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EFFECTS OF TWO 8-WEEK PHYSICAL TRAINING MODELS (TRADITIONAL AND SPECIFIC) ON IMPROVED MILITARY PHYSICAL PERFORMANCE

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Abstract:
The aim of this study was to compare the effect of eight weeks of traditional physical training (TPT) and military-specific physical training (MSPT) on the physical and operational performance of infantry cadets of the Brazilian Air Force (BAF). This study consisted of 27 male cadets (22.8±1.6 years, 76.0±9.2 kg, 1.77±0.05 m) stratified according to initial levels of physical fitness and randomly allocated in TPT (n= 13) or MSPT (n= 14) groups. The TPT group performed the basic military physical training provided for the military and the MSPT group conducted specific operational training. The variables were analyzed through two evaluations at the beginning and end of the eight-week training protocol. Anthropometric evaluations, physical fitness, and military operational physical tests were performed. Internal training load was determined through session rating of perceived exertion. Two-way (group and time) analysis of variance was used to compare groups and periods of training. Bonferroni test was used as a post-hoc when necessary.

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The effect sizes were presented by partial eta squared (η_{p^2}) and Cohen d_z. No group and time interaction was found for any variable. Regarding the time effect, there was a decrease in both groups in the anthropometric variables. The variables that increased over time for both groups were push-up and sit-up repetitions in 1 min, aerobic power, and squat jump height, whereas time in the military operational physical test decreased. Regarding the internal training load, no interaction between the group and period was observed. Therefore, both TPT and MSPT groups were effective in improving the physical and operational performance of military personnel after eight weeks of training.

Keywords: armed forces, military operational capability, military physical training, exercise

1. Introduction

The Brazilian Air Force (BAF) represents the Brazilian military institution that takes care of air defense and has as its mission to maintain the sovereignty of airspace and integrate the Brazilian territory, with a view to the defense of Brazil (Brazil, 2018). The physical conditioning of its members represents an important aspect of the execution of the duties of military personnel who face strenuous conditions in their field of activity. Physically fitter military personnel improve professional performance and psychological attributes (Deuster & Silverman, 2013).

Given the importance of physical conditioning, systematized physical exercise programs are important in the military area, since they promote the improvement of aerobic fitness (Santtila et al., 2008), muscle power, and endurance (Maior et al., 2006), in addition to morphological changes, such as the reduction in body fat percentage (Mikkola et al., 2009, 2012). In the case of BAF, the main physical capacities required are muscle strength, aerobic fitness, anaerobic endurance, localized muscle endurance, and flexibility (Brazil, 2011). Such capabilities should be trained according to the theoretical assumptions for the improvement of the physical fitness of the subjects and appropriate to the specific requirements of the daily life of military personnel. In particular, combined training of muscle strength and aerobic endurance should be the basis of physical performance in the military (Kraemer et al., 2004).

On a daily basis at BAF, physical training is developed based on the guidelines of the Manual of Military Professional Physical Training in the Aeronautics Command (Brazil, 2007). This training is carried out for all military personnel, seeking at improving physical fitness and has as its goal, the approval of the military in the Physical Conditioning Assessment Test, held annually. The training integrates aerobic activities (continuous running, interval running, and circuit training) and muscle endurance (localized calisthenics), both for the upper and lower limbs (Brazil, 2007).

On the other hand, programs in circuit, emphasizing specific exercises, performed in high intensity, gained popularity among the military, especially by using movements experienced in possible combat situations (Heinrich et al., 2012). By addressing several domains of physical conditioning, this training seems to favor greater physical and mental readiness in an operational environment (Jonas et al., 2010), in addition to developing high levels of aerobic endurance, muscle endurance, and strength in relation to the current recommendations of physical training for military personnel (Haddock et al., 2016). This strategy has been demonstrated to produce similar and significant improvements in military physical performance as the traditional approach (Harman et al., 2008; Heinrich et al., 2012). Studies of this nature, which aim to explore the responses of specific training (focused on military operation), may be important to optimize the preparation of BAF military personnel, especially in training schools. Thus, the present study aimed to compare the effect of eight weeks of traditional physical training (TPT) and military-specific physical training (MSPT) on physical and operational performance in infantry cadets of the BAF. The two hypotheses of the study were: 1) eight weeks of systematized physical training would result in positive effects on the physical and operational capacity of the military and; 2) MSPT training would be more effective in the physical fitness of the military.

2. Material and Methods

2.1 Participants and Study Design

For the selection of the sample (intentional and casuist), the following criteria were used: a) to be an infantry male cadet of the BAF; b) to have a history of at least one year of systematized physical training; and c) to present a medical certificate of good health conditions to perform physical exertion. After meeting the participation criteria, the cadets were randomly allocated, after physical fitness stratification into two physical training groups: TPT Group, which carried out the Traditional Physical Training provided for the BAF military; and the MSPT Group, which carried out specific operational exercises. Initially, the study started with 28 cadets, 14 for each group and, during the course of the research, one of the TPT group left the study because he was dismissed from the BAF (for academic reasons), resulting in 13 individuals in the TPT and 14 in the MSPT Group.

Stratification to training groups resulted in statistically equivalent groups in all anthropometric, body composition, and physical fitness measurements at baseline. The subjects participated voluntarily by being informed about the study design and about the possible risks and discomforts that could occur. This study was approved by the local ethics committee (nº 3.094.084).

The cadets were submitted to anthropometric measurements (height, body mass, and circumferences), body composition assessments (skinfold thickness, body fat percentage, and muscle thickness measurements), and physical fitness tests: strength endurance via push-ups and sit-ups in one minute, aerobic power (12-minute Cooper test), lower limbs muscle power (vertical jumps) and military operational physical test.

Each of the measurements was performed before the beginning (baseline) and at the end of the respective training programs (post-training). All physical tests were performed at the same time of day and under similar climatic conditions, being performed on four consecutive days. It is worth be noted that in the present study, no injury was observed that took the subject away for more than two days of training.

2.1. Procedures

2.1.1 Anthropometric and Body Composition Measurements

For height collection, a Wiso® (Santa Barbara d'Oeste, Brazil) stadiometer was used, the cadets remained in an upright position, bare feet, leaning against a flat and vertical surface, heels together, head adjusted to the Frankfurt plane and deep inspiration. Body mass was measured with barefoot cadets, dressed in shorts on a digital scale (Welmy®, Santa Barbara d'Oeste, Brazil) with an accuracy of 50g. Skinfold thickness measurements were performed by a Cescorf® adipometer (Curitiba, Brazil), previously calibrated. All measurements (triceps, pectoral, abdominal, thigh, and medial leg, measured in mm) were collected alternately three times on the right side of the body by two experienced evaluators, with an inter-evaluator error of 1.3%, being considered acceptable for this type of test (Perini et al., 2005). To estimate body fat percentage, the equation for three skinfolds (pectoral, abdominal, and thigh) was applied according to the protocol proposed by Jackson & Pollock (1978) for the determination of body density and the Siri equation (Siri, 1961).

Muscle thickness was measured using a B-mode ultrasound (Bodymetrix pro System, Intelametrix Inc., Livermore, USA). A trained researcher in imaging equipment performed all evaluations. Measurements were performed on the right side of the body in four sites: brachial biceps, brachial triceps, vastus lateralis, and femoral rectus. Data collection followed the pre-established protocol (Abe et al., 2000). Each of the anatomical points was scanned three times and the mean values of the three images were considered. In addition, the analyzed sites were marked with henna ink throughout the study to ensure that the probe was positioned correctly in the same location after the training period.

Data on the circumferences of contracted biceps, waist, and hip were collected. To perform the circumference measurements, a flexible anthropometric tape was used that allowed the application of adequate pressure on the skin surface during the measurement. The circumference of the biceps was measured with the elbow flexed at 90º and contracted, being measured as the largest circumference in centimeters. Waist circumference was measured in the horizontal plane from the point coincident with the mean distance between the last rib and the iliac crest. The measurement was obtained at the end of a normal expiration, without excessive compression of the skin. On the other hand, hip circumference was measured in the horizontal plane, at the highest level of posterior protuberance of the buttocks. According to the results, the waist and hip circumference ratio (WHR = Waist/Hip) was performed.

2.1.2 Physical Fitness Tests

- Push-up: The cadet started the test with his hands open and supported to the ground, slightly apart from the projection of the shoulders, elbows fully extended, maintaining the alignment between trunk, hip, and legs. Being given the starting sign, he flexed his elbows, trying to approach the chest of the ground, keeping the body extended, passing the trunk from the elbow line (projected out approximately 45º in relation to the trunk), and returning later to the initial position. As a result, the highest number of correct repetitions performed was registered in one minute (Brazil, 2011).
- Sit-up: The cadet began the test in dorsal decubitus position, with knees flexed and the soles of the feet fixed to the ground, right and left forearms crossed over the trunk with his hands resting on his shoulders. At the beginning sign, the cadet performed the anterior flexion of the spine by touching the elbows in the distal third of the thigh and returning to the initial position. The highest number of repetitions were performed in one minute (Brazil, 2011).
- 12-minute Cooper test: The test was performed on a 400m track. The track was signaled every 10m to make it easier to measure the distance reached in the test. Cadets should cover as far as possible for a period of 12 minutes. The values were recorded and the calculation of the maximum aerobic power was performed by the formula: VO_{2max} = (distance covered in meters - 504.9) / 44.73. Data were expressed in mL/kg/min (Brazil, 2011).
- Vertical jumps: In the vertical jump test with half squat, the cadet positioned himself on the contact plate (Jump Test®, Hidrofit, Belo Horizonte, Brazil) with his knees flexed at 90º for at least two seconds, with his trunk upright, looking forward and with his hands resting on his waist. The vertical jump was performed with a strong and fast extension of the knees and hip, with his hands always resting on the waist. In the vertical jump test with countermovement, the cadet positioned himself on the contact plate standing, with knees and hip fully extended, looking forward, and with his hands resting on his waist. The cadet then flexed and then extended his knees and hip, keeping his hands always resting on his waist. In both tests, the results were presented by values of the height reached (cm) of the jump performed (Bosco, 1993).
- Military Operational Physical Test (MOPT): The cadet was equipped with a Brazilian operating uniform, which consisted of camouflage uniform, ballistic helmet (1.5 kg), ballistic vest (2.3 kg), a rifle with sling (4 kg) with 20 cartridges 5.56 mm (0.35 kg), a pistol (0.9 kg), a magazine with fifteen 9 mm cartridges and a tactical vest (1.4 kg) totaling approximately 10.75 kg of equipment. The operational track was composed of obstacles simulating a possible ambush situation. The cadet departed from the dorsal decubitus position, got up, and executed 4 consecutive races of 6.2 m in distance each, changing direction after each. After the fourth, the cadet performed 11.3 m of crawling, followed by 21.8 m of running. He

then ran for 21.8 m jumping over three 40 cm hurdles spaced by a distance of 5 m between them. Then he got up, and carried 2 weights of 16 kg for 2.5 m, 4 consecutive times. He then zig-zagged for 42.4 m until he reached a 65 kg mannequin, dragging it through a 24 m circle to, finally, run to the start line, totaling approximately 242.5 m of course (Pihlainen et al., 2018). Before the test, there was a reconnaissance pass (walk) so that the cadet could clearly identify the sequence of test execution. After this initial passage, only one attempt was made by the evaluated person, which was considered valid. Thus, all cadets were asked to make every effort to cover the route in the shortest possible time.

2.1.3 Training Protocols

The physical training protocols were conducted at the beginning of the school year (January, February, and March) of the BAF Infantry Officer Training Course. The training lasted eight weeks. A total of 32 training sessions were held lasting 80 minutes each. The number of training sessions was according to the availability of the military organization's schedule of activities. The internal training load was quantified in all training sessions, in both protocols. Before each training session of both protocols, the cadets performed warm-up and at the end of stretching, both lasting between five and ten minutes.

- Traditional Physical Training: The TPT group performed the MPT composed of continuous and interval running exercises, sports, aquatic activities, and neuromuscular exercises under the format of calisthenics circuit training, based on the Instruction manual of the Air Force Command "Military Professional Physical Training in the Air Force Command (ICA 54-3)” (Brazil, 2007). The continuous running was executed in a time of 30 to 40 min, according to the schedule of each training. The interval running suffered variations in the number of stimuli, distances, and/or by time, and the pauses were from 30 to 80s over the eight weeks period. In the calisthenics circuit training, three to five sets of 15 to 20 repetitions (lunge, push-ups, sit-ups, ascent in the bleachers, isometric plank, lunges, abductor, and trunk extension) of each exercise were executed, being performed with the weight of their own body mass.
- Military-specific Physical Training: At MSPT, training sessions were distributed in: circuit training, cross-country continuous running, high-intensity interval running, and high-intensity specific training (HIST). The circuit training was divided into two (specific and operational), consisting of ten exercises for lower and upper limbs based on operational specific movements (jumping barriers and obstacles, throws, displacements, running with change of direction, and squats). In the circuit, cadets should pass through all stations, covering the entire route in the shortest possible time (8 to 10 passages with a passive interval of 90 s). In the operational circuit, the training load was performed by increasing the number of series (2 to 3) in each exercise and the stimulus times of the circuit (30 s to 1 min).

In both circuits, implements such as medicine balls, tires, barriers, and 10 kg operating backpack were used. The continuous cross-country race was held in rough terrain. The training intensity was gradually increased from 60% to 90% based on initial physical performance. In the interval race, the training sessions were held on a dirt track. The running sprints were performed at a distance of 400 m. The number of repetitions performed was increased weekly according to the degree of conditioning of the volunteer (6 to 13 sprints) with a passive interval of 90s. HIST training was composed of plyometrics, sit-ups, push-ups, and squats, which were performed at high intensity for 20 s, with a passive interval of 10 s, with 5 to 8 sets.

- Internal training load: The internal training load was quantified through the rating or perceived exertion (RPE), multiplied by the duration of the training session (in minutes), expressed in arbitrary units (a.u.) (Foster et al., 2001). Based on the values obtained, the internal weekly training load was also calculated, summing up all training days, and determining the average load of the week and its variation (standard deviation). These measures were used to calculate monotony (weekly variation indicator). Monotony, along with the total weekly load (sum of the daily), was used to calculate the strain (stress index applied to the cadet in the week). The following formulas were applied (Foster et al., 2001): Daily load = RPE x daily session duration in minutes; Total weekly load = ∑ daily load; Average weekly load = ∑ daily load/∑ days of training; Monotony = average weekly load/standard deviation of daily loads; Strain = Monotony x total weekly load.

2.2 Statistical Analyses

Data were expressed as mean and standard deviation. Data normality was verified by the Shapiro-Wilk test and the homogeneity test by the Levene test. The Mauchly sphericity test was used to determine sphericity, which was confirmed. To verify possible differences in randomized groups according to the initial levels of physical fitness at the beginning of training, an independent Student t-test was applied. To compare the groups and the training period, a two-way analysis of variance (ANOVA; group: TPT vs MSPT and time: pre and after eight weeks) with repeated measurements in the second factor was used. For the comparison of the internal training load (RPE and a.u.), a two-way ANOVA (group: TPT and MSPT; time: week 1 to week 8) with repeated measurements for the second factor was used. When a significant difference was detected by ANOVA, the Bonferroni post-hoc test was conducted.

The effect sizes were presented by the partial squared eta (η_p^2), considered small (< 0.06), medium (0.06 to 0.14), and large (> 0.15) (Lakens, 2013), and Cohen's d_z, dimensioned as trivial (≤ 0.2), small (> 0.2 to < 0.6), medium (> 0.6 to < 1.2), large (> 1.2 to < 2.0), and very large (≥ 2.0) according to theoretical assumptions (Hopkins et al., 2001; Hopkins et al., 2009). The analyses were performed using Statistica for Windows software, version 5.0, and IBM SPSS, version 22.0. The significance level was $p < 0.05$.

3. Results

Table 1 shows the effect of training on anthropometric and body composition variables. No interaction of week and group factors was found for any variable.

Table 1: Results of anthropometric and body composition variables in relation to the two training models in the pre- and post-intervention moments

	MSPT (n = 14)		TPT (n = 13)		Interaction Group*Time		
	Pre	**Post**	**Pre**	**Post**	**F**	**η_p^2**	**P**
Body mass (kg)	73.6±8.5	73.3±8.4*	78.5±9.6	76.9±7.8*	2.50	0.091	0.126
Body fat (%)	11.4±3.8	10.9±4.1	14.3±5.9	13.6±5.3	0.12	0.011	0.397
Circumferences (cm)							
Contracted Biceps	31.6±2.2	29.6±2.0*	32.9±1.8	31.7±2.3*	1.92	0.072	0.178
Waist	81.4±5.5	77.4±3.8*	83.9±7.9	79.7±5.2*	0.03	0.002	0.868
Hip	95.5±4.8	94.5±5.0*	99.8±6.9	98.3±6.4*	0.16	0.007	0.691
Waist-Hip Ratio	0.85±0.04	0.82±0.03*	0.84±0.05	0.81±0.03*	0.01	0.001	0.933
Muscle thickness (mm)							
Rectus Femoris	36.000 ±4.548	34.788 ±4.293*	34.613 ±5.269	33.406 ±5.139*	0.00	0.000	0.995
Vastus Lateralis	21.089 ±1.734	21.644 ±2.192	22.262 ±2.681	22.123 ±2.558	0.86	0.035	0.365
Brachial Biceps	27.820 ±4.011	27.021 ±4.347	27.916 ±4.911	29.173 ±4.756	2.90	0.107	0.101
Brachial Triceps	25.326 ±3.115	26.171 ±3.006	28.306 ±5.920	28.525 ±4.903	0.30	0.012	0.594

Note: MSPT = Military-specific Physical Training; TPT = Traditional Physical Training; Σ = Summatory; * = time factor effect ($p < 0.05$). Data expressed as mean ± standard deviation.

Regarding the moments' differences, the main effect revealed that the variables that decreased with the weeks were: body mass ($F_{1,25} = 6.03$; $\eta_p^2 = 0.194$; P = 0.021), with pre values superior to the post-training (p = 0.024; d = 0.11, trivial); circumferences of the contracted biceps ($F_{1,25} = 31.99$; $\eta_p^2 = 0.561$; P < 0.001), with pre values superior to the post-training (p < 0.001; d = 0.72, mean); waist ($F_{1,25} = 20.32$; $\eta_p^2 = 0.448$; P < 0.001), with pre values superior to the post-training (p < 0.001; d = 0.70, medium); hip ($F_{1,25} = 6.81$; $\eta_p^2 = 0.214$; P = 0.015), with pre values superior to the post-training (p = 0.015; d = 0.21, small); waist-hip ratio ($F_{1,25} = 12.46$; $\eta_p^2 = 0.333$; P < 0.001), with pre values superior to the post-training (p < 0.001; d = 0.85, mean); and rectus femoris thickness ($F_{1,24} = 6.81$; $\eta p^2 = 0.221$; P = 0.015), with pre values higher to the post-training (p = 0.015; d = 0.25, small).

Table 2 presents the neuromuscular and military-specific results at the different moments of the study. No interaction between the week and group factors was found.

Regarding the moments comparisons, the main effect indicated an increase push-up performance ($F_{1,24}$ = 48.28; η_p^2= 0.668; P < 0.001), with pre values lower than the post-training (p < 0.001; d = - 1.04, medium); sit-ups ($F_{1,25}$ = 26.04; η_p^2 =0.510; P < 0.001), with pre values less than the post -training (p < 0.001, d = - 0.56, small); aerobic power ($F_{1,25}$ = 84.36; ηp^2 = 0.771; P < 0.001), with pre values lower than the post-training (p < 0.001; d = - 1.39, large), and height in the squat jump ($F_{1,25}$ = 6.77; η_p^2 =0.213; P = 0.015), with pre values inferior to the post-training (p = 0.014; d = - 0.40, small); and reduced the time in the military operational physical test ($F_{1,25}$ = 17.83; η_p^2= 0.416; p < 0.001), with pre values higher than the post-training (p < 0.001; d = 0.64, medium).

Table 2: Results of neuromotor and functional variables in relation to the two training models in the pre- and post-intervention moments

	MSPT (n = 14)		**TPT** (n = 13)		**Interaction Group*Time**		
	Pre	**Post**	**Pre**	**Post**	**F**	**η_p^2**	**P**
Push-ups 1 min (n)	47±6	60±9*	46±13	54±13*	4.19	0.149	0.051
Sit-ups 1 min (n)	61±8	66±8*	65±9	70±11*	0.09	0.004	0.774
VO_2max (mL/kg/min)	46.8±5.2	52.5±3.9*	45.0±5.1	51.8±3.7*	0.77	0.030	0.390
Squat Jump - Height (cm)	30.2±3.6	32.4±3.7*	29.9±6.1	31.4±5.6*	0.22	0.009	0.645
Countermovement Jump - Height (cm)	31.6±5.1	33.0±5.0	30.4±5.9	31.3±6.6	0.08	0.032	0.777
Military operational physical test (s)	107.3 ±8.7	101.4 ±7.1*	110.7 ±11.3	104.3 ±11.4*	0.02	0.000	0.882

Note: MSPT = Military-specific Physical Training; TPT = Traditional Physical Training; * = time factor effect (p < 0.05). Data expressed as mean ± standard deviation.

Table 3 presents the characteristics of the training weeks of the MSPT and TPT groups. Regarding the internal training load, there was an effect on the group factor ($F_{1,7}$ = 4.73; η_p^2= 0.159; P = 0.039), with higher values for the MSPT group compared to the TPT group (p = 0.039). There was a significant effect for the week factor ($F_{1,7}$ = 53.23; η_p^2= 0.680; P < 0.001). Specifically, the internal load at week 1 was lower than those of weeks 2, 3, 4, 7, and 8 (p < 0.001). The internal load at week 2 was higher than those of weeks 5 and 6 (p < 0.001), and lower than in week 8 (p = 0.020). The internal load at week 3 was higher than those of weeks 4, 5, 6, and 7 (p < 0.001). The internal load at week 4 was higher than those of weeks 5 and 6 (p < 0.001), and lower than in week 8 (p < 0.001). Week 5 was lower than those of weeks 7 and 8 (p < 0.001). The internal load at week 6 was lower than those of weeks 7 and 8 (p < 0.001). Week 7 was lower than week 8 (p < 0.001).

In relation to monotony, a week effect was observed ($F_{1,7}$ = 4.85; η_p^2= 0.162; P < 0.001). Monotony at week 8 was higher than weeks 1 (p < 0.001; d = - 1.07, medium), 2 (p

< 0.001; d = - 0.81, medium), 3 ($p < 0.001$; d = - 0.93, medium), 4 (p = 0.006; d = - 0.79, medium), 5 (p = 0.027; d = - 0.60, medium), and 7 (p = 0.047; d = - 0.64, medium). For the strain, the effect of weeks was observed ($F_{1,7}$ = 11.27; η_p^2= 0.310; $P < 0.001$). The strain at week 8 was higher than weeks 1 (96.8; $p < 0.001$; d = - 1.26, large), 2 (59.5; $p < 0.001$; d = - 0.68, mean), 3 (62.9; $p < 0.001$; d = - 0.84, medium), 4 (65.5; $p < 0.001$; d = - 0.85, medium), 5 (90.8; $p < 0.001$; d = - 1.21, large), 6 (89.1; $p < 0.001$; d = - 1.19, medium), and 7 (57.2; $p < 0.001$; d = - 0.68, medium). Group and week interaction was observed ($F_{1,7}$ = 2.30; η_p^2= 0.085; P = 0.029). In the MSPT group, the strain at week 8 was higher than weeks 1 (77.7; p = 0.003; d = - 1.03, medium), 5 (82.1; $p < 0.01$; d = - 1.17, medium), and 6 (75.2; $p < 0.01$; d = -1.07, medium). For the TPT group, the strain at week 8 was higher than weeks 1 (117.5; $p < 0.01$; d = - 1.49, large), 2 (103.4; $p < 0.05$; d = - 1.30, large), 3 (72.6; p = 0.017; d = - 0.89, medium), 4 (70.2; p = 0.029; d = - 0.82, medium), 5 (100.1; $p < 0.001$; d = - 1.21, large), and 6 (104.1; $p < 0.001$; d = - 1.29, large).

Table 3: Description of the characteristics of the training weeks
of the Military-specific Physical Training and Traditional Physical Training

Week	MSPT				TPT			
	Average Weekly RPE (a.u)	**Average Load Internal Weekly Total (a.u.)**	**Monotony (a.u.)**	**Strain (a.u.)**	**Average Weekly RPE (a.u.)**	**Average Load Internal Weekly Total (a.u.)**	**Monotony (a.u.)**	**Strain (a.u.)**
1*	3.5±1.4	846±327	2.6±2.7	2741 ±4196	2.6±1.0	615±252	1.4±1.1	979 ±1171
2	4.3±1.9	1726±768	3.6±2.9	7464 ±7171	2.8±1.0	1126±415	1.8±0.8	2104 ±1477
3	4.6±1.1	1823±446	2.4±1.0	4652 ±2829	3.8±1.1	1502±433	3.0±1.5	4566 ±2544
4	3.7±1.4	1463±557	2.5±1.2	4059 ±3323	3.1±1.2	1225±468	3.4±2.1	4760 ±3575
5**	4.6±1.2	731±193	3.0±3.1	2388 ±2843	3.8±1.2	615±197	3.3±3.0	2367 ±2786
6**	4.8±0.7	760±116	3.7±3.5	2938 ±2869	3.8±0.8	609±125	3.1±2.6	2052 ±2103
7	3.5±1.5	1394±616	2.6±1.6	4361 ±4312	3.1±1.3	1225±504	4.0±2.6	5821 ±5783
8	4.6±1.0	1857±402	4.5±3.4	8954 ±7405 a,e,f	4.0±0.9	1588±371	5.9±3.6	10378 ±8897 a,b,c,d,e,f

Note: MSPT = Military-specific Physical Training; TPT = Traditional Physical Training. *Three training sessions per week. ** Two training sessions per week. Moment main effect: MSPT: a = different from week 1 ($p < 0.01$); e = different from week 5 ($p < 0.01$); f = different from week 6 ($p < 0.01$) and TPT: a = different from week 1 ($p < 0.01$); b = different from week 2 ($p < 0.05$); c = different from week 3 ($p < 0.05$); d = different from week 4 ($p < 0.05$); e = different from week 5 ($p < 0.001$); f = different from week 6 ($p < 0.001$).

4. Discussion

The aim of this study was to compare two types of physical training on physical and operational performance in infantry cadets of the BAF. To the best of our knowledge, this was the first study that compared different methods of physical training in this population. The results indicate that both training programs (TPT and MSPT) were effective in improving physical fitness and operational performance, with no statistical differences between them. Thus, the initial hypothesis of the present study that these eight-week training programs would induce significant improvements in the physical and operational fitness of the military was confirmed. However, the second hypothesis was rejected since the MSPT was not significantly better when compared to TPT.

The control of body mass, especially muscle mass, is fundamental for the military, since some studies (Chuang et al., 2017; Silva et al., 2020) demonstrated the relationship between body mass and physical fitness. Military personnel with high body mass may have lower-than-expected performances for the operational functions they perform (Gomez et al., 2019). Regarding body composition, similar results to our study were observed after eight weeks of intervention (Santtila et al., 2008) and after 12 weeks (El Hage & Reis Filho, 2013; Campos et al., 2017), which reported body mass and waist circumference reduction. We can point out that the decreases related to circumferences in the present study are possibly due to the reduction of total body mass. The reduction of waist circumferences and in the waist-hip ratio presented in both groups (TPT and MSPT) has clinical relevance, since it is an anthropometric indicator that confirms abdominal obesity. The waist-hip ratio is an important index to verify whether body fat is gathered predominantly in the central region of the body or extremities. It should be emphasized that the training phase of infantry cadets is extremely important, considering that this period has the function of preparing them for their military career, in which healthy habits, such as body mass control, may accompany them for the rest of their professional lives.

It was observed that only the thickness of the rectus femuris presented differences comparing the eight weeks of training. In a similar study with the same duration of the intervention period, there were no differences in the thicknesses of vastus lateralis and vastus medialis after a period of intervention in three different training groups (resistance, strength, and traditional training). However, in the thickness of the brachial triceps, a significant reduction was identified in resistance training and traditional training, with no changes in the strength training group (Santtila, 2010). We can consider that, in the present study, one only variable occurs a change in muscle thicknesses, indicating that the activities developed throughout the two types of military training (TPT and MSPT) were not specifically developed for this purpose. The training methodologies were elaborated with a view to improving various physical capacities. It is possible to affirm that a longer period of training, above eight weeks, could cause significant differences in this variable, since this same fact was found in a similar study (Spineti et al., 2013).

Some studies have indicated significant improvements in military personnel after undergoing MPT sessions in upper limbs endurance, corroborating that military training with an approximate duration of eight weeks promotes important adaptations in physical fitness (Campos et al., 2017; De Avila et al., 2013; El Hage & Reis Filho, 2013; Heinrich et al., 2012; Ojanen et al., 2020). Similar to the present study, however with lower improvement, Heinrich et al. (2012) showed that, after eight weeks of FMT intervention, the functional circuit training group presented greater efficacy compared to the traditional training of physical readiness of the Army.

Regarding abdominal endurance, studies with military personnel (Campos et al., 2017; El Hage & Reis Filho, 2013; Vantarakis et al., 2017) found significant results after MPT sessions, corroborating the results of the present study. It is noteworthy that, in a study with Greek military personnel lasting eight weeks, only the group that underwent additional strength training showed a significant improvement of 17.2%, whereas the control group did not change its performance (Vantarakis et al., 2017). In a study conducted with recruits, an increase of ~15 repetitions was observed in the sit-up test after a period of 12 weeks of training combined (running workouts, strength, agility, and flexibility) (Campos et al., 2017). In soldiers of the military police training course, an average improvement of ~12 repetitions were observed in the sit-up test after 12 weeks (El Hage & Reis Filho, 2013).

Such considerable increase in upper limbs and abdominal endurance in both groups are directly linked to the training applied, since, both in localized calisthenics (TPT) and circuit training (MSPT), strength endurance levels increased gradually due to the systematization developed during the eight weeks of intervention. It is considered that neuromuscular fitness is of paramount importance and much demanded in the military environment, since its members need to carry equipment for long periods. Even with technological advances, thanks to which the materials are lighter, the weight transported increased (Ojanen et al., 2020). This is mainly due to the need to carry more equipment, such as armors and radios (Drain et al., 2016; Kraemer & Ratamess, 2005).

When analyzing the aerobic power test, the MSPT group had an increase of 10.3% and the TPT group showed an increase of 12.5% in the distance covered. The results found in the present study are in line with those previously conducted, with training periods of six to 12 weeks of MPT (Campos et al., 2017; Conte & Dias Ferreira, 2016; El Hage & Reis Filho, 2013; Mikkola et al., 2012; Santtila, 2010). In a study with military personnel entering the Finnish mandatory military service, after 12 weeks of intervention, using a specific exercise protocol, obtained an average increase of 169 m in the 12-minute Cooper test (Mikkola et al., 2012). In Brazil, a study conducted with military personnel of the Military Police, after 12 weeks of running training, showed a variation from 2,572.1±261.6 m to 2,761.0±192.2 m in the same test (El Hage & Reis Filho, 2013). It is noteworthy that, in the present study, both training protocols presented positive results in the Cooper test after an eight-week intervention, corroborating with previous research with a similar period (Santtila, 2010).

When investigating the mean VO_2max of the participants in this study after the training period (52.2±3.7 mL/kg/min), we found that the values were higher when compared to Brazilians entering the mandatory military service: 50.4±4.8 mL/kg/min (Campos et al., 2017) after 12 weeks of MPT intervention. It is important to highlight that young military personnel present physical fitness levels above the population average for the same age group (Harman et al., 2008; Rossi Neto et al., 2019). It is also emphasized that aerobic power is one of the essential components of physical fitness in the military environment (Piirainen et al., 2019), and being relevant in optimizing the maximum performance of the execution of operational tasks, because these tasks frequently consist of several activities that require this capacity, such as marching, moving on terrains with different intensities and prolonged activity (Santtila et al., 2015).

We found an increase in the height of the squat jump test in both groups. These results are in line with those previously found in a study that analyzed two groups of physical training after eight weeks (Harman et al., 2008). In another study, developed with Finnish military personnel, three groups were evaluated: specific training for soldier tasks, strength training, and the control group, which performed basic training for military personnel. It was verified that only the group that performed the specific training for the soldier's tasks showed significant improvements in the lower limbs' muscle power (Ojanen et al., 2020).

In the present study, there was no improvement in the countermovement jump test performance, which allows us to assume that, possibly, a longer period or even a specific training of lower limbs strength/power would be needed to increase performance in this variable. It is worth mentioning that muscle power and force are physical capacities with a decisive impact on military activities, being involved in basically all the actions that the military performs. This degree of development, together with muscle endurance, directly conditions their ability to work operationally in the fulfillment of the missions imposed on them.

The results of the military operational physical test indicate that there was a reduction in time in both groups, which indicates that both training protocols were effective regarding the military operational physical performance. In addition to traditional physical fitness tests, a previous study included specific military tests to verify military physical performance, after eight weeks of intervention in two training groups (functional using body mass and standardized army training) and verified significant improvements in military tests in both groups (Harman et al., 2008), as observed in the present study. It is noteworthy that studies have reported that regular physical tests (aiming to analyze the health of the military) are not good predictors when compared to specific operational tests (Redmond et al. 2015; Silva et al. 2020; Worden and White III, 2012), thus needing specific tests aimed at military operational action. In addition to specific tests, physical training programs for military personnel, based on operational movements are of the utmost relevance because these types of training may favor greater physical and mental readiness in possible combat situations (Jonas et al., 2010).

Thus, it is of paramount importance to verify operational performance through specific tests. The test performed in the present study is a specific evaluation method of muscle strength, as well as resistance capacity which are crucial performance components in combat situations (Pihlainen et al., 2018). Current military activities require good physical conditioning in the execution of specific activities and are supported by their own equipment, such as armaments. In this way, survival on a battlefield is largely conditioned by specific muscle strength and endurance.

Notedly, the lack of studies and information aimed at analyzing the internal load of training in infantry personnel prevents specific comparisons of different training models. However, the weekly training load observed in our subjects was in the range reported in athletes from different sports: basketball athletes - between 2791±239 a.u. with two games per week and 3334±256 a.u. with no games in the week (Manzi et al., 2010); futsal athletes - from 440±234 a.u. to 3213±910 a.u. (Miloski et al., 2012); volleyball athletes - 1509,2±329.4 a.u. to 1987.1±371.5 a.u. (Freitas et al., 2015).

Both TPT and MSPT groups presented values of monotony above 2.0 a.u., except for weeks 1 and 2 for the TPT group. Monotony values above 2.0 a.u. indicate that there was little oscillation of training loads, favoring negative adaptations of training, and consequently providing decreased performance, and increased incidence of diseases, infections, and injuries (Foster, 1998). However, in the present study, it was observed that there was an improvement in performance (physical and operational) in both groups (TPT and MSPT), and no type of acute or chronic injury was reported that prevented cadets from participating in training.

The strain index variation found in both groups exceeds 6000 a.u. in some weeks. According to Foster (1998) strain index above this value may favor healthy problems. It is important to highlight that infantry cadets are trained to withstand hostile and extreme situations and engaged in real missions (Botta et al., 2022), a fact that may have influenced the rating of perceived exertion, since they "must" resist all kinds of effort. It can be observed that even contrary to the assumptions of the literature, it was found that significant improvements occurred in relation to physical and operational performance, as well as no reports of injury, diseases, and infections were verified. Therefore, the results obtained for both training groups were positive. However, future studies in relation to internal load in military personnel should be conducted for comparisons in this population.

This study presented some limitations, such as the number of training sessions, which had to adapt to the academic routine. Although the routine of cadets during the week is that of boarding school, whose eating habits are the same for everyone, that is, breakfast, lunch, dinner, and supper, there were no mechanisms to control what was consumed by them. These facts were mitigated with the randomization of the sample, but that may have influenced equally the results for both groups. The sample was knowledgeable of which group it belonged, since they were knowledgeable about TPT, however, it is believed that this did not influence the results of both groups. Finally, during the training, the cadets were verbally stimulated, but no tools were used to evaluate the feedback of satisfaction in relation to the training. Future research may examine whether a longer training time (over eight weeks) could lead to differences in the comparison between the two types of training.

5. Conclusion

The results indicate that both trainings (TPT and MSPT) were effective in improving physical capacities and operational performance, with no statistical differences between them. In fact, the training performed in the present study by both groups combined training methods of strength, power, and endurance, which may have contributed to the significant improvement after eight weeks of training as well as the absence of difference between the groups. The main difference between the groups refers to the fact that in the MSPT the exercises were performed from operational specific movements. Another point to be emphasized is that the cadets had at least one year of physical training in a military environment, which may have provided a significant homogeneity of the whole group regarding physical fitness. The internal training load did not differ between the training groups. However, for all outcome variables there was no interaction effect or main group effect. Thus, the results indicate that after eight weeks of TPT or MSPT improved in a similar way the physical and operational performance of infantry cadets of the BAF. In this way, the results provide additional support for the deployment of standardized MSPT-style programs.

Conflicts of Interest Statement
The author reports that there are no competing interests to declare.

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