

EFFECT OF 13 WEEKS OF MILITARY EXERCISE TRAINING ON THE BODY COMPOSITION AND PHYSICAL PERFORMANCE OF ESPCEX STUDENTS



ORIGINAL ARTICLE

Josiel Almeida de Avila
(Military Sciences)^{1,2}
Paulo Davi de Barros Lima Filho
(Military Sciences)¹
Mauro Alexandre Páscoa
(Physical Educator)³
Lucas Samuel Tessutti
(Physical Educator)^{4,5}

1. Preparatory School of Army Cadets – Campinas, SP, Brazil.
2. FCM – State University of Campinas, Unicamp – Campinas, SP, Brazil.
3. Department of Biochemistry, Biology Institute, Unicamp – Campinas, SP, Brazil.
4. FEF – State University of Campinas, Unicamp – Campinas, SP, Brazil.
5. Adventist School of Hortolandia.

Mailing address:

Av. Papa Pio XII, 350, EsPCEX,
Jardim Chapadão. 13070-903
Campinas, SP, Brasil.
josiel_sm@yahoo.com.br

ABSTRACT

Introduction: Armies from all over the world acknowledge the importance of good physical fitness for the performance of military duties. The Military Exercise Training (MET) attempts to provide assistance to this search for better physical fitness and performance. **Objective:** To verify the effect on the body composition and physical performance of the students at EsPCEX (Military Academy Preparatory School) after 13 weeks of MET. **Methods:** The sample was composed of 287 male students from the EsPCEX, whose average age was 18.33 ± 1.26 . Such students accomplished a boarding school routine, having defined schedules, meals and activities from which they were only released during the weekends. The MET was accomplished five days a week and it comprised both aerobic and resistance training. Measurement of body mass, height, skinfold (triceps, abdominal and suprailiac) was accomplished during pre and post training periods, and the following tests were performed: 12-minutes-run, oblique sit up, arm push up and pull up. Fat percentage, fat-free body mass and fat body mass were calculated using the anthropometric data based on the Guedes 3 skinfold protocol. **Results:** Significant reduction in fat body mass, fat percentage and in triceptal and abdominal skinfold, as well as increase in suprailiac skinfold and fat-free body mass was observed when anthropometric and body composition data were compared, during the initial and the final periods of training. Significant improvement also occurred in all performed physical tests, in which better performance was achieved. **Conclusion:** The acquired data suggest that performance of MET 5 days a week brought significantly improved body composition as well as physical performance.

Keywords: skinfold thickness, body composition, military, exercise.

Article received on 8/31/2011 and approved on 8/26/2012.

INTRODUCTION

The Military Academy Preparatory School (EsPCEX) is a military educational institution which has the aim to be the first step in the formation of a career line officer of the Brazilian Army. Its admission exam occurs with a federal public test and the distribution of its students represents all the regions of the Country. In the EsPCEX, the students are submitted to a boarding school routine in which all the academic activities are controlled and regulated by internal rules, including class, meals, physical and military activities times.

The Armed Forces around the world acknowledge the importance of the military exercise training (MET) in the preparation, leadership and activity of their troops. In the many battles where the American Army was present, it was corroborated that physical fitness plays an important role on the battlefield¹. The Canadian also state that physical activity increases vigor, alertness and self-esteem in the operations². Moreover, better physical fitness makes it possible to better cope with the stressful situations intrinsic to the military activity³.

The training and assessment methods of the North-American and Canadian Armies are similar to the ones used by the Brazilian Army,

with differences in the indices and performed exercises; however, they reach to improve the cardiopulmonary system, strength and endurance of their militaries. In the EsPCEX the training methods used were: running, basic gymnastics (calisthenic exercises), training track in circuit (TTC), swimming and sports activities. These physical activities were gradually and systematically performed with the aim to familiarize the students to the peculiarities and demands of the military life. They also attempted to provide prevention maintenance of the military's health; develop, keep or recover total physical conditioning of the military; as well as cooperate in the development of his moral qualities⁴.

Body composition may be divided in two compartments: fat mass (FM) and fat-free mass (FFM)⁵. The measurement of these body fat percentages through skinfolds is one of the ways of assessing body composition. Although there are more accurate techniques (hydrostatic weighing and plethysmography), the skinfolds are accepted for body composition determination and have the advantage of being a cheaper method which is easy to be obtained and adapted to the field work⁶.

The fat percentage is mentioned as one of the physical

performance variables, considering that it limits movements and leads to early fatigue due to the overload, causing higher energy expenditure⁷. Therefore, Bale *et al.*⁸, when divided runners according to their performance in 10km, verified that those who had lower skinfold sum presented better performance.

Man studies try to show that periodized physical training efficiently acts in the improvement of physical performance and body composition of many different populations⁹⁻¹¹. Due to the need to form militaries with good physical fitness and body composition, the aim of this study was to verify the effect of 13 weeks of MET in the body composition and physical performance of the EsPCEEx students.

METHODOLOGY

Sample

The study developed in the EsPCEEx, in the city of Campinas, SP, Brazil and 287 male students from the year of 2010, all of them having passed in a national public exam, participated in it. The sample mean age was of 18.33 ± 1.26 years, mean height of 1.75 ± 0.06 meters, body weight of 69.67 ± 8.83 kg, BMI 22.59 ± 2.43 kg/m² and fat percentage of $13.62 \pm 5.04\%$. Inclusion criteria were: to be considered apt by a health inspection board when examinations mentioned in the bid data sheet of the admission exam were presented¹². Additionally, they must be apt in the physical fitness examination (PFE), composed of the following events (with respective minimum standard): 12-minute run (2,100 m), pull-ups (three repetitions), push-ups (15 repetitions) and crunches (30 repetitions)¹². The students who were members of the sports teams of the EsPCEEx were excluded from the study, since they performed specific training of the modalities. Those who presented any kind of injury were also excluded.

Assessment protocol

All the selected subjects were submitted to anthropometric, body composition and physical fitness assessment. These evaluations occurred on the first week of the students in the school (ASS 1) and after 13 weeks of training (ASS 2).

The anthropometric and body composition evaluations were performed in the morning shift, at fasting, between five and six o'clock. Body weight was obtained on a Balmak[®] scale with precision of 100 g and maximum load of 200 kg. The scale was calibrated at the beginning of each day and the students were weighed at standing position, barefoot and wearing only a pair of shorts. Height was verified on the same scale, using the metal lever marked in centimeters until the 2 m height. At that measurement, the subject was barefoot, touching the heels, hips, shoulders and occipital part of the skull on the lever surface.

Body density was evaluated by the thickness of the subcutaneous tissue, following the three-skinfold equation (tricipital, suprailiac and abdominal) by Guedes and Guedes¹³. A CESCORF[®] scientific adipometer with precision of 0.1 mm was used for this measurement. The measurements were three times taken from the right side of the body, in a rotation, being their mean used for the analysis. The fat percentage was estimated from the density by the Siri's equation¹⁴.

The military exercise training (MET) was performed on two consecutive days. On the first day, the students performed a run-

ning test, when they should run 3 km as fast as possible, and performed push-up and twisted crunch tests⁴, in the most number of repetitions as possible. On the second day, they performed the pull-up test⁴.

Training protocol

Having the results obtained in the pre-training tests, the physical performance of the students was verified, which made it possible to set goals and periodize the training according to the levels of physical fitness. The exercises used in the MET followed recommendations from the Manual of Military Physical Training C 20-20⁴.

The training proposed had duration of 13 weeks. The MET was performed in a frequency of five weekly sessions (Monday to Friday) and had duration of 90 minutes, generally distributed in two cardiopulmonary training sessions, two neuromuscular sessions and one swimming session. Before each training sessions, the students performed stretching and warm-up in a centralized manner, as prescribed in the C 20-20 manual⁴.

As cardiopulmonary training, continuous running (CR) based on the pre-training test results was used. The running was gradually performed and the students were divided in three levels of cardiopulmonary fitness (Gp A, Gp B and Gp C), in which the Gp A presented the best and the C the worst fitness. In an attempt to provide more customized training, the volume for the Gp B was always 500 meters longer than for the C and the one for the Gp A was 1,000 meters longer than for the C. The distances ranged from 4,000 m to 7,000 m (Gp C) and, as an intensity criterion, the mean time obtained in the three-kilometer pre-training test was established as maximal rhythm per group (100%), and it suffered variation from 55 to 90% during the training period.

The neuromuscular work tried to provide gradual exercise load aiming adaptation, coordination improvement as well as recruitment of motor units for subsequent load increment. Thus, training track in circuit (TTC) and basic gymnastics (calisthenic exercises) sessions were used. In the periodization proposed by the researchers, the basic gymnastics (BG) was performed first and the TTC was applied only after the students were adapted to the neuromuscular exercises. For the BG, initially the correct performance of the exercises was the goal for subsequent load increase (number of repetitions). For the TTC, a school-track was performed with subsequent load removal before its complete performance. The BG and TTC volume ranged during the period, being initially of seven repetitions in each exercise for the BG and a passage with 30-sec duration in each event for the TTC. After the ninth week, the BG started to be performed at nine repetitions and the TTC at a passage with 45-sec duration in each event.

The swimming training aimed at familiarizing the EsPCEEx student to the water medium, providing conditions for correct performance of the crawl swimming style. Therefore, this was the followed order: familiarization to the water medium, floatation, breathing, propulsion and basic diving¹⁵.

Concerning their food ingestion, the students performed four mandatory daily meals (breakfast, snack, lunch and dinner), from Monday to Friday, during almost the entire study period. Such control was possible due to the students' boarding school routine

during the entire week, being only dismissed at the weekends to visit their families. The menu ranged according to the day of the week and it was the same to all students.

Statistical treatment

The STATISTICA™ package was used for descriptive analysis and inferential statistics of all data. The Student's *t* test for dependent and paired samples was applied for evaluation of the alterations observed pre and post-training. A *p* < 0.05 value was set for the null hypothesis rejection.

RESULTS

Table 1 presents the results obtained pre and post-training for the anthropometric and body composition variables. The values are presented in mean, standard deviation, significance test and percentage value of the variation occurred between the two collections. Statistically significant reduction has occurred between the two assessments for the variables: fat percentage, triceps, suprailiac, abdominal skinfolds (SF), fat mass (FM) and fat-free mass (FFM). However, despite light increase, no significant alterations have been verified for body weight, height and BMI. Table 2 presents the performance obtained by the students in the many pre and post-training tests. It was possible to verify significant alterations in performance in all events: time decrease in the 3-km run, increase in the number of repetitions in the pull-ups, push-ups and twist crunches.

Table 1. Effects of the training on the body composition of the students.

Parameters	ASS1	ASS2 (Δ ASS1-ASS2)	p
Body weight (kg)	69.67 ± 8.83	69.97 ± 7.64 (0.4%)	0.172
Height (m)	1.75 ± 0.06	1.76 ± 0.06 (0%)	0.312
BMI (kg/m ²)	22.59 ± 2.43	22.67 ± 2.02 (0.4%)	0.255
Fat percentage (%)	13.62 ± 5.04	12.95 ± 3.64 (-4.9%)	0.003 *
Triceps SF (mm)	10.77 ± 6.18	9.52 ± 2.72 (-11.7%)	0.000 *
Suprailiac SF (mm)	11.17 ± 5.65	11.98 ± 5.37 (7.2%)	0.022 *
Abdominal SF (mm)	15.93 ± 7.52	13.14 ± 4.42 (-17.5%)	0.000 *
Fat mass (kg)	9.74 ± 4.36	9.19 ± 3.18 (-5.7%)	0.002 *
Fat-free mass (kg)	59.93 ± 6.24	60.78 ± 5.88 (1.4%)	0.000 *

* *p* < 0.05.

Table 2. Effects of the training on the physical performance of the students.

Parameters	ASS1	ASS2 (Δ ASS1-ASS2)	p
Running (mm:ss,00)	14:14.80 ± 1:17.42	12:42.40 ± 00:42.8 (-10.8%)	0.000 *
Pull-ups (rep)	8.45 ± 3.00	10.16 ± 2.72 (20.3%)	0.000 *
Push-ups (rep)	29.94 ± 7.75	36.79 ± 8.57 (22.9%)	0.000 *
Twist Crunches (rep)	43.95 ± 7.13	49.55 ± 5.73 (12.7%)	0.000 *

* *p* < 0.05.

DISCUSSION

Many studies have shown the influence of the body composition in physical performance. When the FM is analyzed, regardless of the body weight, it was observed that it causes negative effects in velocity, in the cardiovascular system, agility and jumping capacity, besides the fact that greater FFM helps in activities involving strength, power and muscular endurance¹⁶. Vogel and Friedl¹⁷, when assessed 1,126 American soldiers, observed that body composition is related to aerobic tests and muscular endurance, verifying that individuals with lower fat percentages obtained better results in

both tests. According to the authors, the FFM is responsible for 1/3 of the variation in muscular endurance performance and the FM for 1/3 of the aerobic.

Additionally, Cureton *et al.*¹⁸, when added successive weight in volunteers trying to increase FM, verified significant performance decrease in the maximal test on treadmill, 12-minute run and VO_{2max} by total body weight. Increase in the energy expenditure for performance of the activity without the respective increase of VO_{2max} was mentioned as one of the probable causes for this worse performance.

In the present study, it was possible to verify that this correlation between body composition and physical performance is true. Such statement may be corroborated by the performance improvement reached in all physical events assessed, as well as by the alteration of body composition occurred, in which the FM and the fat percentage were significantly decreased and the FFM increased.

Research has shown that the weekly frequency of three sessions during a period of eight weeks using aerobic or anaerobic training seems to be efficient to cause body weight and fat percentage loss and physical capacity improvement in obese adolescents^{19,20}. In this investigation, body weight did not suffer significant alteration, with onset of FM loss proportional to the FFM gain. This fact seems to be associated with the fact the sample used be composed of physically active and non-obese young subjects. However, after the effect of weight weeks of MET on militaries recruited for a Peace mission was verified²¹, the results are similar to the ones found in the present article. In the experimental group of such study significant alterations have been verified concerning the SF sum and improvement in the number of repetitions in the push-ups and 12-minute run. However, no alterations have been found in the number of repetitions in the pull-ups and crunches performed. This fact may have been a result of the sample of that study has been composed of older militaries already adapted to the MET, its shorter training and weekly sessions time.

Assessing exercises on a cycle ergometer during a period of 20 weeks in different sexes and ethnic groups, Wilmore *et al.*²² verified decrease in all SF assessed, perimeters, body weight, FM, visceral fat and increase in FFM and body density. Slentz *et al.*²³, when assessed the effect of aerobic training of different intensities and volumes, also obtained similar results in the SF, body weight, FM and FFM, finding a strong correlation between training volume and alterations observed in the body composition. The results of the mentioned articles indicate that aerobic exercise, besides producing decrease in body fat, may also aid in the maintenance and even gain of FFM. In our study, it was possible to verify reduction of the abdominal and tricipital skinfolds; however, the suprailiac one suffered significant increase. Shorter training time, age and body composition characteristics of the sample studied here may have contributed to this fact. When assessing the effect of 10 weeks of resistance training on the body composition of young subjects, Santos *et al.*²⁴ found significant increase in FFM and body weight. The difference found in body weight may have suffered influence of the training intensity and time, as well as the absence of eating guidance and control. In the present study, although it was not possible to control the diet the students ingested at the weekends, this control was efficiently done during the week, since the students were submitted to the same menu and followed the same routine.

Corroborating the findings in this study, when assessing the effect of 10 and 20 weeks of resistance training on the body composition and strength, Wilmore²⁵ and Gettman *et al.*²⁶ respectively, found reduction of FM and increase of FFM. Although the training performed in the present article gives emphasis to aerobic training, it was possible to observe that periodization which uses the two kinds of training (aerobic and resistance) may get a result similar to work only resisted. Some studies also try to verify the effect of combined training (aerobic and resistance) on the body composition and physical performance. Trying to verify the effect of this kind of training in militaries, improvement in both aspects has been found after the training period^{10,21}. Verifying the effect of three months of physical training in fire fighters, Verzola *et al.*²⁷ also found alterations in performance and BMI. The alterations found in the BMI pre and post-training were a consequence of the FM, FFM and body weight increase. However, the data obtained in the previous article are different from the majority of the studies found, in which there is almost a consensus that aerobic activity reduces adipose tissue²⁸. These results are possibly connected with the presence of nutritional control and the low number of weekly sessions. Concerning the improvement obtained in neuromuscular exercises, such fact seems to have been caused by the neural adaptation and muscular hypertrophy. This fact is corroborated in the many investigations concerning this issue, in which in the initial training period (four to eight weeks) the strength gain is more associated with the neural adaptation and only after this period muscular hypertrophy begins to be distributed more effectively for strength increase²⁹.

In this study, although the circumference of the many muscles has not been measured, increase in body lean mass was observed over FM, where this increase of FFM was possibly caused by

hypertrophy of the muscles involved in the neuromuscular exercises under consideration.

The Army active duty officer functions require good physical fitness due to the missions and needs intrinsic to the military service. Thus, there is constant concern with the body composition and physical performance of these professionals.

CONCLUSION

The results of this investigation evidenced that the periodized MET performed five weekly times, with duration of 13 weeks, is able to promote alterations in the body composition and physical performance, Reduction in fat percentage and FM, as well as increase in FFM was significantly observed. However, this alteration was not observed in the body mass, a fact which reflects on the FFM gain proportional to the FM loss. When the SF were separately analyzed, it was possible to verify decrease of the tricipital and abdominal ones and increase of the suprailiac one, but the reason for this behavior is not clear.

Concerning physical performance, significant gain in the reached results in all assessed events has occurred. Thus, it is possible that the training presented here, besides resulting in improvement in the body composition and physical performance, generated adaptations in the neuromuscular, cardiovascular and pulmonary systems.

Further research should investigate the behavior of a higher number of skinfolds to training, the alteration of the suprailiac skinfold in response to training and finally, the correlation between the body composition variables and performance in each physical test.

All authors have declared there is not any potential conflict of interests concerning this article.

REFERENCES

- Headquarters department of the Army. Physical Fitness Training (FM 21-20). Washington, 1998.
- Land Force Command. Army Fitness Manual (B-GL-382-001/PT-001). Toronto, 2001.
- O'Connor JS, Bahrkem MS, Tetu RG. 1988 Active Army Physical Fitness Survey. *Mil Med* 1990;125:79-85.
- Estado Maior do Exército. Manual de Campanha: Treinamento Físico Militar (C 20 20). 3 ed. Brasília: Egceef, 2002.
- American College of Sports Medicine. ACSM'S Guidelines for exercise Testing and Prescription. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2009;61-103.
- Marriott BM, Grumstrup-Scott J. Body composition and physical performance: applications for the military services. Washington: National Academy Press, 1992.
- Harman EA, Frykman PN. The relationship of body size and composition to the performance of physically demanding Military tasks. In Marriott BM, Grumstrup-Scott J. Body composition and physical performance: applications for the military services. Washington: National Academy Press, 1992.
- Bale P, Bradbury D, Colley E. Anthropometric and training variables related to 10km running performance. *Brit J Sports Med* 1986;20:170-3.
- Malina RM, Bouchard C, Bar-Or O. Growth, maturation, and physical activity. 2 nd ed. Champaign: Human Kinetics, 2004.
- Cearini RB, Pontes LM, Cardoso AB, Gomes ALM, Dantas EHM. Impacto do treinamento físico militar sobre os níveis de aptidão física de alunos do núcleo de preparação de oficiais da reserva (NPOR). *Rev AMRIGS* 2008;52:164-9.
- Filho AO, Shiromoto RN. Efeitos do exercício físico regular sobre índices preditores de gordura corporal: índice de massa corporal, relação cintura-quadril e dobras cutâneas. *Revista da Educação Física/UEM* 2001;12:105-12.
- Escola Preparatória de Cadetes do Exército. Edital Nr 1: Concurso de Admissão à Escola Preparatória de Cadetes do Exército. Campinas, 2009.
- Guedes DP, Guedes JERP. Manual prático para avaliação em educação física. Barueri: Manole, 2006.
- Siri WE. Body composition from fluid spaces and density. In: Brozek J, Henschel A. Techniques for measuring body composition. Washington: National Academy of Science, 1961;223-44.
- Gomes, WDF. Natação, uma alternativa metodológica. Rio de Janeiro: Sprint, 1995.
- Wolinsky L. Nutrition in exercise and sport. 3 rd ed. New York: CRC Press, 1998;621-43.
- Vogel JA, Friedl KE. Army data: body composition and physical capacity. In: Marriott BM, Grumstrup-Scott J, editors. Body composition and physical performance: applications for the military services. Washington: National Academy Press, 1992.
- Cureton KJ, Sparling PB, Evans BW, Johnson SM, Kong UD, Purvis JW. Effect of experimental alterations in excess weight on aerobic capacity and distance running performance. *Med Sci Sports* 1978;10:194-9.
- Fernandez AC, Mello MT, Tufik S, Castro PM, Fisberg M. Influência do treinamento aeróbio e anaeróbio na massa de gordura corporal em adolescentes obesos. *Rev Bras Med Esporte* 2004;10:152-8.
- Sabia RV, Santos JE, Ribeiro RPP. Efeito da atividade física associada à orientação alimentar em adolescentes obesos: comparação entre o exercício aeróbio e anaeróbio. *Rev Bras Med Esporte* 2004;10:349-55.
- Vieira G, Duarte D, Silva R, Fraga C, Oliveira M, Rocha R, et al. Efeitos 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. *Rev Educ Fis* 2006;134:30-40.
- Wilmore JH, Després JP, Stanforth PR, Mandel S, Rice T, Gagnon J, et al. Alterations in body weight and composition consequent to 20 wk of endurance training: the HERITAGE family study. *Am J Clin Nutr* 1999;70:346-52.
- Slentz CA, Duscha BD, Johnson JL, Ketchum K, Aiken LB, Samsa GP, et al. Effects of the amount of exercise on body weight, body composition, and measures of central obesity. *Arch Intern Med* 2004;164:31-9.
- Santos CF, Crestan TA, Picheth DM, Felix G, Mattano RS, Porto DB, et al. Efeito de 10 semanas de treinamento com pesos sobre indicadores da composição corporal. *Rev Bras Ciên e Mov* 2002;10:79-84.
- Wilmore JH. Alterations in strength, body composition and anthropometric measurements consequent to a 10-week weight training program. *Med Sci Sports* 1974;6:133-8.
- Gettman LR, Ayres JJ, Pollock ML, Jackson A. The effect of circuit weight training on strength, cardiorespiratory function, and body composition of adult men. *Med Sci Sports* 1978;10:171-6.
- Verzola MR, Viera G, Petroski EF. Três meses de treinamento físico melhora a composição corporal e aptidão física de bombeiros. *Rev Educ Fis* 2009;146:11-8.
- Francischi RP, Pereira LO, Lancha Jr AH. Exercício, comportamento alimentar e obesidade: revisão dos efeitos sobre a composição corporal e parâmetros metabólicos. *Rev Paul Educ Fis* 2001;15:117-40.
- Maior AS, Alves A. A contribuição dos fatores neurais em fases iniciais do treinamento de força muscular: uma revisão bibliográfica. *Rev Motriz* 2003;9:161-8.