



Original Research

Effects of 12 Weeks of Physical Training on Body Composition and Physical Fitness in Military Recruits

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ABSTRACT

International Journal of Exercise Science 10(4): 560-567, 2017. The aim of this study was to analyze the morphological and functional changes in military recruits after twelve weeks of physical training. The sample consisted of 130 volunteer recruits aged 18-19 years. Anthropometric variables were assessed (body weight, height, body mass index, arm, waist, and hip circumference, waist/hip ratio, skinfold thickness of the triceps, suprailiac, and abdomen, and body fat percentage) and the sit-up test (1 minute), push-up test, and 12-minute running test. The physical training protocol involved running workouts, strength, agility, and flexibility. Descriptive statistical procedures were performed with mean, standard deviation, variance, and percentage and the comparison between the two moments was performed using the Student t test for dependent samples. The significance level was set at $p < 0.05$. The results demonstrated a decrease in the sum of the three skinfolds (42.7 ± 25.2 mm to 33.9 ± 17.7 mm), a decrease in fat percentage ($14.1 \pm 7.3\%$ to $11.8 \pm 6.1\%$), an increase in lean mass (57.6 ± 6.0 kg to 58.6 ± 8.0 kg), and decreased fat mass (10.1 ± 6.4 kg to 8.3 ± 5.2 kg). They also showed improvements in push-up test (21.3 ± 9.0 to 33.5 ± 8.9), sit-up test (35.2 ± 8.3 to 49.8 ± 7.4), the 12 minute test (2212 ± 316 m to 2760 ± 214 m), and $\dot{V}O_2$ max (35.2 ± 8.3 ml.kg⁻¹.min⁻¹ to 49.8 ± 7.4 ml.kg⁻¹.min⁻¹). No differences were observed in body mass, height, body mass index, or hip circumference. According to the above, it was found that the methodology adopted in the physical training was effective in reducing the percentage of fat and increasing cardiorespiratory fitness, improving the physical capacity and health of the military recruits.

KEY WORDS: Soldiers, military activities, morphological, C 20-20

INTRODUCTION

The career of soldiers in military organizations is characterized by an initial course during which they are called recruits and pass through a period of military adaptation, later being called soldiers. The recruits are prepared for a military career, ensuring the safety of military organizations and society. Within this context, they must be physically fit to be able to perform

the missions imposed (4). The Brazilian Army has a Military Physical Training Manual - C 20-20, whose purpose is to standardize the technical foundations, provide the desired knowledge, and establish procedures for planning, coordination, conduction, and execution of physical activity, this manual is also used as a beacon in the military (2).

Body composition and physical fitness are associated with greater physical performance and a lower risk of health problems. Military activities are characterized as having a high physical and psychological load; physical fitness and body composition have an adverse effect on military performance (21). Previous studies report that military physical training promotes positive biological adaptations in increasing power and muscular endurance (10, 12, 23), reducing body fat (13, 14) and increasing cardiorespiratory fitness (8, 15). Naghii (16) states that fat-free muscle mass is an important variable related to operational physical performance in different military tasks. However, research studies on the morphological and physical fitness changes based on the fitness of the Brazilian army manual are little known.

Due to the lack of studies investigating the development of organic and neuromuscular capabilities in military recruits submitted to the Brazilian army manual, specifically the C 20-20 program, the aim of this study was to evaluate the morphological and functional adaptations in young military recruits after completion of twelve weeks of physical training. Our hypothesis was that this period of training would generate positive benefits on variables related to morphological behavior such as body weight, skinfold percentage, and physical fitness, such as sit-ups, upper limbs, and aerobic fitness in the military recruits.

METHODS

Participants

This study is classified as descriptive, monitoring the morphological and functional adaptations of young soldiers in a twelve-week training macrocycle. The sample consisted of 130 male recruits belonging to a unit of the Brazilian Air Force, aged 18 and 19 years. The sample was considered fit according to the initial military health inspection to which they were submitted, being non-smokers, and free of pharmacological treatments or any disturbances that could alter the results of the present research.

Data were collected with the subjects of the first group of soldiers performing the training course in 2016. The participants were informed of the study objectives and procedures by signing the consent form and were clear and free to discontinue participation at any time they wished. This study met the standards for conducting research on human subjects of the National Council of Brazilian Health and was approved by the local ethics committee n^o 112/2015.

Protocol

Anthropometric variables measured were height (meters), body mass (kg), skinfold thickness (triceps, suprailiac and abdomen - mm), circumferences (arm, waist, and hip - cm), body fat percentage, lean body mass, and fat body mass. All measurements were collected by two

evaluators with a 2.2% acceptable error (19). To verify the percentage of body fat, the protocol proposed by Guedes (6) was applied to determine the body density, and the Siri equation to determine the percentage of body fat. Lean body mass (LBM) and fat mass (GCM) were calculated according to the following equations: $MCM = \text{body mass} - GCM$ and $MG = \text{body mass} \times (\% \text{ fat} / 100)$. According to the anthropometric results the body mass index was calculated ($BMI = \text{body weight} / (\text{height})^2$) and ratio of waist and hip circumference ($WHR = \text{waist circumference} / \text{hip circumference}$).

Data were collected in three functional tests: sit-ups (one minute), push-ups, and aerobic power test (12 minute protocol) according to the protocols proposed by the Brazilian Air Force (3). The 12-minute test was performed on the official athletic track of the military organization. The athletic track was marked every 10 meters to facilitate the measurement of the maximum distance achieved in the test. The values were recorded and the calculation was performed by $\dot{V}O_2\text{max} = (\text{maximum distance in meters} - 504.9) / 44.73$ (5). The 12-minute test shows a moderate/high correlation with $\dot{V}O_2\text{max}$ and is widely used in military organizations in Brazil due to ease of administration, low operating costs, and the possibility of a large number of people being evaluated at the same time (7), although this method has some specific exceptions (9).

The training period was based on the considerations described in the Brazilian Army Manual, used as a guide to military physical training in the Brazilian Armed Forces. After the initial test, the physical performance of the military recruits was verified, which allowed strategies to be traced and training to be periodized according to fitness levels. The proposed training was 12 weeks, totaling 32 sessions, distributed into cardiopulmonary and neuromuscular training sessions. Table 1 represents the period of the study. In the physical training period, sessions were used involving short, medium and long runs (continuous and interval), stretching and localized exercises (e.g. push-ups, sit-ups, squat, single leg squat, basic plank, elbow plank, and jumping jacks). Table 2 shows the distribution of the loads in this macrocycle.

Table 1. Experimental design of this study.

Months	Start Test	Period of training												Final Test
	March	March			April					May				May
Weeks	01	01	02	03	04	05	06	07	08	09	10	11	12	13
Sessions (n)	02	02	02	02	03	02	02	02	03	03	03	03	05	02

Table 2. Percentage distribution of loads during the macrocycle.

Physical capacity	March	April	May
Aerobic training	40 %	40 %	25 %
Anaerobic training	30 %	35 %	25 %
Strength	10 %	10 %	25 %
Speed	10 %	10 %	15 %
Agility	10 %	10 %	15 %
Flexibility	10 %	5 %	10 %

Data Analysis

For exploratory analysis, we used descriptive statistics, and the data were processed as mean, standard deviation, and percentages of the variables under analysis. The data distribution was analyzed using the Shapiro-Wilk test, intending to identify the normal distribution of the data set. Analysis of data between the two moments (pre and post physical training) was performed through the Student t test, with a significance level of $p < 0.05$. Data were analyzed using SPSS 17.0 (SPSS Inc., Chicago, USA).

RESULTS

All subjects in this study began and ended the proposed protocol. Table 3 shows the results of the general parameters of the training period.

Table 3. Values of the load carried out in the training macrocycle.

General parameters	Units - Days Sessions
Training units (n)	32
Weeks of training (n)	12
Time of each training session - mean (min)	90
Total training volume (hs)	38

When comparing the anthropometric variables and body composition shown in Table 4, there were significant differences in height and skinfold variables (triceps, iliac, and abdominal). The majority of the variables demonstrated statistical differences; the sum of the three skinfolds, body fat percentage, fat mass, circumference (biceps and waist), waist-hip ratio ($p < 0.01$) and lean body mass ($p < 0.05$). No statistical differences were observed in body mass variables or hip circumference ($p > 0.05$).

In comparing the physical fitness and functional variables shown in Table 5, it was observed that there were significant differences in the variables sit-ups, push-ups, 12-minute test, relative $\dot{V}O_2\text{max}$, and absolute $\dot{V}O_2\text{max}$ ($p < 0.01$).

Table 4 . Anthropometric results of the military recruits investigated.

	Start Training	Final Training	<i>p</i>	<i>t</i>
Weight (kg)	67.47±10.18	66.96±9.23	>0.05	1.837
Height (cm)	1.76±0.07	1.76±0.07	>0.05	0.517
BMI (kg/m ²)	21.86±2.93	21.84±2.65	>0.05	0.215
Tricipital skinfold (mm)	9.5±4.9	7.8±3.3	<0.01	7.425
Suprailiac skinfold (mm)	17.0±10.5	11.9±6.8	<0.01	7.401
Abdominal skinfold (mm)	15.8±10.4	13.9±8.5	<0.01	3.872
Sum of three skinfolds (mm)	42.3±25.4	33.5±17.3	<0.01	7.794
Body fat (%)	14.0±7.2	11.6±6.1	<0.01	8.124
Lean mass (kg)	57.5±6.0	58.8±6.1	<0.05	-2.397
Fat free mass (kg)	9.9±6.4	8.1±5.1	<0.01	7.828
Arm Circumference (cm)	27.3±3.0	25.6±2.9	<0.01	9.277
Waist Circumference (cm)	75.0±7.4	72.7±6.1	<0.01	5.722
Hip Circumference (cm)	90.0±7.0	89.9±6.9	>0.05	0.254
Waist-Hip Ratio	0.83±0.05	0.81±0.05	<0.01	5.052

Table 5. Neuromuscular results and aerobic power of the military recruits investigated.

	Start Training	Final Training	P	t
Push-ups (n)	21.5±9.0	33.7±9.1	<0.01	-17.062
Sit-ups (n)	35.1±8.5	49.8±7.6	<0.01	-20.488
12 Minute Test (meters)	2207±319	2756±217	<0.01	-21.754
Relative $\dot{V}O_2\text{max}$ (l.kg ⁻¹ .min ⁻¹)	38.1±7.1	50.3±4.9	<0.01	-21.756
Absolute $\dot{V}O_2\text{max}$ (l.min ⁻¹)	2.5±0.5	3.4±0.5	<0.01	-20.106

DISCUSSION

This study aimed to investigate the effects of a 12 week military physical training period. According to the results, the training caused benefits in body composition and physical fitness of young recruits. The manual of the Brazilian Army (C 20-20) is widespread in military organizations in order to outline the physical training of the military. However, few studies in the literature have investigated the effects of Brazilian military training, especially with regard to morphological composition. Although the influence of calorie consumption cannot be ruled out during the period, it is plausible that the increase in energy expenditure from the training volume conducted contributed to the reduction in body fat (table 3). In fact, the body composition values might be used to develop specific dietary interventions or to help create, optimize, and support training programs (22). Naghii (16) stated that body composition levels have a negative relationship with physical performance of military duties.

Importantly, in this study a decrease in muscle mass was not verified (in the present study there was a significant increase), when compared to previous studies (11, 17). One of the possible reasons for this fact lies in the duration of the present study (twelve weeks) compared to previous studies (less than eight weeks) and conducting exercises for muscular strength and endurance during the training macrocycle in the present study. More recently, a study analyzing thirteen weeks of military physical training, also did not verify a reduction in muscle mass (1).

Analyzing aspects related to physical fitness, there was a positive adaptation in push-ups (58%), sit-ups (41%), and relative $\dot{V}O_2\text{max}$ (32%). In a recent study with a 21-week training period, Lemes et al., (10) analyzed the adaptations of military physical training and concluded that there was a lower improvement in the sit-up test (16%) and $\dot{V}O_2\text{max}$ (13%) compared to the present study. One of the hypotheses for this difference was that in the present study there was a progressive increase in weekly training load, generating higher cardiorespiratory stress.

The improvement in physical fitness has been investigated in some studies. Pinheiro et al., (20) investigated the effects of aerobic training (intensity of $55 \pm 3\%$ and $72 \pm 4\%$ of $\dot{V}O_2\text{max}$) on the body composition of young soldiers after twelve weeks of training. According to the authors, there were no adjustments in the body composition of the military personnel. The authors reinforce the importance of aerobic training in the adaptation of body composition. Moraes et al., (15) analyzed the changes in aerobic capacity after completion of interval training over a six-week period, verifying changes in aerobic power, even though the frequency was only one session per week. Investigating thirteen weeks of training, Parmagnani et al., (18) showed that

specific aerobic training was effective in relation to cardiorespiratory parameters as the $\dot{V}O_2\text{max}$ values increased significantly in a group of firefighters. Similarly, Vieira et al., (24) evaluated the effects of eight weeks of Military Physical Training in Brazilian Army individuals and despite the improvement in running performance in the 12-minute test, reported that the military physical training was not enough to improve cardiovascular indicators.

This study has some limitations. One limitation relates to the control of caloric intake of the volunteers during the twelve weeks. Thus, it is not possible to attribute the reductions in body fat exclusively to the program. However, we should highlight that all the individuals were in the internship phase during the intervention, and the food routine was, for everyone: breakfast, lunch, fruit, dinner, and a snack. Another limitation was not including a control group, the reason for this being that all military personnel are required to participate in the physical training protocol.

The data from this study suggest that physical training carried out based on the Brazilian army manual causes alterations in morphological and physical fitness. The results support the hypothesis that the twelve-week periodized physical training is a factor in chronic adaptations in body composition and physical fitness of the military. In addition, it reinforces the idea that testing using low cost, easy to understand protocols can enable large-scale monitoring projects of military physical training. Thus, it can be suggested that the application of this knowledge is important for the correct administration of physical training programs, in order to contribute to improvement in the physical fitness and quality of life of military personnel. Future research should address the guidelines of the Brazilian army manual, as well as analyze the calorie intake during the internship period with the aim of evaluating in a more specific way the changes in the body composition of the military.

REFERENCES

1. Avila JAD, Lima Filho PDDB, Páscoa MA, Tessutti LS. Effect of 13 weeks of military exercise training on the body composition and physical performance of ESPCEX students. *Rev Bras Med Esporte* 19(5): 363-366, 2013.
2. Brazil. Estado Maior do Exército. Manual de treinamento físico militar (C 20-20). Brasília: Egceef. 2002.
3. Brazil. Ministério da Defesa. ICA 54-1: teste de avaliação do condicionamento físico no comando da Aeronáutica. Brasília, DF: Comando da Aeronáutica / Educação Física e Desportos, 2011.
4. Campos LCB, Campos FAD, Bezerra TAR, Pellegrinotti IL. Evaluation of recruits morphofunctional profile from a military unit of Brazilian Air Force. *Cinergis* 17(2): 91-95, 2016.
5. Cooper KH. A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. *JAMA* 203(3): 201-204, 1968.
6. Guedes DP. Composição Corporal: Princípios Técnicas e Aplicações. Ed. APEF - Londrina, 2ª ed., 1994.

7. Hage CC, Reis Filho AD. Performance analysis and anthropometric profile of students of 28 training course for soldiers PM / MT - CEsp after 12 weeks of physical training. *Revista Brasileira de Prescrição e Fisiologia do Exercício* 7(41): 498-505, 2013.
8. Jacobina DDS, Souza DFXD, Nunes JPDS, Curto LB, Aguiar LFM, Vasconcelos LFCD, et al. Comparação do estado nutricional e do nível de condicionamento físico de oficiais combatentes do exército brasileiro nos cursos de formação, aperfeiçoamento e comando e estado-maior. *Revista de Educação Física* 137(2): 41-55, 2007.
9. Kravchychyn ACP, Alves JCC, Kravchychyn TP, Nogueira GÂ, Machado FA. Comparison between the direct and indirect methods of VO_2 máx determination in runners. *Rev Bras Med Esporte* 21(1): 17-21, 2015.
10. Lemes B, Vieira SS, Silva Jr JA, Costa WO, Bocalini DS, Serra AJ. Military physical training modifies anthropometric and functional parameters. *Con Scientiae Saúde* 13(1): 31, 2014.
11. Lucas SJ, Anson JG, Palmer CD, Hellemans IJ, Cotter JD. The impact of 100 hours of exercise and sleep deprivation on cognitive function and physical capacities. *J Sports Sci* 27(7): 719-728, 2009.
12. Maior AS, Souza MWBJD, Defilippo E, Granado FD, Boadbaid JWDS, Beyruth RMDP, et al. Efeitos do treinamento físico militar na potência muscular dos membros inferiores e nos indicadores da composição corporal. *Revista de Educação Física* 135: 5-12, 2006.
13. Malavolti M, Battistini NC, Dugoni M, Bagni B, Bagni I, Pietrobelli A. Effect of intense military training on body composition. *J Strength Cond Res* 22(2): 503-508, 2008.
14. Mikkola I, Jokelainen JJ, Timonen MJ, Harkonen PK, Saastamoinen E, Laakso MA, et al. Physical activity and body composition changes during military service. *Med Sci Sports Exerc* 41(9): 1735-1742, 2009.
15. Moraes CG, Rodrigues LC, Kroeff MB, Navarro F. Weekly frequency effect of AIT on the aerobic power of recently incorporated military on the Brazilian Army. *RBPFEEX - Revista Brasileira de Prescrição e Fisiologia do Exercício* 2(8): 192-199, 2011
16. Naghii MR. The importance of body weight and weight management for military personnel. *Mil Med* 171(6): 550-555, 2006.
17. Nindl BC, Barnes BR, Alemany JA, Frykman PN, Shippee RL, Friedl KE. Physiological consequences of U.S. Army Ranger training. *Med Sci Sports Exerc* 39(8):1380-1387, 2007.
18. Parmagnani F, Magalhaes MA, Carletti L, Perez AJ. Effect of aerobic training in military, analyzed by different techniques of evaluation of the body composition and for the maximal oxygen uptake. *Revista Brasileira de Atividade Física e Saúde* 5(3): 21-30. 2000.
19. Perini TA, Oliveira GLD, Ornellas JDS, Oliveira FPD. Cálculo do erro técnico de medição em antropometria. *Rev Bras Med Esporte* 11(1): 81-85, 2005
20. Pinheiro JCS, Dantas EHM, Fernandes Filho J, Coutinho W. Efeitos do treinamento aeróbico com intensidade na zona do fatmax (64+ 4% do vo_2 máx) na composição corporal de cadetes da Academia Militar das Agulhas Negras. *Fitness Performance J* 4(3): 157-162, 2005.
21. Pļaviņa L, Umbrāško S. Analysis of physical fitness tests and the body composition of the military personnel. *Papers Anthropol* 25(1): 27-36, 2016.
22. Reguli Z, Bernaciková M, Kumstát M, Reguli Z, Bernaciková M, Kumstát M. Anthropometric characteristics and body composition in aikido practitioners. *Int J Morphol* 34(2): 417-423, 2016.

23. Vaara JP, Kokko J, Isoranta M, Kyröläinen H. Effects of added resistance training on physical fitness, body composition, and serum hormone concentrations during eight weeks of special military training period. *J Strength Cond Res* 29: S168-S172, 2015.
24. Vieira G, Duarte D, Silva R, Fraga C, Oliveira M, Rocha R, Ferreira G, Alves K, Duarte AFA. Efeito de oito semanas de treinamento físico militar sobre o desempenho físico, variáveis cardiovasculares e somatório de dobras cutâneas de militares de Força de Paz do Exército Brasileiro. *Revista de Educação Física* 134: 30-40, 2006.

