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Comparison of physical conditioning in students of three Colombian National Army schools

Comparación del acondicionamiento físico en alumnos de tres escuelas del Ejército Nacional de Colombia

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Abstract. Proper physical condition is essential for performance and survival in military operations. This cross-sectional study evaluates the physical conditioning of military trainees in three Colombian National Army schools, measuring and comparing the morphological and physiological variables in 120 students (40 per school). The differences were established using the Léger test for VO_2 consumption, the sit and reach test for flexibility, hand dynamometry for prehensile strength, and body mass index. Jumping platforms were used to measure in-flight time. Although the Army training plan is standard, differences in conditioning, benefiting the professional soldier schools, respond to their intensity, duration, and frequency.

Keywords: aerobic capacity; armed forces; conditioning; military education; muscular strength; physical education

Resumen. Una condición física adecuada es fundamental para el desempeño y la supervivencia en operaciones militares. Por ello, este estudio evalúa el acondicionamiento físico de los militares en formación de tres escuelas del Ejército Nacional de Colombia mediante un estudio transversal, donde se midieron y compararon variables morfológicas y fisiológicas de 120 estudiantes (40 por escuela). Se evidenciaron diferencias en el consumo de VO_2 mediante el test de Léger; en flexibilidad mediante el test de *Sit and Reach*; en fuerza prensil mediante dinamometría de mano; en tiempo de vuelo mediante plataformas de salto y en el índice de masa corporal. Aunque el plan de entrenamiento del Ejército es estándar, estas diferencias en el acondicionamiento, favorables para la escuela de soldados profesionales, se deben a su intensidad, duración y frecuencia.

Palabras clave: acondicionamiento; capacidad aeróbica; educación física; educación militar; fuerza muscular; fuerzas armadas

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Introduction

Military personnel must undergo demanding physical activities, either during tactical and physical training in military garrisons or operational zones in different areas of the country (Kyröläinen et al., 2018). Among these activities is the hauling of campaign equipment (personal belongings, supplies, ammunition, and armament) over long distances and irregular terrain and the performance of common military tasks such as jogging, sprinting, digging, and obstacle avoidance, among others (Research and Technology Organisation [RTO], 2009). The speed and skill with which these activities are performed can determine the soldier's effectiveness in combat and, ultimately, survival. Therefore, it is essential to describe, evaluate, and update the best training programs during the time spent in the Army to effectively and efficiently prepare the soldier for the activities of his profession (Harman et al., 2008).

Military operations require a series of specific tasks, which, combined with exposure to the theater of operations' different environments, can become stressors for the soldier, caused by many factors. These include caloric deficits, sleep deprivation, mood alterations, and continuous physical activity –in some cases, even reaching cases of fatigue (Müller-Schilling et al., 2019; Salonen et al., 2019). The soldier requires high levels of both aerobic capacity and muscular strength during these activities. Therefore, adequate *fitness* (aerobic and muscular endurance, strength, flexibility, and body composition) and physical conditioning are critical factors in the prevention of stress fractures and musculoskeletal injuries, especially in populations of recruits where the incidences of injuries surpass 40%; the most prevalent, affecting the lower limbs. These types of musculoskeletal injuries are the primary cause of disability and retirement from active duty (Pihlainen et al., 2018; Burley et al., 2020).

Traditionally, military training has been considered an essential element in the success of military operations. For military performance, physical condition is a fundamental element to execute an operative action in the best physiological, musculoskeletal, and metabolic conditions, with higher levels of resistance and short recovery times. This training must be aimed at obtaining the particular skills necessary to develop the military profession, especially focused on the most effective method to improve capabilities or maintain performance under conditions of progressively increasing weight-bearing, considering accuracy and balance according to the regularity, specificity, and variety of weight-bearing activities. According to Piirainen et al. (2019), the achievement sought in basic military training is based on reaching a certain level of physical performance that allows the soldier to remain operative in developing his mission.

Unfortunately, over the past few decades, *fitness* and aerobic capacity have declined among young people in Western countries, and obesity in both civilian and military personnel has also increased (Seo et al., 2020; Friedl, 2012). As a result, the costs of caring for the sequelae of weight gain have exceeded US$147 billion per year. As in the civilian population, overweight and obesity in military personnel increases their risk of health problems and decrease their physical performance. For the defense system, the annual costs (unable to maintain the active personnel) in lost productivity are estimated at approximately US$106 million and US$1.1 billion in the treatment of conditions resulting from this problem (Reyes-Guzman et al., 2015). This phenomenon represents a major challenge for today's military training, where logistical and technological developments reduce certain physical activities (Cawley & Maclean, 2010).

Military training programs are standard worldwide. Physical conditioning in military training focuses on improving cardiorespiratory fitness and muscular endurance (Haddock et al., 2016). However, the equal importance of assessing other physical conditions, such as body composition, flexibility, and propulsive strength, for the characterization of all the conditioning factors of military *fitness* is becoming increasingly common in the literature (Cubides, 2020).

Recently, the U.S. Army announced that women could be eligible for certain jobs in the operations area that were previously exclusive to men. However, applicants must demonstrate the physical ability to complete the mission satisfactorily without injury in the selection process. Thus, the U.S. Department of Defense developed a series of assessments (regardless of gender) to be applied and successfully passed to select the roles to be performed in combat (Anderson et al., 2017).

In the Colombian National Army, Permanent Directive 1081-1 of 2016 outlines the guidelines for physical conditioning (Ejército Nacional de Colombia, 2016). It not only determines the requirements necessary for the success of military training; it also indicates how they should be evaluated, controlled, and modified according to particular conditions. This directive is strictly enforced to ensure the homogeneity of the instruction provided in each of the military units in charge of military training (training battalions and training schools). Thus, recognizing the physical condition of officers, non-commissioned officers, and professional soldiers in the Military Forces is vital for the hierarchical superiors as it allows them to know the personnel's physical characteristics to carry out the operations (Rojas, 2017).

This study compares the components of military physical conditioning among the students of the last level of the three Colombian National Army training schools to verify if there are differences, considering the student's time of permanence in these institutions.

Methods

The study was conducted at three military training centers: 1) the *Escuela Militar de Cadetes "General José María Córdova"* (ESMIC; Miltary Cadet Academy), in the city of Bogota, at 2,600 meters above sea level (masl), where officers of the National Army are trained; 2) the *Escuela de Suboficiales "Sargento Inocencio Chinca"* (EMSUB; School of Non-commissioned Officers), in the city of Melgar, at 323 masl, in the department of Tolima, and 3) the *"Pedro Pascasio Martínez Rojas" Escuela de Soldados Profesionales* (ESPRO; School of Professional Soldiers), located in the municipality of Nilo, at 336 masl, in the department of Cundinamarca.

This study and the use of the data derived from it complied with the ethical principles for medical research on human subjects according to the Declaration of Helsinki (Kori-Lindner, 2000) and Resolution 8430 of the Colombian Ministry of Health (1993), which establishes the technical, scientific, and administrative standards for health-related research. This work was also approved by the Committee of Ethics in Social and Exact Sciences (CECSE) of the *Escuela Militar de Cadetes*. Therefore, all the participants were invited to participate in the study voluntarily. The study subjects signed the informed consent form and remained anonymized, and were advised that declining to participate in the study would have no consequences on their military career.

The length of time spent during military training varies by institution. Because of the type of academic training, future officers' permanence is four years. Non-commissioned officers remain one and a half years, and professional soldiers remain six months. Therefore, a study design was proposed to evaluate physical conditioning in the last phase of military training in each school before the departure of the personnel to active duty.

This study design was non-experimental-transversal in scope, with an analytical component, and some physiological and kinetic variables of the participants were measured. The sample was by convenience and consisted of 120 male students in the last level of military training from the three training schools.

A category 2 ISAK (International Society for the Advancement of Kinanthropometry) anthropometric nutritionist measured the variables for determining body composition according to the "pre-test" protocol that standardized the conditions for the correct data collection as in the morning hours and at the same time for all groups. According to these standards, the participants were weighed barefoot in their underwear. Other criteria included that, prior to the analysis, the participants had not performed physical exercise in the last 24 hours, ingested food in the last 4 hours, maintained a good state of hydration, and performed their last urination 30 minutes before the start of the tests.

A SECA mBCA 525® (Medical Body Composition Analyzer, Hans E. Ruth S.A., Hamburg, Germany) with 19 measurement frequencies ranging from 1 to 1000 kHz was used to measure body composition by bioelectrical impedance, using the 8-point bioelectrical impedance analysis method. Height was measured with a hand-held platform stadiometer (Seca 274, Hamburg, Germany). Waist circumference was measured at the midpoint between the last rib and the iliac crest using a tape measure (Ohaus® 8004-MA, Parsippany, MJ, U.S.A.), according to World Health Organization (WHO) protocol (World Health Organization, 2008).

Upper limb muscle strength was assessed using hand dynamometry, which is the simple and easy method recommended to assess muscle strength in clinical practice by the Centers for Disease Control and Prevention (CDC) of Atlanta (National Health and Nutrition Examination Survey, 2011). An electronic dynamometer with a maximum capacity of 90 kg and a tolerance of ±0.5 kg, CAMRY EH 101®, was used. Three repeated measurements of each limb were taken with a 3-minute rest between each measurement. According to protocol, the average of these measurements was used for statistical analysis, which did not require a prior warm-up.

To determine the explosive strength of the lower limbs, one of the components of the Bosco test was used, employing the *Squat Jump* test, which begins at take-off with the participant at a 90° semi-flexion of the knees, straight trunk, toes 20 centimeters apart, and hands placed at waist level. For the jump, the participant was asked to propel himself from a bipedal position and a semi-flexed position of the knees, executing the upward and downward movement as fast and powerfully as possible to achieve the greatest height with the jump. The height was determined using an AXON JUMP® six-cell "S" model jumping platform, with a load capacity of 7400 kg and minimum pressure tolerance of 110 G/cm^2. Calisthenics and muscle activation exercises were performed by jogging and running with changes of direction before recording the variables. The participants were allowed to rehearse the jumping protocol. Three repeating jumps were performed with a rest of one minute between each attempt to avoid fatigue in the neuromuscular evaluation. The average of these attempts was used for the statistical analysis.

The upper limb explosive strength assessment was accomplished employing the *Push-up* test, using the same platforms. For this test, the participant's hands were at shoulder level, starting from a distance between the mat and the chest of 15 cm; during the push-up, the trunk and limbs were straight, with toes kept together for support. As in the evaluation of the upper body, three repeated attempts were made with intermediate pauses of 1 minute, preventing muscle and joint fatigue due to posture during exercise. The average of these attempts was used for the analysis. The assessment of VO_2

max consumption was carried out indirectly using the Léger test, according to the protocol (García & Secchi, 2014).

The ischiosural flexibility and a large part of the posterior muscular chain were assessed using the classic *Sit and Reach* test, where three repeated attempts were made, taking their average for statistical analysis (Holt et al., 1999). All the measuring instruments used in the study were previously calibrated to avoid systematic errors in the evaluation of the variables.

The data were analyzed by determining measures of central tendency (mean) and measures of dispersion (standard deviations, absolute error of the standard deviation, upper and lower limit of the 95 % confidence interval). The normality of data distribution was assessed using the Kolmogorov-Smirnov test. A one-factor analysis of variance (ANOVA) test was performed *post hoc* (Tukey and Games-Howell) for multiple comparisons to determine the differences between the variables considering the assumptions for test performance. The statistical *software* packages for the Social Sciences® V.24 (SPSS 24) and Graph Pad Prism 7 were used for the analysis of the data and diagramming the results. The level of statistical significance was defined by a confidence level of 95 % and the probability of a value of $p < 0.05$.

Figure 1. Components of military *fitness* and variables evaluated in the study.
Source: Created by the authors.

Results

The sample consisted of 40 male students from each of the schools, for a total of 120 students. The mean age and anthropometric variables of weight, height, and waist circumference were determined for the students by military training school (Table 1). For the analysis of body composition, some variables were selected, and differences in body mass index (BMI) and the absolute value of fat-free mass were determined as averages between schools.

Table 1. Average anthropometric characteristics of participants by schools

Features		ESMIC	EMSUB	ESPRO
	Average age (years)	22 ± 1.3	21 ± 1.7	21 ± 1.3
Anthropometric variables	Average weight (kg)	69.01 ± 8.2	64.61 ± 8.0	65.2 ± 6.1
	Average height (m)	1.71 ± 0.06	1.65 ± 0.06	1.69 ± 0.07
	Waist circumference (cm)	80.4 ± 5.9	79.2 ± 5.9	76.4 ± 3.7
Body composition	BMI (weight/size^2)	23.5	23.7	22.4
	Fat-free mass (kg)	56.4	52	56

Source: Created by the authors.

Regarding the comparison of the components of military physical conditioning among the students of the training schools of the National Army, significant differences were found in all the variables measured to determine maximum oxygen consumption (VO_2 máx), explosive strength, flexibility, and some body composition components. In the case of the Léger test, which is used to determine the VO_2 max indirectly, it showed differences between the three schools (49.8 ml x kg^{-1} x min^{-1} for the ESMIC, 48.3 for the EMSUB, and 53.5 for the ESPRO, $p = 0.001$). In the *Sit and Reach* test, which evaluates the ischiosural flexibility and the flexibility of the posterior chain muscle group of the lumbar region, differences were found between the participants of the three schools (4.5 cm for the ESMIC, 3.2 cm for the EMSUB, and 10 cm for the ESPRO, $p = 0.001$).

In assessing the prehensile strength of the upper limbs by hand dynamometry, variations were found among the members of the three schools. The prehensile strength of the right hand was 44.4 kg for the ESMIC, 37.1 kg for the EMSUB, and 48.3 kg for the ESPRO, $p = 0.001$. For the left hand, the prehensile strength was 42.7 kg for the ESMIC, 36.6 kg for the EMSUB, and 46.5 kg for the ESPRO, $p = 0.001$). The evaluation of explosive strength in the lower limbs showed differences between the members of the three schools when applying the *Squat Jump* test on jumping platforms: in air time (481.6 milliseconds for the ESMIC, 451.1 for the EMSUB, and 482.4 for the ESPRO, $p = 0.001$), the jump-height reached (28.5 for the ESMIC, 25.4 cm for the EMSUB, and 28.7 cm for the ESPRO, $p = 0.002$), and take-off speed (2.3 m/s for the ESMIC, 2.7 m/s for the EMSUB, and 2.4 m/s for the ESPRO, $p = 0.618$). The assessment of upper body explosive strength was determined with the *Push-up* test, and statistically significant differences in flight time were found (404.6 milliseconds for the ESMIC, 316.7 for the EMSUB, and 375.5 for the ESPRO, $p = 0.001$), for the jump-height (20.5 cm for the ESMIC, 12.8 cm for the EMSUB, and 18.3 cm for the ESPRO, $p = 0.0001$), and take-off speed (1.9 m/s for the ESMIC, 1.56 for the EMSUB, and 1.8 for the ESPRO, $p = 0.0001$) (Table 2).

Table 2. Determinants of *fitness* in military personnel in training at the three schools

Parameter	School	($\tilde{x}$)	ds	IC - 95 %	*Anova* $p =$
Right hand prehensile strength (kg)	ESMIC	44.43	6.81	(42.2 – 46.6)	
	EMSUB	37.15	5.62	(35.3 – 38.9)	0.001**
	ESPRO	48.36	9.22	(45.4 – 51.3)	
Left hand prehensile strength (kg)	ESMIC	42.29	6.26	(40.7 – 44.7)	
	EMSUB	36.63	6.39	(34.5 – 38.6)	0.001**
	ESPRO	46.57	7.78	(44.0 – 49.0)	
Consumption of VO_2 (ml x kg^{-1} x min^{-1})	ESMIC	49.85	4.99	(48.2 – 51.4)	
	EMSUB	48.31	3.69	(47.1 – 49.4)	0.001**
	ESPRO	53.65	3.78	(52.4 – 54.8)	
Flexibility (centimeters)	ESMIC	4.5	6.2	(2.56 – 6.54)	
	EMSUB	3.2	9.8	(0.04 – 6.36)	0.001**
	ESPRO	10.0	7.0	(7.76 – 12.29)	
Air time (Push Up) (milliseconds)	ESMIC	404.6	63.9	(384.1 – 425.0)	
	EMSUB	316.7	51.6	(300.2 – 333.2)	0.001**
	ESPRO	375.5	54.1	(355.0 – 396.1)	

Table continues...

Parameter	School	$(\tilde{x})$	ds	IC - 95 %	*Anova* *p* =
Air time (Squat Jump) (milliseconds)	ESMIC	481.3	35.6	(469.7 – 492.5)	0.001**
	EMSUB	451.1	45.8	(436.4 – 465.8)	
	ESPRO	482.4	40.6	(469.4 – 495.3)	
BMI (weight/height)	ESMIC	23.5	2.3	(22.7 – 24.2)	0.027*
	EMSUB	23.7	2.6	(22.8 – 24.5)	
	ESPRO	22.4	1.3	(22.0 – 22.9)	
Lean body mass (kg)	ESMIC	56.4	7.2	(54.1 – 58.7)	0.009**
	EMSUB	52.0	7.6	(49.6 – 54.3)	
	ESPRO	56.0	6.0	(54.0 – 57.9)	

$(\tilde{x})$: median; *ds*: standard deviation; IC: confidence interval; BMI: body mass index.
Level of significance: *significant statistical differences ($p \leq 0.05$); **highly significant statistical differences ($p \leq 0.001$).

Source: Created by the authors.

Once the one-way variance analysis was performed, multiple comparisons were made. These showed differences in right-hand prehensile strength between the ESMIC and the EMSUB students ($p = 0.0001$) and between the EMSUB and the ESPRO ($p = 0.0001$). In VO_2 max, differences were found between the ESMIC and the ESPRO ($p = 0.0001$) and between the EMSUB and the ESPRO ($p = 0.0001$). In flexibility, differences were found between the ESMIC and the ESPRO ($p = 0.0001$) and the EMSUB and the ESPRO ($p = 0.0001$). In the assessment of lower limb explosive strength, differences were found in air time between the ESMIC and the EMSUB students ($p = 0.004$) and the EMSUB and the ESPRO ($p = 0.002$).

The determination of body composition by bioimpedance showed significant differences in the BMI between the ESMIC and the ESPRO ($p = 0.045$) and between the EMSUB and the ESPRO ($p = 0.030$). Regarding the absolute value of fat mass, differences appeared between the ESMIC and the ESPRO ($p = 0.03$) and between the EMSUB and the ESPRO ($p = 0.004$). Finally, in the absolute value of fat-free mass, differences were found between the ESMIC and the EMSUB ($p = 0.014$) and between the EMSUB and the ESPRO ($p = 0.029$) (Figure 2).

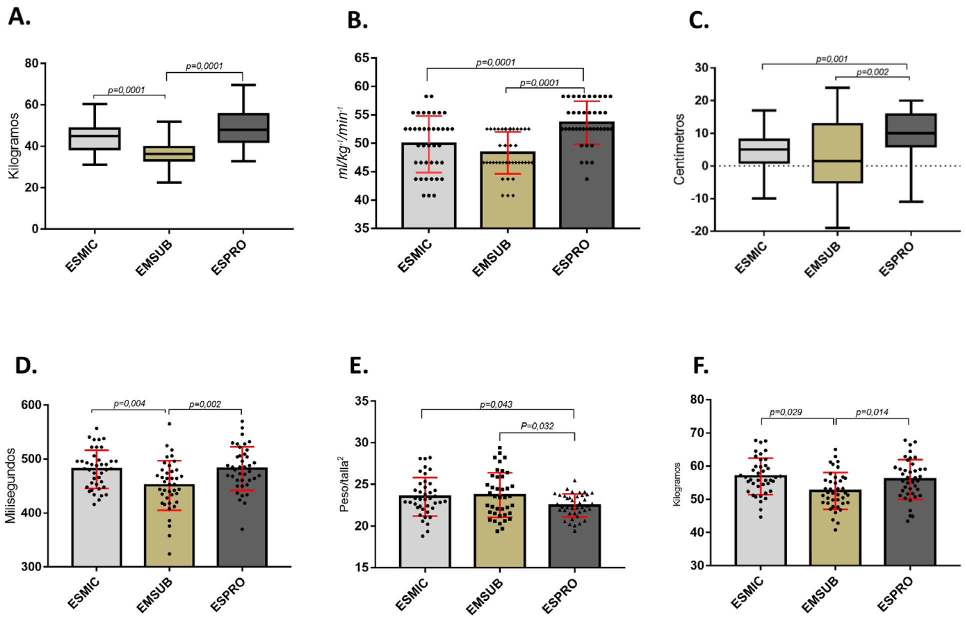

Figure 2. Comparisons of the determinants of military *fitness* among trainees at the three training schools.
A: Comparison of prehensile strength by means of right-hand dynamometry. **B:** Comparison of indirect VO_2 consumption using the Léger test. **C:** Comparison of flexibility using the *Sit and Reach* flexibility test. **D:** Comparison of air time in the *Squat Jump*. **E:** BMI comparison. **F:** Comparison of the absolute value of fat-free mass.
Source: Created by the authors.

Discussion

The literature reports sufficient evidence to support the assertion that population groups that undergo basic military training for at least eight weeks, for the most part, respond positively in the improvement of their physical adaptation. The cases in which an increase in this capacity was not demonstrated involved previously trained personnel who did not improve the load or intensity conditions during their military training. However, in terms of physical attributes such as cardiorespiratory endurance, muscular endurance, explosive strength, flexibility, and body composition, the heterogeneity in the population is very marked and poorly described (Burley et al., 2018). Thus, this variability of the physical and physiological conditions of the students of the National Army training schools has not been evaluated before with adequate methodological rigor.

Therefore, this study sought firstly to describe the findings arising from the determination of the physical conditioning variables of the students at the end of their last level of military training, whether as officers, non-commissioned officers, or professional soldiers. Based on this evaluation, we compared the intergroup results of *fitness* conditions with foreign military populations. This comparison showed that they are not far from what is reported in the international literature. However, they do show statistically significant differences in the intra-group comparison of students from the three schools.

An example of this is the results obtained for the ESPRO students. The multiple comparisons analysis demonstrated that flexibility, BMI, and indirect VO_2 consumption presented a better performance in the tests regarding the ESMIC and EMSUB students. Considering that the ESMIC students performed the test at 2,264 masl, it could be inferred that the altitude played against them in the Léger test, as it is an endurance test in which altitude conditions the results (Sellers et al., 2016). Moreover, in the fieldwork, it was possible to verify that the ESPRO students carry their campaign equipment everywhere during most of their training phase (24 weeks), which could favor resistance training with higher loads for shorter periods compared to the other two schools (Wills et al., 2019). Because of this, it is possible that the changes were not as marked by altitude, a statement in line with reports in Latin American military populations in which altitude did not seem to affect the measurement of VO_2 consumption (Rivadeneyra et al., 2017).

On the other hand, in the tests to determine prehensile strength, air time in the evaluation of lower body propulsive strength, and net fat-free mass content in body composition, the students of the professional soldiers' school showed statistically significant differences compared to the students of the non-commissioned officers' school. However, no differences were found in the students of the military officers' school. This allows us to affirm that, of the three training schools, the one that presented the lowest performance in the data obtained to determine *fitness* the military school was the non-commissioned officers, school, albeit the result's slight difference compared to those found in tests in other world scenarios.

In a study involving 119 cadets evaluated for body composition, aerobic fitness, hydration status, cardiovascular endurance, physical activity, and energy expenditure in the three U.S. military forces, improvements were observed at the end of their basic training, especially in the Army and Navy compared to the Air Force (Blacker et al., 2011). This confirms the possibility of increasing the volume of physical training in training plans, especially with improvements in aerobic fitness, body composition, and health-related conditions of military personnel in training. Similarly, the students of the professional soldier school showed the best results in almost all the *fitness* variables. This institution is characterized by providing physical training in short periods, with high intensities (16 weeks). As stated by Dyrstad et al. (2006), this favors performance in comparison to the results of the officers' school, where the military career lasts approximately four years, and the results of the non-commissioned officers' school, where the career lasts one and a half years.

Assessment of body composition regarding fat mass and fat-free mass is an important predictor of well-being in the military. Excess fat mass is associated with the risk of chronic disease, musculoskeletal injury, and poor physical performance (Steed et al., 2016). Different methods have been used to analyze body composition, ranging from classification mechanisms such as BMI to the determination of the different components that make up the human body. In the study published by Lenart (2015), they sought to evaluate physical conditioning in cadets of Poland's officers' military academy. In a sample of 90 senior cadets, this study was able to determine a fatty body mass of 13.10 ± 3.79 kg, a lean body mass of 65.38 ± 5.60 kg, a muscle mass of 62.13 ± 5.35 kg, a bone mass of 3.25 ± 0.25 kg, and a BMI of 24.4 ± 2.1 kg/m^2. These values are similar to those obtained in the three training schools of the Colombian National Army.

In another study, Aandstad et al. (2012) evaluated a cohort of 30 cadets in the Norwegian Air Force, where the acceptance criteria require at least a favorable BMI (BMI of 18-28 kg/m^2) and proper aerobic *fitness* (VO_2 máx ≥ 40 ml x kg^{-1} x min^{-1} during the mile test). It was determined that they did not present statistically significant changes in body composition and VO_2 max consumption during the entire stay at the military academy. An average weight of 76.3 kg (71.8-80.8 kg), a BMI of 23.6 kg/m^2 (22.6-24.7 kg/m^2), and an estimated fat percentage of 17.9 % (15.2-20.6 %). VO_2 max consumption was determined to be 56.7 (54.1-59.3 ml x kg^{-1} x min^{-1}) (Aandstad et al., 2012).

In 2008, a study conducted with 137 Israeli army soldiers determined the differences due to physical training between men and women in a 12-week basic training course (Yanovich et al., 2008). In that study, the average weight at the end of the training was 68.6 ± 11.7 kg, the BMI was 22.3 ± 3 kg/m^2, and the fat percentage was 15.9 ± 4.5 %. Regarding women, the only statistically significant difference was their lower fat mass loss percentage compared to men (1 % vs. 2.3 %).

In Latin America, a study involving 130 volunteer soldiers between the ages of 18 and 19 (Campos et al., 2017) analyzed morphological and functional changes after a 12-week physical training. At the end of the course, they reported a BMI of 21.84 ± 2.65 kg/m^2, a fat mass percentage of 11.6 ± 6.1 %, a fat-free mass of 8.1 ± 5.1 kg, a lean body mass of 58.8 ± 6.1 kg, and VO_2 max of 50.3 ± 4.9 ml x kg^{-1} x min^{-1}.

Improving physical performance in terms of increased muscular strength development requires developing resistance training programs that include a large component of specificity and variability (Blacker et al., 2011). Some reports have shown a significant increase in the aerobic capacity of soldiers, especially in high-intensity based training sessions in the first few weeks (Cormie et al., 2007). In contrast, other studies have found no changes in VO_2 max consumption, with levels of 54.9 ml x kg^{-1} x min^{-1}, despite training (Kraemer et al., 2004). In the Colombian military population in the process of basic military training, an average VO_2 max was found at a school level of 50.5 ml x kg^{-1} x min^{-1}, with differences between the students of the three schools, indicating a better performance for the school of professional soldiers.

A 2016 study in Indonesia involving 40 soldiers aged 18-21, belonging to the 303rd/SSM infantry battalion, compared predicted VO_2 max values using two tests: the 12-minute test and the 3200-meter test (Abdillah et al., 2016). They reported that the VO_2 max values in the 12-minute test were 52.04 ± 2.98 ml x kg^{-1} x min^{-1}, while, in the 3200 meters, it was 55.32 ± 3.23 ml x kg^{-1} x min^{-1}.

In 2015, a study of Brazilian military men sought to determine the association between cardiorespiratory *fitness* and body composition. This study established a prediction of VO_2 max using Cooper's test of 52.8 (52.0-53.6 ml x kg^{-1} x min^{-1}) in 1306 volunteers between the ages of 18 and 25 with normal weight (BMI ≤ 25) (Nogueira et al., 2016). Studies in the Norwegian military (107 soldiers) are also reported in the literature involving VO_2 max intakes that ranged from 49.4 ± 2.8 when entering the military service and 59.47 ± 2.5 ml x kg^{-1} x min^{-1} at the end of basic military training (Dyrstad et al., 2006).

In humans, jumping is a complex movement that requires complex motor coordination between the upper and lower body segments, and in particular, the propulsive action of the lower limbs during the vertical jump (Welsh et al., 2008). Because of the increased physical demands during military operations, endurance and propulsive strength training of both the upper and lower extremities are a vital part of modern physical training and soldier readiness for operations (Kyröläinen et al., 2018). Since the 1970s, it has been proposed that explosive force is a magnitude of a rapid nature whose duration time is limited; it guarantees maximum use of energy in the shortest possible time (Bosco & Komi, 1979). Therefore, adequate conditioning of this, in normal conditions of military training and military maneuvers (such as escape and evasion, obstacle jumping, and high jumping), influence the incidence of lower-body injuries (Rosendal et al., 2003).

In this sense, jump tests have been used to monitor physical performance in military populations after a high level of mechanical stress during short duration (8 days) special operations, finding a reduction in the results of explosive strength involved in jumping (Tillin et al., 2012). On average, in the Colombian Army military training schools, the evaluation of lower limb explosive strength using the *Squat Jump* yielded jump heights of 26.94 ± 3.3 cm, air times of 462.54 ± milliseconds, and speeds of 2.42 ± 0.5 m/s. With these variables and using Sayers' equation (Sayers et al., 1999), the calculation of the maximum power developed in the *Squat Jump* was 2801 watts for the ESMIC students, 2642 watts for the EMSUB students, and 2891 watts for the ESPRO students.

In 2019, an intervention paper in two platoons of Australian Army recruits implemented a 12-week training program to reduce the intensity volumes of military training with a prior period of calisthenics compared to the traditional basic training program (Burley et al., 2020). At the end of the study, it was evidenced that the students who received the warm-up period with decreased volume in the training intensity developed a maximum power that ranged between 1714 and 1837 watts in the vertical jump test. This value is somewhat different from the results obtained for this test in the present study; it should be considered that an inertial accelerometry device was used for its evaluation, which could improve the possibility of capturing the data.

One of the limitations of this study was the difficulty in making comparisons with foreign military populations. The method of evaluation of physiological variables was adapted to each military environment, mainly with indirect evaluations. Therefore, these tests are modified concerning those reported in the articles of specialized journals on the subject. On the other hand, although it is not considered possible to methodologically compare VO_2 max consumptions at different altitudes, the results obtained in the study, compared with other similar populations, show that, because of the type of population, age group, and type of training received, it is possible because of the homogeneity of the population groups and the type of training applied, as no marked differences were found between the groups in the performance of the test applied.

Within the possible future studies related to the subject and the object of study, it is recommended to continue monitoring both at the beginning (when the student enters his or her training process) and the end of the course to determine the actual changes produced by the training. Likewise, the performance in these tests when subjected to the loads that military personnel must commonly carry (such as field equipment, armaments, supplies, communications equipment) should be determined.

Conclusion

Although the Colombian National Army's education and doctrine system regulate military physical training programs homogeneously, the result of the conditioning plan depends largely on the volume (duration and repetitions), the intensity (load and speed), and the frequency with which it is performed, without neglecting the individual genetic, physiological, and psychological conditions of those who undergo it, in search of optimization of their physical capabilities.

A first approach to the evaluation of the physical conditioning of the students of the three training schools of the Colombian National Army allowed us to determine that there are differences in the results obtained in the measurement of most of the variables that make up military *fitness*. The results favored the personnel of the school of professional soldiers, evidencing better consumption of VO_2 max, greater flexibility, and better body composition (BMI, higher fat-free mass, and better muscle mass volume). In variables such as upper limb muscle strength (hand dynamometry) and lower body explosive strength (air time and maximum power), the ESPRO students performed better in the tests compared to the EMSUB but not when compared to the ESMIC students.

Due to conditions of individual variability, it is suggested that future studies with larger sample sizes be conducted to determine the effectiveness of these training plans in each of the schools, considering the adaptation variability to physical conditioning in basic military training. This will translate into better possibilities to evaluate performance and combat survivability for future members of the Colombian National Army.

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