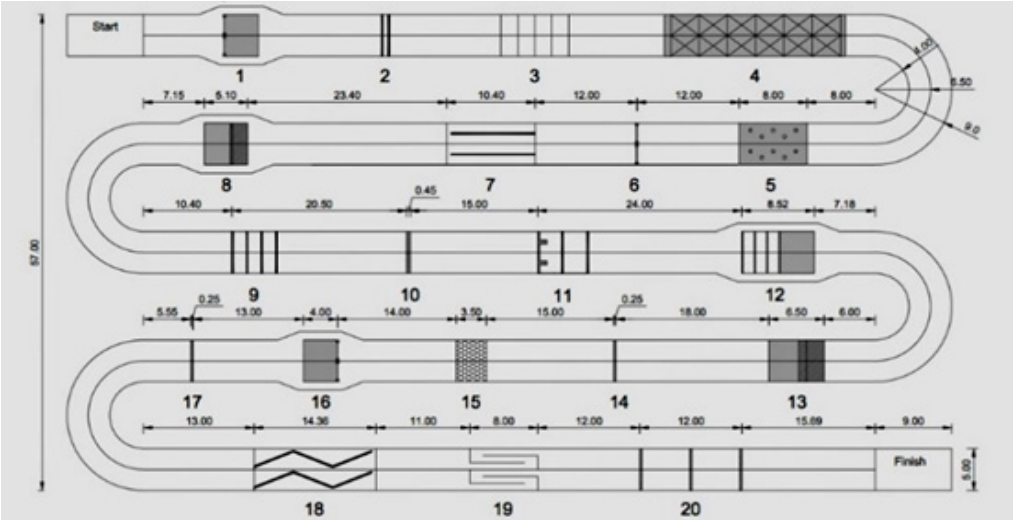

Fig. 2. CISM-type obstacle course diagram

Sources: Military pentathlon competition regulations on https://www.military-pentathlon.info/cms/military-pentathlon/regulations.html p. 32

The fundamental objective of this research is to investigate and compare the effects of neuromotor training on athletic performance in the CISM obstacle course. The study aims to determine the extent to which the integration of this method into the main training plan contributes to reducing the risk of injury, as well as to developing self-confidence and courage, considered direct results of exercises designed to improve agility, balance, coordination, and neuromuscular control.

The analysis of the technique of approaching obstacles during running, as well as how the athlete perceives the intensity of the effort during the test, was the starting point for implementing the neuromuscular training method. The research is based on the premise that performance in military-style obstacle course running is significantly influenced by factors such as proprioception, motivation, courage, and individual effort capacity, alongside the tactical and technical components of competition training (Cohal., 2025).

Therefore, the study aims to provide an applied perspective on the impact of the neuromuscular training method on the physical and psychological behavior of military athletes, while also contributing to the optimization of training strategies in CISM-type events.

Research hypothesis

Regular neuromuscular exercises performed under the direct supervision of specialists improve obstacle-clearing technique over time, leading to better effort and orientation capacity and reducing the incidence of accidents among military pentathletes in the obstacle course event.

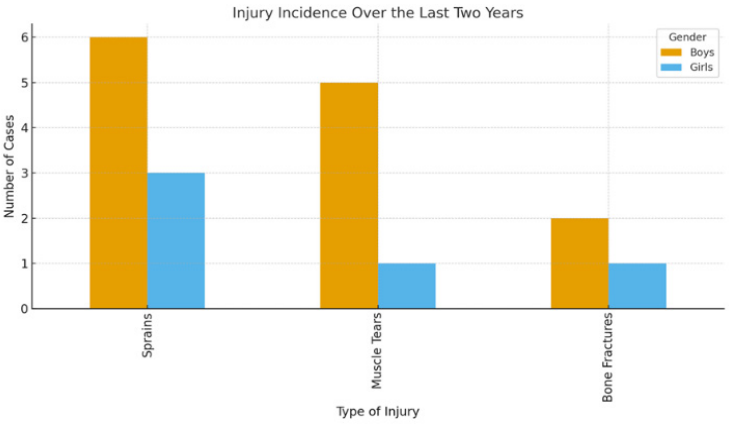

Fig. 3. Graphical interpretation of the incidence of injuries on the CISM-type obstacle course between 2023 and 2024 of athletes from the military pentathlon team.

MATERIAL AND METHODS

In our approach, we used the following research methods: study of specialized literature, observation method, testing and evaluation method, statistical-mathematical and graphical interpretation method.

Study of specialized literature: a structured review of specialized literature was conducted to establish the theoretical framework of the research. Scientific sources indexed in international databases were analyzed, focusing on neuromotor training, integrative neuromuscular training, motor control, agility development, and injury prevention in military and performance sports. The review supported the design and methodological structuring of the 12-week intervention program.

Observation method: systematic direct and video-assisted observation was applied throughout the intervention period. Technical execution during obstacle course simulations was monitored, emphasizing movement coordination, balance control, transition efficiency, and landing mechanics. Video analysis enabled objective identification of technical adaptations and motor pattern optimization.

Testing and evaluation method: performance assessment was conducted through pre- and post-intervention testing under standardized conditions. Obstacle course completion times were recorded using electronic timing devices. Technical execution was evaluated using structured criteria based on biomechanical parameters. Injury incidence was monitored to assess the preventive effects of the training program.

Statistical-mathematical and graphical methods: descriptive statistical indicators (mean, standard deviation, percentage progress) were calculated to quantify performance changes. Comparative analysis between initial and final testing was performed to determine the magnitude of improvement. Graphical representations were used to illustrate performance evolution and injury trends.

The equipment used included agility ladders, fitness balls, balance boards, small trampolines, beams, gymnastics boxes and vaulting horses, plyometric boxes, elastic bands, TRX systems, unstable surfaces (rubber, sand, synthetic turf), Swing Stick flexible bar, smart watches, and video recording devices (Wan, 2025).

Research stages

To achieve the proposed objective, the following research stages were established:

A. Establishing the research sample: 12 military athletes from the extended military pentathlon team in the pre-competition period. Of these, 6 athletes performed specific neuromuscular training (experimental group - Group A) and

6 of them continued their classic training but did not use neuromuscular exercises (control group - Group B). The group homogeneity expressed through the calculation of the standard deviation (SD) is appropriate for conducting the experiment. The average age of the test participants is 23.56 years, with 24.5 years for females and 22.62 years for males. All test participants were informed in advance that the research results would be part of academic research. They took part voluntarily, and the military institution approved the conduct of the study. They also gave their written consent to participate in the research.

B. Development of a neuromotor training plan: the neuromuscular training program included specific exercises to improve coordination, balance, agility, and motor control and was based on a preliminary analysis of the following factors:

- Development of movement coordination skills.
- Increased adaptability.
- Ability to maintain running pace between obstacles.
- Ability to apply obstacle-approach techniques during intense physical effort.

The program was implemented during the pre-competition period between March and May 2025. Until then, the athletes' training plan did not include neuromuscular exercises. The military athletes from the extended national team who participated in the tests have between two and five years of competitive experience as pentathletes. Of these, four are girls and eight are boys, and following the final evaluations, eight were selected, five boys and three girls, to form the representative national team of the army.

The final performance was evaluated by recording the final results of the obstacle course test. Technical execution and injury incidence were monitored through video and photographic analysis. The neuromuscular training program was implemented for athletes in Group A, which was formed based on their results in the initial obstacle course test. Thus, the first six times were combined with the last six, forming two homogeneous groups in terms of results. Neuromuscular training took place in the gym four times a week for 60 minutes, regardless of gender and age. It was individualized and considered all the didactic and pedagogical factors in the training of a combined event such as the military pentathlon.

C. Setting research tasks:

– Evaluating the objectives pursued.
– Enalyzing video and photo sequences.
– Data analysis.

Table 1. Initial testing of CISM-type obstacle course running

Group	Time/Sex						Standard Deviation (SD)
A Experimental Group	2'44''♂	2'49'' ♂	2'51''♂	2'56"♀	2'59" ♂	3'10" ♀	**9.11 sec** (≈ ± 0'09'')
B Control Group	2'47" ♂	2'50" ♂	2'54"♀	2'57" ♂	3'01" ♂	3'13" ♀	**9.27 sec** (≈ ± 0'09'')

Legend: ♂ symbol for male sex, ♀ symbol for female sex

RESULTS

During the 12 weeks of testing, athletes in group A did not suffer any injuries during training on the obstacle course. In contrast, in group B, there were several minor contusions to the lower limbs, and one athlete suffered a broken finger while crossing obstacle number 11.

At the end of the testing period, the athletes in the experimental group showed a higher level of motivation and greater capacity for effort compared to those in the control group. Analysis of the technique used to approach the obstacles revealed a significant improvement in group A, which was confirmed by analysis of the photo and video sequences taken during the experiment.

Furthermore, the overall approach to running showed notable progress for athletes in group A, with final test results indicating significant improvements in both the female and male categories. Intermediate times showed a progressive increase in the exercise capacity of athletes in group A compared to those in group B.

In particular, the application of the neuromuscular training method to the female participants had a significant impact on the development of self-confidence and courage, which was reflected in their obstacle-crossing technique and in the times recorded both during training and in the final test. The athletes in group A recorded an improvement in timed performance of over 9.8% compared to the initial test results, which is above the overall average obtained of 7.67% (Henry, 2001).

Table 2. Final CISM-type obstacle course running test

Group	Time/Sex						Average Times
A Experimental Group	Performence time/ Percentage increase						Average ∑-sec./ %
	2' 33"♂	**2'37"♂**	**2'38"♂**	**2'41"♀**	**2'50"♂**	**2'49"♀**	2'41"
	11"/6.7%	12"/7.1%	13"/7.6%	15"/8.5*	9"/5.03%	21"/11.1%*	∑-14"/7.67%
B Control Group	**2'40"♂**	**2'44"♂**	**2'49"♀**	**2'52"♂**	**2'57"♂**	**3'03"♀**	2'47"
	7"/4.2%	6"/3.5%	5"/2.9%	5"/2.8%	4"/2.2%	10"/5.2%	∑-6'/3.46%

Legend: ♂ symbol for male sex, ♀ symbol for female sex, ∑ symbol for arithmetic mean.
*Significant differences, over 9.8% performance increase.

Experimental Group has a standard deviation (SD) of 6.78 seconds, with a coefficient of variation (CV) of 4.2%, whereas Control Group has an SD of 8.17 seconds and a CV of 4.8%. The experimental group shows lower dispersion (6.78 sec), indicating greater homogeneity. The control group presents higher variability (8.17 sec). The mean difference between the groups is approximately 9.8 seconds in favor of the experimental group. A CV below 5% in both groups indicates good homogeneity for research purposes.

DISCUSSION

The results of the present study align with findings reported in previous research on neuromotor and integrative neuromuscular training. Akbar et al. (2022) demonstrated that structured neuromuscular programs significantly improve athletes' physical fitness, including coordination, balance, and agility, which corresponds with the improvements observed in obstacle course performance in our participants. Similarly, Chen et al. (2025) highlighted that integrative neuromuscular training enhances technical execution and movement efficiency, supporting the present findings on reduced movement errors and improved obstacle negotiation. Furthermore, the reduction in injury incidence observed in our participants corroborates the conclusions of Wan et al. (2025) and Peng et al. (2024), who reported that neuromotor and proprioceptive training significantly contribute to injury prevention by enhancing motor control and dynamic stability. Referring to recent studies highlighting the importance of neuromuscular training methods, this research confirms this information through a comparative analysis of the initial and final results obtained by the two experimental groups, A and B. The results reveal that, over a relatively short training period, the level of

neuromuscular control of the athletes in group A increased progressively, and their ability to adapt to the complex demands of the obstacle course improved considerably. The study confirms these observations, showing measurable improvements in both completion times and technical performance after a 12-week neuromotor intervention.

An essential aspect is injury prevention, determined by improving the technique and tactics of approaching the running route, with a significant impact on the psychological state of both athletes and coaches.

Looking ahead, it is necessary to expand the research by applying this type of training program to a larger sample of athletes and within different training cycles. At the same time, we aim to compare the results obtained with those generated by other training models in order to identify the most effective methods for individual performance optimization, especially in complex events such as the military pentathlon.

CONCLUSIONS

- Neuromotor training is a valuable complementary method in military pentathlon training.
- The neuromotor training contributes to improving performance, strengthening physical endurance, and preventing injuries.
- neuromuscular training significantly increased performance in girls
- Future studies with larger samples and varied competitive conditions are recommended to validate the results.

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