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RESEARCH ARTICLE

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PHYSICAL CHARACTERISTICS AND SOME CENTRAL NERVOUS SYSTEM FUNCTIONAL INDICES OF CHEMICAL DEFENSE SOLDIERS

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ABSTRACT

Objective: To describe the physical characteristics and selected central nervous system (CNS) functional indices of chemical defense soldiers. **Methods:** A cross-sectional descriptive study was conducted on 200 male soldiers (aged 18-35 years) from Unit X, Chemical Corps, comprising 130 recruits and 70 experienced soldiers (≥ 1 year of service). Evaluated variables included body mass index (BMI), Pignet index, handgrip strength, back-pull strength, typical weekly physical activity (GPAQ), attentional focus (25-number test), short-term memory (12-number test), reaction time, information processing speed, and emotional stress (Spielberger inventory). **Results:** Chemical defense soldiers demonstrated a well-proportioned physical development (median height: 169 cm, median weight: 60.10 kg, median BMI: 21.04 kg/m²); 99.5% of the personnel met Physical Fitness Level 1 and Level 2 health standards according to Circular No. 37/2021/TT-BQP, with 88.5% classified as strong to very strong based on the Pignet index. Compared to recruits, experienced soldiers exhibited statistically significant superiority ($p < 0.05$) in: Physical fitness - larger mean chest circumference (84.80 ± 4.77 vs. 83.28 ± 4.69 cm), better Pignet index (24.25 vs. 26.00), higher energy expenditure (18,000 vs. 15,600 MET-min/week), and greater dominant handgrip strength (45.00 vs. 42.50 kg); CNS function - higher attentional focus (19.59 ± 1.12 vs. 14.50 ± 5.13 points), shorter simple and complex sensorimotor reaction times (260.40 ± 16.45 vs. 268.40 ± 18.20 ms; 303.28 ± 11.72 vs. 362.10 ± 26.50 ms, respectively), faster information processing speed (1.37 ± 1.09 vs. 0.96 ± 0.62 bit/s), and significantly lower emotional stress levels (26.40 ± 4.20 vs. 33.40 ± 5.20 points). **Conclusion:** Chemical defense soldiers demonstrated a solid physical foundation; soldiers with ≥ 1 year of service exhibited superior adaptation in physical fitness, neural reflexes, and psychological state compared with recruits.

Key words: Chemical defense soldiers; physical characteristics; central nervous system function; adaptation.

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1. Introduction

Chemical defense soldiers serve as the core force ensuring safety and mitigating the consequences of radiological, chemical, and biological weapons or incidents, thereby protecting the armed forces and the public. Military operations in the Chemical Corps are characterized by heavy physical exertion, including rapid mobility over various distances on complex terrain, carrying and operating specialized equipment, and performing reconnaissance and decontamination tasks. These duties demand a robust physical foundation and regular high-intensity training to maintain muscular strength and general endurance. Furthermore, to ensure safety under hazardous and specialized working conditions, chemical defense personnel must routinely wear chemical protective suits and gas masks weighing approximately 3.5 kg in total, working continuously for prolonged periods even in harsh climates. Heat strain combined with high-intensity physical exertion can cause dehydration, increase cardiorespiratory load, and directly affect the central nervous system (CNS), leading to cortical inhibition, disrupted neural impulse transmission, heightened emotional stress, impaired attentional focus, reduced information processing speed, and prolonged sensorimotor reaction times [1]. Consequently, physical characteristics and CNS functional status are fundamental determinants of soldiers' adaptive capacity, occupational workload tolerance, and the risk of excessive fatigue [2], helping to maintain the accuracy of specialized technical procedures. Currently, although several studies have investigated physiological changes or thermal status in chemical defense soldiers during training with protective equipment [3], [4], studies concurrently examining baseline physical characteristics and CNS functional status, as well as assessing adaptation following military training, remain limited. Characterizing these parameters not only helps evaluate the quality of personnel selection and routine physical training within the unit but also provides a scientific database for predicting work capacity and proposing measures to protect and enhance soldiers' health. Against this background, we conducted this study with the objective: *To investigate the physical characteristics and selected central nervous system functional indices of chemical defense soldiers.*

2. Materials and Methods

2.1. Materials

The study was conducted on 200 male military personnel from Unit X, Chemical Corps, in June 2026. Divided into 2 groups based on length of military service, consisting of:

- Recruits: enlisted in March 2026, < 1 year of military service.

- Soldiers with ≥ 1 year of service (experienced soldiers): Second-year conscripts, officers, and professional military personnel (enlisted prior to June 2025).

Inclusion criteria: Male military personnel aged 18-35 years who were actively serving, training, and living under normal conditions at the unit and voluntarily agreed to participate in the study.

Exclusion criteria: A history of or current chronic diseases (e.g., cardiovascular, respiratory, or neurological disorders), acute illnesses, or musculoskeletal injuries at the time of the study.

2.2 Methods

Study design: A cross-sectional descriptive study was conducted.

Sampling method and sample size: Convenience sampling was used to recruit all 200 military personnel at the unit who met the inclusion criteria.

Study variables and assessment methods:

*** General and physical characteristics:**

- General information: Age (years), length of military service (years).

- Anthropometric measurements: Height (cm), body weight (kg), and mean chest circumference (cm). Body mass index (BMI, kg/m²) was calculated and classified according to the World Health Organization (WHO) criteria for Asian populations [5]: Underweight (< 18.5 kg/m²); Normal (18.5-22.9 kg/m²); Overweight (23.0-24.9 kg/m²); Obesity Class I (25.0-29.9 kg/m²); and Obesity Class II (≥ 30 kg/m²).

- Physical fitness classification based on BMI: BMI-based physical fitness classification for active-duty military personnel undergoing periodic health examinations was determined according to Ministry of National Defence Circular No. 37/2021/TT-BQP, dated April 15, 2021 [6]:

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Physical fitness level	Level 1	Level 2	Level 3	Level 4
BMI	18-22	15-17 or 23-29	12-14 or 30-35	< 12 or > 35

- The Pignet index = Height (cm) – Body weight (kg) – Mean chest circumference (cm). Physical fitness based on the Pignet index was classified into 7 levels: extremely strong (< 23), very strong (23-28), strong (29-34.9), average (35-41), weak (41.1-47), very weak (47.1-53), and extremely weak (> 53) [7].

- Weekly physical activity: Average physical activity during a typical week was assessed using the WHO Global Physical Activity Questionnaire (GPAQ) [8]. Total energy expenditure was expressed in metabolic equivalent minutes per week (MET-min/week); a high level of physical activity was defined as ≥ 3000 MET-min/week.

- Muscle strength measurements: Dominant-hand grip strength (kg) was measured using a handgrip dynamometer, and trunk-pulling strength (kg) was measured using a trunk-pull dynamometer. The strength index was calculated as follows [9]:

Strength index = [Trunk-pulling strength (kg) / Body weight (kg)] × 100 %.

*** Central nervous system functional indices:**

- Attention: Assessed using the 25-digit random-sequencing test, performed within 2 minutes [9]. Using a table containing 25 randomly arranged two-digit numbers (< 100), participants were instructed to observe, locate, and arrange the numbers in ascending order from left to right and top to bottom on a response grid within a 2-minute time limit. The test score was recorded as the total number of digits arranged in the correct sequence and classified as excellent (> 22 digits), good (17-22 digits), average (12-16 digits), or poor (< 12 digits).

- Short-term memory: Assessed using the 12 two-digit number memorization test, with a viewing time of 30 seconds [9]. Participants observed a table of 12 two-digit numbers (ranging from 10 to 99) for 30 seconds, after which the table was removed and participants wrote down the recalled numbers in any order. The score was recorded as the total number of accurately recalled numbers and classified as excellent (9-12 digits), good (6-8 digits), average (4-5 digits), or poor (0-3 digits).

- Sensory-motor reaction time and information processing speed:

+ Simple and complex visual-motor reaction times (ms) were measured using a computer-based test with the specialized Ritm-MET software (Russia) [9]. For simple reaction time, participants pressed a key as quickly as possible upon the appearance of a single visual stimulus (color/shape) on the screen. For complex reaction time, participants discriminated among randomly presented visual stimuli to make the appropriate key-press (or inhibition) response according to predefined rules. Reaction latency from stimulus onset to key press was automatically recorded in milliseconds (ms).

+ Information processing speed was calculated using the Hick-Hyman formula: $I = (X_2 - X_1) / X_1$ (bit/s). Performance was classified as excellent (6-7 bit/s), good (4-5.9 bit/s), average (3-3.9 bit/s), and poor (< 3 bit/s).

- Emotional state and adaptation: Part I of the Spielberger questionnaire, comprising 20 items, was used to assess emotional stress (state anxiety) in chemical defense soldiers prior to equipment training. The total score was classified into four levels: low (< 30), moderate (31-45), high (46-64), and pathological (> 64) [10].

2.3. Statistical Analysis

Data were statistically analyzed using SPSS version 22.0. Quantitative variables were expressed as mean ± standard deviation (mean ± SD) or median (interquartile range, Q1-Q3), while categorical variables were presented as frequencies (n) and percentages (%). Normally distributed variables were compared using the independent-samples t-test, whereas non-normally distributed variables were compared using the Mann-Whitney U test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant.

2.4 Research Ethics

The data analyzed in this study were part of an institutional research project (Project No. ĐTCS.09.2026), which was approved by The Biomedical Research Ethics Committee of Vietnam Military Medical University under Certificate No. 170/2026/CNChT-HĐĐĐ, dated July 16, 2026. Participants were fully informed about the study before enrollment. All participant data were kept strictly confidential and used exclusively for research purposes.

3. Results

3.1. General and physical characteristics

Table 1. General and anthropometric characteristics of chemical defense soldiers

Characteristic		Recruits (n_1=130)	Experienced soldiers (n_2=70)	Total (N=200)	p_{1-2}
Age (Years)		19.5 (19 - 21)	21.5 (20 - 24)	20 (19 - 23)	< 0.01*
Height (cm)		169 (165 - 172)	168 (165 - 170)	169 (165 - 172)	0.269*
Body weight (kg)		59.75 (55.40 - 64.63)	60.80 (56.63 - 66.78)	60.10 (55.63 - 65.00)	0.202*
Mean chest circumference (cm)		83.28 ± 4.69	84.80 ± 4.77	83.81 ± 4.76	0.024*
BMI (kg/m²)		20.95 (19.77 - 22.69)	21.51 (20.43 - 23.82)	21.04 (20.08 - 22.96)	0.07*
WHO BMI classification (n, %)	Underweight	6 (4.6)	4 (5.7)	10 (5.0)	0.269**
	Normal	99 (76.2)	44 (62.9)	143 (71.5)	
	Overweight	25 (19.2)	21 (30.0)	46 (23.0)	
	Obesity	0 (0.0)	1 (1.4)	1 (0.5)	
Physical fitness classification according to Circular No. TT 37/2021/TT-BQP (n, %)	Level 1	102 (78.5)	46 (65.7)	148 (74.0)	0.048**
	Level 2	28 (21.5)	23 (32.9)	51 (25.5)	
	Level 3	0 (0.0)	1 (1.4)	1 (0.5)	
Pignet index		26.00 (18.10 - 31.93)	24.25 (13.00 - 28.53)	25.4 (17.5 - 30.45)	0.027*
Physical fitness classification according to the Pignet index (n, %)	Extremely strong	44 (33.8)	31 (44.3)	75 (37.5)	0.62**
	Very strong	31 (23.8)	17 (24.3)	48 (24.0)	
	Strong	38 (29.2)	16 (22.9)	54 (27.0)	
	Average	14 (10.8)	5 (7.1)	19 (9.5)	
	Weak	3 (2.3)	1 (1.4)	4 (2.0)	

*Note: Data are presented as median (Q1–Q3) or mean ± SD or n (%), as appropriate. *Mann–Whitney U test; **Fisher's exact test.*

Recruits were significantly younger than soldiers with ≥ 1 year of service (median age: 19.5 vs. 21.5 years; p < 0.01). Regarding basic anthropometric indices, no statistically significant differences were observed between the two groups in height, body weight, BMI, or BMI classification (p > 0.05), with 71.5% of the total sample having a normal BMI according to WHO criteria. However, soldiers with ≥ 1 year of service had a significantly greater mean chest circumference (84.80 ± 4.77 vs. 83.28 ± 4.69 cm; p = 0.024) and a significantly lower median Pignet index (24.25 vs. 26.00; p = 0.027). Although a higher proportion of recruits achieved Physical Fitness Level 1 compared with soldiers with ≥ 1 year of service (78.5% vs. 65.7%; p = 0.048) according to Circular No. 37/2021/TT-BQP, the Pignet index classification showed that most soldiers in both groups fell within the strong to extremely strong categories, with no statistically significant difference between groups (p = 0.62).

Table 2. Typical weekly physical activity and baseline physical fitness indices

Characteristic		Recruits (n_1=130)	Experienced soldiers (n_2=70)	Total (N=200)	p_{1-2}
Typical weekly physical activity (GPAQ) (MET-min/week)		15600 (15360 - 15840)	18000 (17280 - 18240)	15840 (15600 - 17550)	<0.01*
Physical activity level (n, %)	High	130 (100.0)	70 (100.0)	200 (100.0)	1
	Moderate/Low	0	0	0	
Dominant-hand grip strength (kg)		42.50 (38.75 - 48.00)	45.00 (42.00 - 49.25)	44.00 (39.25 - 48.00)	0.004*
Trunk-pulling strength (kg)		105.31 ± 18.06	107.74 ± 18.19	106.61 ± 18.10	0.438**
Strength index (%)		172.65 ± 25.9	173.74 ± 34.91	173.03 ± 29.29	0.819**

*Note: Data are presented as median (Q1–Q3) or mean ± SD or n (%), as appropriate. * Mann-Whitney U test; **Welch's independent-samples t-test.*

All chemical defense soldiers (100%) maintained a high level of typical weekly physical activity according to the GPAQ. However, soldiers with ≥ 1 year of service had significantly higher weekly physical activity levels and dominant-hand grip strength than recruits (medians: 18,000 vs. 15,600 MET-min/week and 45.00 vs. 42.50 kg, respectively; $p < 0.01$). In contrast, no statistically significant between-group differences were observed in trunk muscle strength indices (trunk-pulling strength and strength index; $p > 0.05$).

3.2. Assessment of CNS function

Table 3. Attention and Short-Term Memory

Characteristic		Recruits (n_1=130)	Experienced soldiers (n_2=70)	Total (N=200)	p_{1-2}
25-digit random-sequencing test score		14.50 ± 5.13	19.59 ± 1.12	16.28 ± 4.84	<0.001*
Attention classification (n,%)	Excellent	18 (13.8)	14 (20.0)	32 (16.0)	0.002**
	Good	40 (30.8)	37 (52.8)	77 (38.5)	
	Average	45 (34.6)	12 (17.1)	57 (28.5)	
	Poor	27 (20.8)	7 (10.0)	34 (17.0)	
12 two-digit number memorization test score		6.96 ± 2.01	6.30 ± 1.87	6.73 ± 1.98	0.022*
Short-term memory classification (n,%)	Excellent	19 (14.6)	12 (17.1)	31 (15.5)	0.197**
	Good	58 (44.6)	36 (51.4)	94 (47.0)	
	Average	38 (29.2)	20 (28.6)	58 (29.0)	
	Poor	15 (11.5)	2 (2.9)	17 (8.5)	

*Note: Data are presented as mean ± SD or n (%), as appropriate. *Independent-samples t-test; **Chi-square test.*

Regarding attention (25-digit random-sequencing test), soldiers with ≥ 1 year of service had significantly higher mean scores than recruits (19.59 ± 1.12 vs. 14.50 ± 5.13 points; $p < 0.001$), with a significantly higher proportion achieving good or excellent ratings ($p = 0.002$). Conversely, for short-term memory (12 two-digit number memorization test), recruits recalled significantly more digits than soldiers with ≥ 1 year of service (6.96 ± 2.01 vs. 6.30 ± 1.87 digits; $p = 0.022$). Despite this difference in mean scores, the overall distribution of short-term memory classifications did not differ significantly between the two groups ($p = 0.197$), with the majority of personnel in both groups falling into the good and average categories.

Table 4. Sensory-motor reaction time and information processing speed

Characteristic		Recruits (n_1=130)	Experienced soldiers (n_2=70)	Total (N=200)	p_{1-2}
Simple visual-motor reaction time (ms)		268.40 ± 18.20	260.40 ± 16.45	265.60 ± 17.99	0.002*
Complex visual-motor reaction time (ms)		362.10 ± 26.50	303.28 ± 11.72	341.51 ± 35.96	< 0.001*
Mean information processing speed (Bit/s)		0.96 ± 0.62	1.37 ± 1.09	1.10 ± 0.82	0.013*
Information processing speed classification (n, %)	Very good	20 (15.4)	46 (65.7)	66 (33.0)	< 0.001**
	Good	33 (25.4)	15 (21.4)	48 (24.0)	
	Acceptable	72 (55.4)	8 (11.4)	80 (40.0)	
	Poor	5 (3.8)	1 (1.4)	6 (3.0)	

*Note: Data are presented as mean ± SD or n (%), as appropriate. *Independent-samples t-test; **Fisher's exact test.*

Both simple and complex visual-motor reaction times were significantly shorter in soldiers with ≥ 1 year of service than in recruits (260.40 ± 16.45 vs. 268.40 ± 18.20 ms, $p = 0.002$; and 303.28 ± 11.72 vs. 362.10 ± 26.50 ms, $p < 0.001$, respectively). Mean information processing speed in soldiers with ≥ 1 year of service reached 1.37 ± 1.09 bit/s (with 65.7% classified as very good), which was significantly higher than the 0.96 ± 0.62 bit/s (only 15.4% classified as very good) observed in recruits ($p < 0.05$).

Table 5. Spielberger emotional state

Characteristic		Recruits (n_1=130)	Experienced soldiers (n_2=70)	Total (N=200)	p_{1-2}
Mean Spielberger score		33.40 ± 5.20	26.40 ± 4.20	30.95 ± 5.90	< 0.01*
Emotional stress level (n, %)	Low	34 (26.2)	45 (64.3)	79 (39.5)	<0.001**
	Moderate	82 (63.0)	25 (35.7)	107 (53.5)	
	High	14 (10.8)	0 (0.0)	14 (7.0)	
	Pathological	0 (0.0)	0 (0.0)	0 (0.0)	

Note: *Data are presented as mean ± SD or n (%). *Independent-samples t-test; **Chi-square test.*

The results demonstrated a statistically significant difference in emotional stress between the two groups. Recruits had a moderate mean Spielberger score (33.40 ± 5.20 points), with 10.8% falling into the high emotional stress category. In contrast, soldiers with ≥ 1 year of service had a significantly lower mean Spielberger score (26.40 ± 4.20 points; p < 0.01); 100% of longer-serving personnel maintained a stable emotional state at low (64.3%) or moderate (35.7%) levels, with no cases of high or pathological stress.

4. DISCUSSION

4.1. Physical characteristics of chemical defense soldiers

In our study, the participants were mainly young soldiers with a median age of 20 years, and recruits accounted for 65% of the sample. This age distribution is fully consistent with the force structure responsible for training and combat readiness in mobile units. Most personnel had a balanced physique, with 71.5% having a normal BMI according to WHO criteria, which helps minimize excess cardiovascular load and reduce the risk of overfatigue during military labor [11]. Comparative analysis revealed positive morphological and physical adaptations in soldiers with ≥ 1 year of service compared with recruits. Specifically, soldiers with ≥ 1 year of service had a significantly greater mean chest circumference than recruits (84.80 ± 4.77 vs. 83.28 ± 4.69 cm; p < 0.05). Mean chest circumference reflects the development of the thoracic cage and the mass of accessory respiratory muscles [7]. Chemical defense soldiers frequently perform duties while wearing impermeable rubber protective suits and gas masks that increase respiratory resistance. Continuous physical conditioning combined with specialized training for over one year induces respiratory physiological adaptations, promoting thoracic expansion and increasing vital capacity to meet the gas exchange demands of heavy labor [11], [12]. Concurrently, the Pignet index - a composite indicator of physical robustness - was significantly lower in soldiers with ≥ 1 year of service than in recruits (24.25 vs. 26.00; p < 0.05). According to Quang Quyen Nguyen, a lower Pignet index reflects a stronger and more robust physique [7]. The improvements in both chest circumference and the Pignet index in experienced soldiers compared with recruits demonstrate that regular physical training at the unit effectively promoted body composition remodeling toward increased lean muscle mass [12]. Overall, 88.5% of personnel were classified as strong to extremely strong on the Pignet scale, reflecting a solid physical fitness foundation among chemical defense soldiers. According to the physical fitness standards in Circular No. 37/2021/TT-BQP of the Ministry of National Defence, the majority of soldiers achieved Level 1 (74.0%) and Level 2 (25.5%), with only 0.5% classified as Level 3. However, comparative analysis showed a higher proportion of Level 1 fitness among recruits than among soldiers with ≥ 1 year of service (78.5% vs. 65.7%; p < 0.05). This can be explained by the fact that recruits had recently undergone rigorous selection and medical re-examination upon enlistment. Meanwhile, among soldiers with over one year of training, muscle mass hypertrophy resulting from high-intensity physical conditioning combined with the unit's nutritional regimen caused the BMI of some personnel to increase above 22 kg/m² (median BMI in the ≥ 1 year group was 21.51 kg/m² with an upper quartile [Q3] of 23.82 kg/m², compared with 20.95 kg/m² in recruits). This led to a classification shift from Level 1 to Level 2 under the BMI-based scale of Circular No. 37/2021/TT-BQP, even though their physical robustness (Pignet index) was superior. The single case classified as Level 3 in the ≥ 1 year group was a 24-year-old officer with a BMI > 30 kg/m² (Obesity Class I according to WHO). Overall, the combined proportion of Level 1 and Level 2 physical fitness was very high in both groups (nearly 100%).

Typical weekly physical activity reached a high level (100%) in both groups according to the GPAQ, with an overall sample median of 15840 MET-min/week. This is entirely consistent with the disciplined regimen, operational duties, and rigorous physical training routinely maintained in the military environment. However, experienced soldiers had a significantly higher average weekly physical activity level than recruits (18000 vs. 15600 MET-min/week; $p < 0.01$). This disparity accurately reflects the unit's military training curriculum and the physical development of soldiers after more than one year of training: Newly enlisted recruits primarily perform basic physical conditioning and initial familiarization with chemical defense equipment. Conversely, soldiers with ≥ 1 year of service must both maintain regular physical training and directly undertake advanced specialized chemical defense training (such as weekly 3-km runs while wearing chemical protective gear, or tactical mobility and carrying heavy specialized equipment during reconnaissance, chemical decontamination, and radiological decontamination exercises). This progressive training intensity induces physiological adaptations, enabling longer-serving personnel to better tolerate and respond to heavy military labor demands.

Regarding baseline physical strength indices, dominant-hand grip strength represents the isometric strength of the hand and forearm muscles and serves as an indirect indicator of overall bodily strength [13]. The median grip strength in soldiers with ≥ 1 year of service reached 45.00 kg, significantly higher than that of recruits (42.50 kg; $p < 0.05$). According to adult male reference standards, grip strength values of 42.50-45.00 kg are classified as above average to strong [11]. The statistically significant increase in dominant-hand grip strength among soldiers with ≥ 1 year of service demonstrates the effectiveness of regular physical training (e.g., pull-ups, parallel bars, equipment carrying), which enhances motor unit recruitment and upper-limb muscle fiber hypertrophy [12]. For trunk muscle strength, the overall mean trunk-pulling strength was 106.61 ± 18.10 kg and the strength index was 173.03 ± 29.29%. Trunk-pulling strength reflects the maximal force-generating capacity of the lumbar extensors, spinal extensors, and gluteofemoral muscle groups; compared with adult classification standards, this value falls within the above-average range (100-120 kg) [11]. Although trunk-pulling strength and the strength index tended to be higher in soldiers with ≥ 1 year of service than in recruits (107.74 ± 18.19 vs. 105.31 ± 18.06 kg), the difference did not reach statistical significance ($p > 0.05$).

4.2. Characteristics of selected central nervous system functional indices

The functional status of the CNS plays a decisive role in the accurate reception of commands, spatial orientation, and execution of specialized technical procedures by chemical defense soldiers. Regarding attention, soldiers with ≥ 1 year of service achieved a significantly higher mean score than recruits (19.59 ± 1.12 vs. 14.50 ± 5.13 points), with good and excellent ratings predominating (72.8% vs. 44.6%). This difference is closely linked to physical conditioning and adaptation to occupational heat stress. Previous studies have demonstrated that physical training combined with repeated exposure to exertional heat stress during military training induces a direct protective adaptation in the CNS, helping preserve attentional focus and cortical executive function far more effectively than in unacclimated individuals [1], [14]. Regarding short-term memory, recruits had a higher mean recall score than soldiers with ≥ 1 year of service (6.96 ± 2.01 vs. 6.30 ± 1.87 digits; $p < 0.05$). This difference may be attributable to the younger age of recruits, a stage at which immediate recall processes exhibit high sensitivity. However, in terms of short-term memory classification, there was no statistically significant difference between the two groups ($p = 0.197$), with the majority of soldiers in both groups falling into the good and average categories (accounting for 76.0%). The overall sample mean score in our study is consistent with the findings of Hoang Trung Nguyen et al. in sappers [2].

Our study recorded significantly shorter reaction times in experienced soldiers than in recruits for both simple visual-motor reaction time (260.40 ± 16.45 vs. 268.40 ± 18.20 ms; $p = 0.002$) and complex visual-motor reaction time (303.28 ± 11.72 vs. 362.10 ± 26.50 ms; $p < 0.001$). Compared with other specialized military forces, the simple visual-motor reaction time of chemical defense soldiers (265.60 ± 17.99 ms) was comparable to that of military pilots (258.5 ± 8.7 ms) and radar operators (276.0 ± 4.0 ms) [15]. Furthermore, information processing speed in experienced soldiers reached 1.37 ± 1.09 bit/s (with 65.7% rated as very good), significantly higher than in recruits (0.96 ± 0.62 bit/s, with only 15.4% rated as very good; $p = 0.013$). Information processing speed and complex reaction time are composite indicators reflecting central neural impulse conduction velocity, cortical analytical-synthetic capacity, and neuromuscular coordination. The statistically significant differences between the two groups can be explained by two primary adaptive mechanisms: First,

regular high-intensity physical training improves cerebral blood flow, enhances oxygen metabolism in the prefrontal cortex, and stimulates the secretion of neurotrophic factors (such as BDNF), thereby accelerating cognitive processing speed and motor reflexes [16], [17]. Second, the repeated execution of complex specialized technical procedures during training establishes and consolidates temporary neural pathways in the cerebral cortex, optimizes synaptic transmission, and automates orienting reflexes, enabling experienced soldiers to process situations more rapidly and accurately than recruits [14].

Psychophysiological adaptation through military training was also clearly reflected in emotional state. The mean Spielberger emotional stress score among recruits was at a moderate level (33.40 ± 5.20 points), with 10.8% of new soldiers falling into the high emotional stress category. This reflects the psychophysiological characteristics of recruits during the initial phase of enlistment: the abrupt transition from civilian life to strict military discipline, high-intensity physical conditioning, and initial exposure to specialized chemical defense training mean that the autonomic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis have not yet fully adapted, resulting in higher anxiety and stress levels [17]. Conversely, among soldiers with ≥ 1 year of service, the mean Spielberger score was significantly lower (26.40 ± 4.20 points; $p < 0.001$), with 100% maintaining a stable emotional state at low (64.3%) or moderate (35.7%) levels, and no cases reaching high or pathological thresholds. Adaptation to military operational stress is a complex physiological response involving the sympathetic nervous system, the HPA axis, and the immune system [17]. According to Forse et al., a solid physical fitness foundation combined with technical proficiency helps optimize neuroendocrine responses, effectively regulate emotions, and maintain psychophysiological stability in soldiers [1].

5. CONCLUSION

Chemical defense soldiers demonstrated well-proportioned physical development, with a median height of 169 cm, median weight of 60.10 kg, and a median body mass index (BMI) of 21.04 kg/m², of which 71.5% fell within the normal BMI range. 99.5% of the personnel met Physical Fitness Level 1 and Level 2 health standards according to Circular No. 37/2021/TT-BQP; 88.5% were classified as strong to very strong based on the Pignet index, and 100% maintained a high level of physical activity. Compared to recruits, experienced soldiers (≥ 1 year of service) exhibited superior adaptation and development across key characteristics:

- Physical fitness: Statistically significant improvements were observed in mean chest circumference (84.80 ± 4.77 vs. 83.28 ± 4.69 cm), Pignet index (24.25 vs. 26.00), physical activity level via GPAQ (18000 vs. 15600 MET-min/week), and dominant handgrip strength (45.00 vs. 42.50 kg). No significant differences were found in BMI and back-pull strength between the two groups.

- Central nervous system: Experienced soldiers demonstrated higher attentional focus (19.59 ± 1.12 vs. 14.50 ± 5.13 points), shorter simple and complex sensorimotor reaction times (260.40 ± 16.45 vs. 268.40 ± 18.20 ms; 303.28 ± 11.72 vs. 362.10 ± 26.50 ms, respectively), faster information processing speed (1.37 ± 1.09 vs. 0.96 ± 0.62 bit/s), and significantly lower emotional stress levels (26.40 ± 4.20 vs. 33.40 ± 5.20 points). Furthermore, 100% of the experienced soldiers maintained stable emotional stress levels within the low to moderate thresholds, whereas recruits reported significantly higher stress levels (with 10.8% reaching the high-stress threshold).

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Declaration of Competing Interest

We declare that all authors have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Generative AI and AI-Assisted Technologies

The authors used artificial intelligence tools (Gemini and NotebookLM) during manuscript preparation to assist with proofreading and translation.

Author Contributions

Ngoc Hop Do: Conceptualization and study design, data collection, interpretation of results, manuscript revision and critical review, and approval of the final manuscript. Dac Thang Hoang, Van Manh Phan: Field data collection, contributions to the refinement of the study design, and critical review

and revision of the manuscript. Minh Thanh Bui, Hai Trung Tran, and Quoc Thanh Phan: Participation in clinical examinations of military personnel and field data collection. Thanh Tung Tran Le: Data entry, data analysis, and literature search. Anh Nguyet Le: Conceptualization and study design, data collection, data analysis, interpretation of results, manuscript drafting, revision, and critical review.

References

1. Forse JN, Beckner ME, Giles GE, et al. Psychological, physical, and cognitive factors that influence tactical performance during a military relevant virtual reality scenario. Cogn Res Princ Implic. 2025;10(1):76.

2. Hoang Trung Nguyen, Van Chuyen Nguyen, Duc Minh Tong, et al. Changes in selected central nervous system functional indices in soldiers operating in an underground bunker on Island A. Military Medical and Pharmaceutical Journal. 2024;49(2):57-69. (Vietnamese)

3. Quoc Bao Dang, Hong Phuc Cao. A study of thermal status during occupational activities and military training among chemical defense soldiers. Military Medical and Pharmaceutical Journal. 2012;(2):60-7. (Vietnamese)

4. Thi Tinh Hoang. Research on selected physiological, biochemical, and hematological indices in soldiers undergoing training while wearing Chemical Protective Suit No. 2 and receiving GN16 tablets. Hanoi: Vietnam Military Medical University; 2018. (Vietnamese)

5. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363(9403):157-63.

6. Ministry of National Defence of Vietnam. Circular No. 37/2021/TT-BQP dated 15 April 2021 on health classification, medical examinations, and the allocation of health management responsibilities for military personnel, defense officials, defense workers, and defense public employees. (Vietnamese)

7. Quang Quyen Nguyen. Anthropometry and its applications in research on Vietnamese populations. Hanoi: Medical Publishing House; 1984. (Vietnamese)

8. WHO Expert Consultation. Global Physical Activity Questionnaire (GPAQ): analysis guide. 2012.

9. Vietnam Military Medical University. Principles and methods for assessing the functional status and work capacity of military personnel. In: Textbook of military occupational physiology. Hanoi: People's Army Publishing House; 2017. p. 116-30. (Vietnamese)

10. Van Nhan Nguyen, Sinh Phuc Nguyen. Clinical psychological testing. Hanoi: People's Army Publishing House; 2004. (Vietnamese)

11. Thanh Hai Le. Continuing education materials: Assessment of physical workload. Hanoi: Ministry of Health, National Institute of Occupational and Environmental Health; 2024. (Vietnamese)

12. Helén J, Kyröläinen H, Ojanen T, et al. High-intensity functional training induces superior training adaptations compared with traditional military physical training. J Strength Cond Res. 2023;37(12):2477-83.

13. Haixia Xiao, Shan Huang, Huanshun Xiao, et al. Longitudinal association between body mass index and handgrip strength in community-dwelling older adults: a population-based nationwide cohort study. BMC Geriatr. 2025;25:711.

14. Racinais S, Wilson MG, Gaoua N, et al. Heat acclimation has a protective effect on the central but not peripheral nervous system. J Appl Physiol. 2017;123(4):816-24.

15. Van Quang Le, Hong Quang Nguyen, Thi Huong Bui, et al. An overview of the psychophysiological health of specialized military forces. Vietnam Medical Journal. 2021;508(2):55-60. (Vietnamese)

16. Ashworth ET, Cotter JD, Kilding AE. Impact of elevated core temperature on cognition in hot environments within a military context. Eur J Appl Physiol. 2021;121(4):1061-71.

17. Beckner ME, Main L, Tait JL, Martin BJ, et al. Circulating biomarkers associated with performance and resilience during military operational stress. Eur J Sport Sci. 2022;22(1):72-86.

ĐẶC ĐIỂM THỂ CHẤT VÀ MỘT SỐ CHỈ SỐ CHỨC NĂNG THẦN KINH TRUNG ƯƠNG CỦA BỘ ĐỘI PHÒNG HÓA

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TÓM TẮT

Mục tiêu: Mô tả đặc điểm thể chất và một số chỉ số chức năng thần kinh trung ương (TKTW) của bộ đội phòng hoá. **Phương pháp nghiên cứu:** Nghiên cứu mô tả cắt ngang trên 200 nam quân nhân (18-35 tuổi) thuộc Binh chủng Hóa học, gồm 130 tân binh và 70 người có tuổi quân ≥ 1 năm. Các biến số đánh giá bao gồm: BMI, Pignet, sức bóp tay, sức kéo thân, mức độ hoạt động thể lực (GPAQs), khả năng chú ý (test 25 chữ số), trí nhớ ngắn hạn (test 12 chữ số), thời gian phản xạ, tốc độ xử lý thông tin và mức độ căng thẳng Spielberger. **Kết quả:** Bộ đội phòng hóa có thể trạng phát triển cân đối: trung vị chiều cao 169 cm, cân nặng 60,10 kg, BMI 21,04kg/m^2; 71,5% đạt BMI bình thường. Có 99,5% quân nhân đạt tiêu chuẩn sức khỏe Loại 1 và Loại 2 theo Thông tư 37/2021/TT-BQP; 88,5% đạt loại Pignet từ khỏe đến cực khỏe. So với tân binh, nhóm tuổi quân ≥ 1 năm thể hiện sự khác biệt có ý nghĩa thống kê ($p < 0,05$) về: Thể lực - vòng ngực trung bình lớn hơn (84.80 ± 4.77 so với 83.28 ± 4.69 cm), chỉ số Pignet (24,25 so với 26,00), mức độ hoạt động thể lực trung bình (GPAQs) cao hơn (18000 so với 15600 MET-phút/tuần), sức bóp tay thuận mạnh hơn (45,00 so với 42,50 kg); chức năng TKTW - khả năng tập trung chú ý cao hơn (19.59 ± 1.12 so với 14.50 ± 5.13 điểm), thời gian phản xạ đơn giản/phức tạp ngắn hơn (260.40 ± 16.45 so với 268.40 ± 18.20 ms; 303.28 ± 11.72 so với 362.10 ± 26.50 ms), tốc độ xử lý thông tin nhanh hơn (1.37 ± 1.09 với 0.96 ± 0.62 Bit/s) và mức độ căng thẳng cảm xúc thấp hơn (26.40 ± 4.20 so với 33.40 ± 5.20 điểm). **Kết luận:** Bộ đội phòng hóa có nền tảng thể chất tốt; nhóm tuổi quân ≥ 1 năm có sự thích nghi tốt hơn về thể lực, phản xạ thần kinh và trạng thái tâm lý so với tân binh.

Từ khóa: Bộ đội phòng hóa, thể chất, chức năng thần kinh trung ương, thích nghi.

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