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EDUCATION & TRAINING

Psychophysiological Monitorization in a Special Operation Selection Course

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Abstract
The present research aimed: i. to analyse the psychophysiological response of soldiers undertaking a special operation selection course; ii. to study the relationship between fat and muscle loss and the psychophysiological response of soldiers undertaking a special operation selection course. We analysed 46 professional soldiers from a special operations unit (25.1 ± 5.0 years, 1.8 ± 0.1 cm, 76.8 ± 7.9 kg, 24.4 ± 2.5 kg/m^2) undertaking the last phase of their 10 weeks special operation selection course. Before and immediately after the exercise the following variables were assessed: Stress subjective perception, fatigue subjective perception, rating of perceived perception, cortical arousal, body temperature, blood oxygen saturation, spirometry, isometric hand strength, lower body muscular strength, urine, body composition, life engagement test, coping flexibility scale, acceptance and action questionnaire, perceived stress scale, anxiety state, visual analogue scale and differential aptitude test. A special operation selection course induced an intense stress and physical response as suggested by the psychophysiological changes with a significant ($p < 0.05$) increase in fatigue and stress subjective perception, blood oxygen saturation, Ph, cognitive impairment and motivation-loss. Moreover, decreased leg strength, peak expiratory flow, cortical arousal, body composition, body weight, fat and muscle mass, anxiety stress, alertness, sadness and tension decreased after the exercise. Regarding body composition, higher muscle mass loss participants were related to a higher cognitive impairment and similar psychophysiological response than lower fat mass loss participants.

Keywords Cortical arousal · Stress · Anxiety · Military · Sleep deprivation

Introduction

The physiological and psychological response has been examined on different extreme contexts where the limits of human body could be attained such as in ultraendurance running events [1, 2], parachuting [3–5] or different military situations [6–8]. These circumstances produce a stress response activating the sympathetic nervous system, inducing a succession of physiological and psychological modifications [9]. The organic response subsequently to this activation produces an increase in metabolic, muscular, and cardiovascular response, a decrease in cortical arousal, misinterpretation of rated of perceived exertion (RPE), as well as impairment in superior cognitive process as memory [1, 8, 10]. Military personnel are generally expected to execute their training and missions under these psychophysiological responses while supplies and occasions for readjustment are limited. Specifically, in special operations units, an urban combat and survival maneuvers produced a significant increase in RPE, blood lactate, HR, muscle strength, sympathetic modulation and anxiety response [11] as well as stress and dehydration [12].

Level of experience has also been previously proved to have a strong influence in physiological and psychological responses such as in combat simulation [6] or paratroopers [5, 13] where elite soldiers reflected a better cognitive predisposition and lower psychophysiological stress response than novel soldiers who also experienced a large anticipatory anxiety response. This psychophysiological responses against variables within the military requires high survival and

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strength capacities which could also be compromised by different collateral factors such as high daily energy expenditures and limited sleeping time related to continuous low-to-moderate-intensity physical activity [12, 14, 15]. This has an impact on the warfighters body composition, physical performance and physiological response [16, 17] which needs deepen understanding.

To the best of our knowledge there is limited knowledge about operative training approach either at physiological and psychological level [7, 11, 18], and especially in the effect of cognitive impairment [19]. Therefore, the present research presented the following objectives: i. to analyse the psychophysiological response of soldiers undertaking a special operation selection course; ii. to study the relationship between fat and muscle loss and the psychophysiological response of soldiers undertaking a special operation selection course. The initial hypothesis was that 4 days of a special operation selection course would increase psychophysiological strain and participants with higher body composition variation would present higher cognitive impairment.

Methods

Participants

We analysed 46 professional soldiers from a special operations unit (25.1 ± 5.0 years, 1.8 ± 0.1 cm, 76.8 ± 7.9 kg, 24.4 ± 2.5 kg/m^2) undertaking the last phase of their 10 weeks special operation selection course. All subjects had 29.1 ± 59.3 months of professional experience at the Armed Forces, 4.3 ± 7.7 months at the unit and 0.5 ± 2.5 months of experience of real-life combat in Lebanon, Afghanistan, Bosnia, Kosovo, or Irak. Prior to participation, the experimental procedures were explained to all the participants, who gave their voluntary written informed consent in accordance with the Declaration of Helsinki. The study protocols and procedures were approved by Headquarter of the unit and the University Etic Committee.

Procedure

For this manoeuvre, soldiers undertook the last phase of their special operation selection course during four consecutive days where psychophysiological demands started with a low stress level and continuously increased as days went by. The situation went as follows:

The exercise started on Day 1 with 12 h simulated NATO Capability Evaluation drill consisting in several scenarios where soldiers were evaluated on decision-making and application of operating procedures learnt during the course. Day 2 soldiers carried out different task regarding water survival training like using floater trousers, flouter jackets, apnoea diving and propelling a boat while swimming on their uniforms. During day 3, soldiers were asked to perform tactical manoeuvres under fire, different activities on urban combat such as room breaching and clearing and rappel from a twenty meters five floors tower. Day 4 soldiers executed once again water survival training as part of a high stress activity wheel including an obstacle course, harbour breaching and clearing, group heavy lifting, and different courage and endurance stations.

Materials

Before and immediately after the exercise the following variables were assessed using protocols performed by previous research in military area [9, 19, 20]:

- Stress subjective perception (SSP) in a 1-100 scale.
- Fatigue subjective perception (FSP) in a 1-100 scale.
- Rating of perceived exertion (RPE), Borg 6–20 scale [21]
- Cortical arousal (CFTT) and fatigue of the Central Nervous System (CNS) using the Lafayette Instrument Flicker Fusion Control Unit (Model 12,021) by the average of 5 incremental test (20 to 100 Hz) [1].
- Body temperature (BT) was measured by a digital infrared thermometer (Temp Touch; Xilas Medical, San Antonio, TX).
- Blood oxygen saturation (BOS) and HR by a pulse oximeter (PO 30 Beurer Medical).
- Spirometry: Forced vital capacity (FVC), volume exhale at the end of the first second of forced expiration (FEV1), the peak expiratory flow (PEF), the forced expiratory flow during the middle portion given at 25% portion (FEF_{25}), the forced expiratory flow during the middle portion given at 75% portion (FEF_{75}) and the average forced expiratory flow during the mid (25-75%) portion of the FVC (FEF_{25-75}) using a QM-SP100 (Quirumed, Spain) spirometer in a maximum inhale-exhale cycle.
- Isometric hand strength (IHS) by a grip dynamometer (Takei Kiki Koyo, Japan).
- Lower body muscular strength by means of horizontal jump test. Subjects performed a standardized warm-up consisted in 2 × 10 vertical jumps with 30 s of recovery and then, they performed two maximal horizontal jumps as previous report [22] and the best attempt was used for the statistical analysis.
- Urine samples were collected to analyse dehydration levels which were examined by the urine colour chart (colour range 1—8; where 1 = very pale yellow urine, reflected a good level of hydration and 8 = very dark yellowish brown, reflected a significant level of dehydration); the number closest to the sample colour was recorded [23]. Urine nitrates, protein, glucose and pH were measured

with the Urine Combur-Test (Roche, Madrid, Spain) stripes.

- Body mass index (BMI), muscle mass, and fat mass were determined by using bioelectrical impedance analysis (InBody 720, Biospace Co., Ltd., Seoul, South Korea) [7, 24]
- Life Engagement Test, designed to measure purpose in life, defined in terms of the extent to which a person engages in activities that are personally valued [25]
- The Coping Flexibility Scale. This scale was designed to measure the flexibility in coping to different situations. Refers to the presence of adaptive coping strategies that are associated with a better psychological health. This test has 10 items and is answered on a Likert scale of 1 to 4, being 1 = Very applicable and 4 = Not applicable. Item example: "I am aware of the success or failure of my attempts to deal with stress" [26]
- Acceptance and Action Questionnaire- AAQ-II. Psychological inflexibility, considered a transdiagnostic process across psychological disorders [27]
- Perceived Stress Scale. PSS. This scale assesses the level of perceived stress in a one-month period. Composed of 14 items that are answered in a five-point Likert scale, where 0 = Never and 4 = Very often. An item of Example: "In the last month, how often have you felt that had everything under control?". High scores are related with a higher perception of stress [28]
- Anxiety was evaluated using the Spanish validated STAI version as in previous researches [8].
- Visual Analogue Scale (VAS) technique to measure global Motivation-loss and affect was administered to detect changes in mood and subjective activation. The present method is based on eight unipolar VAS ratings, four primarily concerned with subjective activation or Motivation-loss (alertness, sleepiness, motivation loss and weariness) and four concerned more with feelings or "affective State" (happiness, sadness, calmness, and tension). This method yields two summary measures: global Motivation-loss (GV) and global affect (GA), each ranging in value from 0 to 100 [29].
- Differential Aptitude Test- Spatial Relations Subset test (DAT-SR5) to analyse spatial and abstract reasoning [30], evaluating the number of questions responded right, wrong and the difference between right and wrong questions [31–34]

Statistical analysis

Statistical analysis was performed with the SPSS 21.0 statistical program. The descriptive statistics used to report the results were the mean ± standard deviation (SD). Normality of the sample was determined with the Shapiro-Wilk test. Then, to analyse differences between pre and post samples a T test for related measurement was conducted. To analyse differences between fat mass loss and muscle mass loss groups a T test for independent measurement was used. The effect size was calculated with Cohen D. The level of significance for all the comparisons was set at $p < 0.05$.

Results

Values are reported as mean ± SD. The last phase of a special operation selection course produced a significant increase in stress and fatigue subjective perception, BOS, and a decrease in motivation, happiness, weariness and calmness from VAS, GA and wrong answers from DAT-SR5.

Values of CFTT, PEF, lower body muscular strength, dehydration level and urine Ph, BMI, weight, muscle and fat mass, state anxiety, alertness, sadness and tension from GV and correct answers from DAT-SR5 decreased significantly after the exercise (Table 1).

Regarding fat mass loss division group (Table 2), the group with higher fat mass loss showed a significant decrease in FVC and lower fat mass loss group significantly increased this parameter. Leg strength, Ph, weight, muscle and fat mass, parameters of alertness from VAS significantly decreased in both higher fat mass loss and lower fat mass loss, while parameter of calmness increased for both groups after the course. Higher fat mass group showed significant lower values on weight and fat mass, alertness, and higher values on calmness than lower fat mass loss group. On the other hand, lower fat mass loss group showed significant lower values in leg strength, Ph, muscle mass than in higher fat mass loss group.

Comparing higher muscle loss group and lower muscle loss group (Table 3), both higher muscle mass loss and lower muscle mass loss groups showed a significant increase in fatigue subjective perception, HR, parameter of calmness from VAS and correct answers from DAT-SR5, while muscle and fat mass, wrong and correct/wrong answers relation from DAT-SR5 significantly decreased in both. Higher muscle mass loss group showed significant higher values in fatigue subjective perception and HR, and a higher loss on muscle mass, while lower muscle mass loss group showed a higher loss on fat mass, higher values on parameters of calmness from VAS, correct answers and wrong/correct answers relation from DAT-SR5 than the higher muscle mass loss group.

Discussion

The aim of this study was to analyse the psychophysiological response of soldiers undertaking a special operation selection course. The first hypothesis was complied since 4 days of a special operation selection course increased

Table 1 Modification of the psychophysiological variables analyzed

	PRE	POST	% Change	t	p	Effect Size	95% confidence interval	
							Lower	Higher
SSP (1-100)	67.4 ± 15.3	77.9 ± 11.3	15.6	−5.195	.001	.69	−14.56	−6.41
FSP (1-100)	64.4 ± 16.3	80.1 ± 9.5	24.4	−5.999	.001	.96	−20.95	−10.40
RPE (1-100)	15.0 ± 9.1	16.1 ± 2.0	7.3	−.776	.442	.12	−3.85	1.71
CFTT (Hz)	33.9 ± 2.8	31.5 ± 4.3	−7.1	3.767	.000	−.86	1.08	3.57
BT (°C)	36.5 ± 1.1	36.5 ± 0.5	0.0	.165	.870	.00	−.37	.43
BOS (%)	98.0 ± 1.1	98.7 ± 0.7	0.7	−3.774	.001	.64	−1.00	−.30
HR (bpm)	80.7 ± 16.4	82.9 ± 12.7	2.7	−.676	.503	.13	−8.71	4.34
FVC (ml)	4.8 ± 0.8	4.8 ± 0.8	0.0	.201	.842	.00	−.20	.25
FVE1 (ml)	3.9 ± 0.8	3.8 ± 0.8	−2.6	.635	.529	−.13	−.13	.26
PEF (ml)	9.0 ± 2.5	8.0 ± 2.7	−11.1	2.366	.023	−.40	.14	1.77
FEF25 (ml)	7.2 ± 2.3	6.9 ± 2.0	−4.2	.675	.505	−.13	−.45	.90
FEF75 (ml)	3.5 ± 4.9	2.4 ± 0.7	−31.4	1.411	.166	−.22	−.46	2.59
FEF25/75 (ml)	4.8 ± 2.6	4.5 ± 1.3	−6.3	.802	.427	−.12	−.44	1.03
Isometric hand strength (N)	44.8 ± 6.9	46.5 ± 8.1	3.8	−1.656	.105	.25	−3.74	.37
Horizontal jump (m)	1.6 ± 0.2	1.4 ± 0.2	−12.5	6.880	.001	−1.00	.18	.33
Urine colorimetry	2.6 ± 1.3	2.0 ± 0.9	−23.1	2.402	.021	−.46	.10	1.21
Nitrate (Mg/dl)	0.0 ± 0.0	0.0 ± 0.2	–	−1.431	.160	–	−.11	.02
Ph (Mg (dl)	5.9 ± 0.6	5.4 ± 0.5	−8.5	4.559	.001	−.83	.29	.74
Protein (Mg/dl)	1.3 ± 0.7	1.4 ± 0.9	7.7	−.274	.785	.14	−.39	.30
Glucose (Mg/dl)	0.0 ± 0.0	71.1 ± 216.5	–	−2.203	.033	–	−136.16	−6.07
Weight (Kg)	78.0 ± 7.9	75.6 ± 7.7	−3.1	18.097	.001	−.30	2.10	2.62
BMI (Kg/m^2)	24.4 ± 2.5	23.9 ± 2.4	−2.0	7.370	.001	−.20	.37	.65
Muscle (Kg)	37.3 ± 4.0	36.2 ± 3.7	−2.9	6.923	.001	−.27	.78	1.43
Fat (Kg)	16.0 ± 5.1	12.0 ± 4.2	−25.0	10.433	.001	−.78	3.20	4.74
LET	27.7 ± 2.2	28.2 ± 1.7	1.8	−1.704	.096	.23	−1.04	.09
CFS	18.7 ± 5.0	18.9 ± 4.9	1.1	−.261	.796	.04	−1.71	1.32
AAQ-II	6.0 ± 4.4	5.7 ± 4.3	−5.0	.717	.478	−.07	−.61	1.28
PSS	20.3 ± 7.2	21.2 ± 7.4	4.4	−1.161	.253	.13	−2.38	.65
STAI S/A	21.7 ± 10.1	10.6 ± 6.6	−51.2	6.220	.001	−1.10	7.47	14.69
STAI T/A	9.9 ± 5.1	9.3 ± 5.6	−6.1	.823	.416	−.12	−.92	2.18
Alertness	25.2 ± 6.6	12.0 ± 10.3	−52.4	8.499	.001	−2.00	10.04	16.33
Sadness	9.5 ± 9.1	2.8 ± 3.5	−70.5	5.112	.001	−.74	4.03	9.33
Tension	22.0 ± 9.1	9.1 ± 11.0	−58.6	5.909	.001	−1.42	8.47	17.32
Motivation-loss	18.5 ± 8.2	23.3 ± 10.0	25.9	−3.498	.001	.59	−7.56	−2.01
Happiness	21.4 ± 9.2	31.9 ± 6.5	49.1	−6.290	.001	1.14	−13.95	−7.15
Weariness	21.9 ± 8.9	25.9 ± 7.9	18.3	−2.270	.029	.45	−7.42	−.42
Calmness	15.4 ± 9.1	22.4 ± 11.5	45.5	−3.020	.005	.77	−11.61	−2.29
Sleepiness	18.6 ± 11.7	17.9 ± 11.1	−3.8	.299	.766	−.06	−3.95	5.32
Global Vigour	67.0 ± 4.5	63.1 ± 6.2	−5.8	3.848	.001	−0.87	1.89	5.99
Global Affect	51.4 ± 6.0	59.2 ± 6.9	15.2	−6.236	.001	1.30	−10.33	−5.29
DAT-SR5 (correct)	7.8 ± 1.8	6.8 ± 2.2	−12.8	2.659	.011	−.56	.23	1.67
DAT-SR5 (correct-wrong)	5.2 ± 3.7	3.5 ± 4.2	−32.7	2.520	.016	−.46	.33	2.99
DAT-SR5 (wrong)	2.2 ± 1.8	3.0 ± 2.1	36.4	−2.352	.024	.44	−1.54	−.12

Subjective Stress Perception (SSP), Fatigue Subjective Perception (FSP), Rated Perceived Exertion (RPE), Critical Flicker Fusion Threshold (CFFT), Body Temperature (BT), Blood Oxygen Saturation (BOS), Heart Rate (HR), Forced Vital Capacity (FVC), Forced Expiration Volume (FVE1), Peak Expiratory Flow (PEF), Forced Expiratory Flow (FEF), Body Mass Index (BMI), Life Engagement Test (LET), Coping Flexibility Scale (CFS), Acceptance and Action Questionnaire (AAQ-II), Percieved Stress Scale (PSS), State Anxiety (STAI S/A), Trait Anxiety (STAI T/A), Differential Aptitude Test- Spatial Relations (DAT-SR5)

Table 2 Modification of psychophysiological variables in higher and lower fat mass loss during the exercise

	HIGHER FAT MASS LOSS						LOWER FAT MASS LOSS					
Variable	Pre	Post	% Change	t	P	Effect Size	Pre	Post	% Change	t	P	Effect Size
FVC (ml)	4.8 ± 0.9	4.5 ± 0.9	−6.3	1.186	.250	−.33	4.9 ± 0.6	5.0 ± 0.7 (.039)	2.0	−1.650	.112	.17
Horizontal jump (m)	1.6 ± 0.2	1.4 ± 0.2	−12.5	3.814	.001	−1.00	1.7 ± 0.2 (.004)	1.4 ± 0.2	−17.6	6.433	.001	−1.50
Ph (Mg/dl)	5.8 ± 0.6	5.5 ± 0.5	−5.2	1.674	.110	−.50	6.1 ± 0.5 (.047)	5.4 ± 0.6	−11.5	5.127	.001	−1.40
Weight (Kg)	75.4 ± 6.1	73.0 ± 5.9	−3.2	13.088	.001	−0.39	80.4 ± 8.6 (.024)	78.1 ± 8.5 (.027)	−2.9	12.872	.001	−.27
Muscle (Kg)	34.9 ± 2.9	34.4 ± 2.9	−1.4	3.017	.006	−0.17	39.5 ± 3.6 (.001)	38.0 ± 3.6 (.001)	−3.8	6.851	.001	−.42
Fat (Kg)	18.3 ± 4.4	12.4 ± 3.9	−34.4	16.788	.001	−1.34	13.8 ± 4.8 (.001)	11.6 ± 4.4	−15.9	5.150	.001	−.46
Alertness	23.3 ± 7.3	10.4 ± 10.1	−55.4	5.158	.001	−1.77	26.2 ± 6.4 (.045)	12.9 ± 10.6	−50.8	7.063	.001	−2.08
Calmness	16.0 ± 9.3	27.9 ± 8.7	74.4	−3.783	.001	1.28	15.5 ± 9.2	18.3 ± 12.0 (.005)	18.1	−.947	.355	.30

Forced Vital Capacity (FVC). Between parenthesis *p* values lower than 0.05 between higher and lower fat mass loss groups

Table 3 Modification of psychophysiological variables in higher and lower muscle mass loss during the exercise

	HIGHER MUSCLE MASS LOSS						LOWER MUSCLE MASS LOSS					
Variable	Pre	Post	% Change	t	P	Effect Size	Pre	Post	% Change	t	P	Effect Size
FSP (1-100)	59.3 ± 17.9	79.3 ± 7.6	33.7	−4.531	.001	−0.46	69.8 ± 13.6 (.027)	80.9 ± 11.3	15.9	−4.578	.001	−0.82
HR (bpm)	75.7 ± 14.8	79.2 ± 12.7	4.6	−.820	.421	−1.21	85.9 ± 16.6 (.029)	86.7 ± 11.8 (.050)	0.9	−.163	.872	−0.05
Muscle (Kg)	38.5 ± 3.5	36.6 ± 3.5	−4.9	10.643	.001	0.11	36.1 ± 4.2 (.045)	35.7 ± 4.0	−1.1	2.250	.035	0.10
Fat (Kg)	13.9 ± 4.7	11.4 ± 4.1	−18.0	6.548	.001	−0.38	18.2 ± 4.6 (.003)	12.7 ± 4.2	−30.2	11.149	.001	1.20
Calmness	13.5 ± 8.8	17.7 ± 11.6	31.1	−1.389	.181	−0.32	17.7 ± 9.1	27.6 ± 9.1 (.025)	55.9	−2.909	.010	0.31
DAT-SR5 (right)	8.1 ± 1.8	6.3 ± 2.2	−22.2	3.962	.001	0.21	7.4 ± 1.6 (.050)	7.4 ± 2.2	0.0	−.111	.913	−0.03
DAT-SR5 (right/wrong)	6.3 ± 3.7	2.9 ± 4.1	−54.0	3.813	.001	1.60	4.1 ± 3.5 (.050)	4.2 ± 4.4	2.4	−.110	.913	0.00
DAT-SR5 (wrong)	1.9 ± 1.8	3.5 ± 2.1	84.2	−3.431	.003	0.65	2.6 ± 1.6 (.050)	2.6 ± 2.2	0.0	.111	.913	0.19

Fatigue Subjective Perception (FSP), Heart Rate (HR), Differential Aptitude Test- Spatial Relations (DAT-SR5). Between parenthesis p values lower than 0.05 between higher and lower muscle mass loss groups psychophysiological response. Second hypothesis was partially complied since higher muscle mass loss group presented cognitive impairment and same psychophysiological response than lower fat mass loss group.

In line with previous studies where there were a stressful, energy deficit and a sleep deprivation environment, fatigue subjective perception, motivation-loss and weariness increased, and alertness, sadness and tension decreased immediately after the finalization of the exercise [14, 35]. This could be explained by the sense of self-accomplishment and the end of the full training program [17], mitigating the adverse effects of sleep deprivation [35] and also reflecting the increase on Global Affect and the decrease on Global Vigour. The increase on the perceived stress could be related to the inherent aspect of survival and obstacles confrontation, that in line with the increase of global affect during the exercise, referred the affective and psychophysiological response of the anxious experience derived by the eliciting combat situations [11, 18]. In this exercise the stress was caused by the uncertainty of the unknown and the high physical and psychological demands.

In contrast with previous researches in military population [11, 36], leg strength decreased significantly while hand strength slightly increased. Decreases in body composition have been related to a decline in leg strength but not in hand strength as in other studies [16, 37, 38], showing different effect of fatigue in muscular systems. The body mass loss after the exercise could also be related to the stress of the continuous effort which decreased body weight, fat mass and fat and muscular mass [16]. This fact was in line with other military training programs were, along with all above-mentioned, there was an energy deficit [14]. The organic response in a stressful situation in which the physical integrity of the individual is endangered is modulated by the activation of fight-flight system [39, 40]. this activation causes an increase in the epinephrine and norepinephrine secretion, inhibiting digestion, dilating the bronchial tubes in the lungs, dilating heart vessels, and tensing muscles [41] and a consequent increase in blood oxygen saturation as previous research [5]. The decrease of leg strength could be explained by the fatigue and the parasympathetic backlash after the fight-flight system activation. After a large sympathetic activation there is a violent reaction of the parasympathetic nervous system which could explain together with sleep deprivation the increase in fatigue having an effect on a decreased alertness, leg strength, peak expiratory flow and cortical arousal [42]. Regarding this transient emotional state, data also demonstrate the decrease in state anxiety and tension. In line with studies with this combat situations and non-experienced subjects [7, 43, 44] the excessive alertness can lead to symptoms of central nervous system fatigue and a shortfall in cortical arousal, also found in our research. This decrease in cortical arousal was associated with fatigue and impairment in executive functions required for information processing and decision-making [45], fact reflected in the increase of bad answers on DAT-SR5, results also found and by previous studies where cognitive functions were negatively affected by combat stress [8, 46]. Stressors that influence warfighters physical performance are exertional fatigue, sleep deprivation, caloric deficit where provisions for full recovery are limited resulting on a degradation of proteins increasing blood glucose levels [14, 17, 38]. This fact could also affect the hydration during the manoeuvre since urine test showed a dehydration and an increase on Ph level. This dehydration, related to possible low ingest of fluid and an increase of sweating rate due to heavy exercise, had a negative effect on sustaining physiological function and worsening physical performance [47].

Comparison among groups showed that the group with lower fat mass loss presented a significative increase post course in full vital capacity in relation to higher fat mass loss. This could be explained by the fact that the group with higher fat mass loss experienced a higher physical and caloric demands showing fatigue of inspiratory muscle in line with previous research [48] also demonstrated by significative comparison post course on weight and muscle mass. Calmness values increased significantly within higher fat mass loss group probably due to the parasympathetic backlash after this high demanding exercise. Regarding muscle the group with a higher muscle mass loss presented a significant increase on wrong answers from DAT-SR5 while lower muscle mass loss group presented a significant increase on correct answers. This could be related with cognitive impairment caused by higher stress and higher muscle degradation as studied in previous research in special operations units such as SEAL's [46]. Higher muscle mass loss activation was reflected in increase in HR which might be caused by the greater physical activity and sympathetic activation as in previous studies during stress combat situations [7].

Limitation of the study

The principal limitation of the present research was the small sample size analysed and the no control of stress hormones as amylase or cortisol. These limitations were unavoidable since the difficulty access to this population group and it was also subjected to financial and technological constraints that foreclosed a larger study.

Practical application

Results on psychophysiological response of soldiers undertaking a special operation selection course enhance the importance of a training programme with strength sessions in order to prevent the decrease in muscle strength when high volume and low intensity aerobic effort are performed. In addition, training should consider psychological effects under high stress situations as it could be an optimal tool to improve cognitive impairment and manage combat stress. Also, caffeine could be useful to mitigate many of the adverse effects caused by sleep deprivation improving mood in a dose-related manner [20, 46].

Conclusion

A special operation selection course induced an intense stress and physical response founding an increase in fatigue and stress subjective perception, blood oxygen saturation, Ph, cognitive impairment motivation-loss. Moreover, decreased leg strength, peak expiratory flow, cortical arousal, body composition, body weight, fat and muscle mass, anxiety stress, alertness, sadness and tension right after the finalization of the exercise In addition, higher muscle mass loss participants presented higher cognitive impairment and a similar psychophysiological response than lower fat mass loss participants.

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Compliance with Ethical Standards

Conflict of Interest Author Alberto Hormeño-Holgado declares that he has no conflict of interest. Vicente Javier Clemente-Suarez declares that he has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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