



CORRELATION BETWEEN THE CARDIORESPIRATORY FITNESS LEVEL AND HABITUAL PHYSICAL ACTIVITY IN BRAZILIAN AIR FORCE RECRUITS

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Abstract:

Cardiorespiratory fitness is the ability to maintain moderate or high-intensity efforts for long periods of time and is highly related to physical activity habits and fitness levels. Analyzing habitual physical activity in military personnel and its relationship with cardiorespiratory fitness is consequently fundamental. Thus, the objective of this study was to verify the correlation between the cardiorespiratory fitness level and habitual physical activity in Brazilian Air Force recruits. The sample consisted of 86 recruits in the final phase of the soldier training course. Data was collected using the 12-minute cardiorespiratory fitness test and the Baecke questionnaire validated for the Portuguese language to assess the practice of habitual physical activity. Descriptive statistics were used for sample characterization and exploratory analysis. The distribution of data normality was analyzed using the Shapiro-Wilk test, followed by Pearson's correlation test and the Mann-Whitney U test to compare the groups with lower and higher cardiorespiratory fitness. The significance level of $p \leq 0.05$ was adopted. According to the results, 63.9% of the sample had satisfactory cardiorespiratory fitness levels (good and excellent). No significant correlations were observed between cardiorespiratory fitness

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and habitual physical activity indices, except for the physical exercise/sports index ($p=0.05$). It was found that only the Body Mass Index showed a difference ($p=0.017$, Effect Size= 0.637) between the cardiorespiratory fitness groups. It is concluded that most military recruits have adequate cardiorespiratory fitness levels, but these are not influenced by the habitual practice of physical activity.

Keywords: exercise; maximum oxygen consumption; physical fitness; military personnel

1. Introduction

According to Art. 142 of the Constitution of the Federative Republic of Brazil, the main mission of the Brazilian Armed Forces, constituted by the Brazilian Army, the Brazilian Air Force, and the Brazilian Navy, is to defend the Fatherland and guarantee constitutional powers, law, and order (Brazil, 1988). Therefore, it is clear that the military must ensure the maintenance of good health conditions and physical and mental performance.

Because of this requirement, and because there is already a consensus in the literature, good cardiorespiratory fitness is related to improved physical fitness, which in turn seems to improve health, physical vigor, body composition (Nikkola et al., 2012; Santtila et al., 2016; Campos et al., 2017; Martinez-Valdes et al., 2017; Aandstad et al., 2020), readiness, self-confidence and the ability to control situations of fatigue and stress (Taylor et al., 2008; Beckner et al., 2021), in addition to improving operational performance (Huang et al., 2018). Candidates must have adequate cardiorespiratory fitness to join the FAs, in addition to other physical attributes, such as strength and body composition within recommended standards.

After being admitted, recruits undergo military training that involves a variety of activities, such as technical learning of the equipment to be used, exhaustive physical training, and technical tactical testing, among other practices. The purpose of this stage is to raise the military to physical stress so that in combat conditions he can adequately respond to operational demands (Orr et al., 2020; Heilbronn et al., 2022). Thus, instruction and physical training is, therefore, one of the pillars of the basic training protocol of all military personnel (Heinrich et al., 2012; Orr & Pope, 2015).

Likewise, higher cardiorespiratory fitness levels need to be maintained during their careers, which demands that military personnel are periodically submitted to physical tests and body analyses, regardless of the nature of the assignments performed (operational or support), rank/graduation, or gender (Knapik, 1989; Avila et al., 2013; Vaara et al., 2020). Regular physical tests have the function of verifying the physical conditions of the military in relation to the minimum standards required for the proper exercise of their operational demands. The FAB, like the other FAs, has regulations that establish minimum criteria for admission, training, maintenance, and constant evaluation of physical attributes (Brazil, 2011).

Military personnel generally have good cardiorespiratory fitness levels, as shown by studies conducted by Oliveira & Anjos (2008), Rocha et al. (2017), and Silva et al. (2020), which presented results in percentages equal to or greater than 70%, with “very good” to “excellent” cardiorespiratory fitness in the military. Despite being a high percentage, considering their attributions it should be noted that approximately 30% of the Brazilian workforce does not have a good cardiorespiratory conditioning level, which may be linked to low levels of habitual physical activity (Rocha et al., 2017; Silva et al., 2020).

Despite the importance of physical exercises in developing cardiorespiratory fitness, it is known that regular physical activities also play an important role in maintaining them at higher levels (Araújo & Araújo, 2000). However, due to technological advances (smartphones, social networks, electric vehicles, etc.), urban violence, and other barriers, there is a reduction in its levels among children, young people, and adults, and a consequent reduction in cardiorespiratory fitness levels (Butcher et al., 2008; Tenório et al., 2010; Lima-Junior et al., 2019; Silva et al., 2020). It should be noted that the data regarding the level of habitual physical activity among the military personnel of the AFs are not very precise, with some studies showing that their levels may be between 60 and 90% of active/very active individuals, depending on the instrument used (Martignago et al., 2016; Rocha et al., 2017).

Despite cardiorespiratory fitness apparently being highly related to physical activity habits, only one Brazilian study has used a FA military personnel sample (Rocha et al., 2017). The results demonstrated a low relationship between physical activity and cardiorespiratory fitness level ($r= 0.203$, $p= 0.026$) (Rocha et al., 2017). It should also be noted that knowledge of aspects related to the leisure/locomotion domains, as well as physical exercise and sports are of paramount importance for the military, as they influence cardiorespiratory fitness to a certain extent. Therefore, it is relevant to better understand these variables and their relationships among military personnel. Thus, the objective of this work was to verify the correlation between the cardiorespiratory fitness level and the habitual physical activity in FAB recruits.

2. Material and Methods

2.1 Study design

This study is classified as cross-sectional and was developed with young people aged 18 and 19, belonging to the FAB, in the city of Rio de Janeiro, RJ, Brazil. The present study was approved by the Research Ethics Committee of the Hospital da Força Aérea do Galeão (Opinion no. 2,486,972/2018) and followed the norms of Resolution no. 466/12 of the National Health Council regarding research involving human beings. Participants were informed of the study objectives and procedures by signing the Informed Consent Form and were free to discontinue participation at any time.

2.2 Sample

The sample consisted of 86 (eighty-six) male recruits aged between 18 and 19 years, considered healthy, and who were in their final stage of adaptation. All subjects were considered fit according to the initial health inspection to which they were submitted, being non-smokers and free of pharmacological treatments or any disorders that could alter the results of this research.

2.3 Procedures

All data collection procedures took place on two subsequent days. The soldiers underwent measurement of anthropometric variables, body mass, and height on the first day, followed by filling out a questionnaire to measure the level of habitual physical activity. Then all military personnel took the 12-minute test on the second day. Each group of 10 soldiers was supervised by a specialist evaluator to control the number of laps on the track, totaling 9 evaluators. All anthropometric tests were performed by a single evaluator.

2.4 Anthropometric evaluation

A Leader digital scale (model P150M) with a maximum load of 200 kg was used to measure body mass (kg). Height (cm) was measured with a Sanny metallic stadiometer with ± 2 mm precision, with the subjects in the standing position, maintaining contact with the device with their heel and with their head adjusted to the Frankfurt plane. Standardization of the International Society for the Advancement of Kinanthropometry (2001) was used for both measures. According to the anthropometric results, the body mass index was calculated ($BMI = \text{body mass} / (\text{height in meters})^2$).

2.5 Cardiorespiratory evaluation

The 12-minute cardiorespiratory fitness test was performed on an official Air Force University athletics track. The track was marked every 10 meters to facilitate the measurement of the maximum distance achieved. Values were recorded by the distance covered by the subject and the calculation was performed by $VO_{2MAX} = (\text{maximum distance in meters} - 504.9) / 44.73$ (Cooper, 1968). The 12-minute test has a moderate/high correlation with the VO_{2MAX} and is widely performed in Military Organizations in Brazil due to several factors, such as ease of administration, low operational cost, and the possibility of evaluating a large number of people simultaneously (Kravchychyn et al., 2015; Campos et al., 2017; Zanetti et al., 2020). The national classification table of cardiorespiratory fitness proposed by Herdy & Caixeta (2016) was used to identify the cardiorespiratory fitness level of the subjects. The sample was then divided into two groups based on the obtained results: lower ($VO_{2MAX} < 48.07$ ml/kg/min) and higher cardiorespiratory fitness groups ($VO_{2MAX} \geq 48.07$ ml/kg/min).

2.6 Assessment of the level of habitual physical activity

The habitual physical activity questionnaire recommended by Baecke and adapted by Florindo & Latorre (2003) was applied to assess the recruits on their levels of physical activities related to practicing physical exercises/sports and leisure/locomotion. The answer options in this questionnaire are coded in the form of a Likert scale, with five answer options. Each score can range from 1 to 5 points, being a dimensionless quantitative variable. Grouping occurred in each of the areas of the questionnaire through the sum of the specific scores attributed to the questions (Florindo & Latorre, 2003).

2.7 Data analysis

Descriptive statistics (mean, standard deviation, minimum, maximum, frequency, and percentages of the variables under analysis) were used for sample characterization and exploratory analysis. The distribution of data normality was analyzed using the Shapiro-Wilk test. The habitual level of physical activity and cardiorespiratory fitness variables were correlated by Pearson's or Spearman's linear coefficient and interpreted according to Mukaka (2012). The Mann-Whitney U test was used to verify the difference between the groups of lower ($VO_{2MAX} < 48.07$ ml/kg/min) and higher cardiorespiratory fitness ($VO_{2MAX} \geq 48.07$ ml/kg/min). A significance level of $p \leq 0.05$ was adopted. Data were analyzed in the JASP 0.16.3.0 program for Windows (University of Amsterdam, Netherlands).

3. Results and Discussion

Information regarding anthropometric and cardiorespiratory fitness variables is presented in Table 1.

Table 1: Anthropometric and cardiorespiratory fitness characteristics of recruits (n= 86)

	Mean	Standard deviation	Minimum	Maximum
Age (years)	18.9	0.3	18.0	19.0
Body mass (kg)	67.3	9.8	49.8	102.1
Height (cm)	175.5	7.4	160.0	200.0
BMI (kg/m ²)	21.9	2.94	15.7	31.1
Distance travelled (m)	2765.0	231.8	2140.0	3260.0
Relative VO_{2MAX} (ml/kg/min)	50.5	5.2	36.6	61.6

The results regarding the classification of cardiorespiratory fitness indicate that the absolute majority of recruits are classified as regular, good, and excellent. Only 2 recruits (2.8% of the sample studied) had a poor cardiorespiratory fitness level (Regular = 34.3%; Good = 38.0%; Excellent = 25.0%, totaling 97.2%). Table 2 presents the habitual physical activity scores in the indices related to physical exercise/sport and leisure/locomotion.

Table 2: Recruits' Habitual Physical Activity Scores (n= 86)

	Mean	Standard deviation	Minimum	Maximum
AFExF	3.76	3.36	0.06	12.50
AFLl	3.24	0.54	2.00	4.50
AFExF+ AFLl	7.00	3.51	2.48	16.25

Legend: AFExF - Physical exercise/sports index; AFLl - Leisure and locomotion physical activity index; AFExF + AFLl - Physical exercise/sports index + Leisure and locomotion physical activity index

Correlations were performed by comparing the results obtained and analyzed with the results of the physical activity practice scales. Table 3 demonstrates the correlation between cardiorespiratory fitness and habitual physical activity indices related to physical exercise/sports and leisure/commuting. The correlations found are "low" ($r=0.205$) to "very low" ($r= -0.063$ and 0.180) due to the case and only the physical exercise/sports index was significant ($p=0.05$).

Table 3: Correlation between cardiorespiratory fitness and habitual physical activity indices of recruits (n= 86)

	Cardiorespiratory fitness	
	Pearson's/Spearman's correlation *	<i>p</i>
AFExF	0.205*	0.050
AFLl	-0.063	0.563
AFExF+ AFLl	0.180	0.098

Legend: AFExF - Physical exercise/sports index; AFLl - Leisure and locomotion physical activity index; AFExF + AFLl - Physical exercise/sports index + Leisure and locomotion physical activity index)

Table 4 shows BMI data and scores of habitual physical activity grouped into two groups ($VO_{2MAX} < 48.07$ ml/kg/min and $VO_{2MAX} \geq 48.07$ ml/kg/min).

Table 4: Comparison of BMI and habitual physical activity indexes grouped by physical conditioning level (n= 86)

	$VO_{2MAX} \leq 48.07$ ml/kg/min (n= 30)		$VO_{2MAX} > 48.07$ ml/kg/min (n= 54)		Statistics		
	Mean	Standard deviation	Mean	Standard deviation	Mann-Whitney	p-value	Effect size
BMI (kg/m ²)	23.00	3.43	21.20	2.45	1086.0	0.017	0.639
AFExF	3.05	3.06	4.15	3.48	704.5	0.221	-0.161
AFLl	3.32	0.57	3.20	0.52	668.0	0.120	-0.205
AFExF + AFLl	6.38	3.25	7.35	3.63	932.0	0.402	0.110

Legend: AFExF - Physical exercise/sports index; AFLl - Leisure and locomotion physical activity index; AFExF + AFLl - Physical exercise/sports index + Leisure and locomotion physical activity index

The results demonstrate that the mean BMI of the group with $VO_{2MAX} < 48.07$ ml/kg/min is significantly lower when compared to the group with lower cardiorespiratory fitness. No differences were found between groups for habitual physical activity scores.

4. Discussion

The present study aimed to verify the correlation between cardiorespiratory fitness and the practice of habitual physical activity related to physical exercise/sport and leisure/locomotion indices in young military recruits of a *FAB* military organization. These results were additionally compared between groups with lower and higher cardiorespiratory fitness. According to the results, it can be seen that 63.0% of the studied sample was classified as “good” and “excellent” cardiorespiratory fitness.

It is noteworthy that the investigated recruits were evaluated at the end of their adaptation stage at the end of an intense physical training period. Therefore, it was expected that all subjects would have good cardiorespiratory fitness levels. However, the percentage of military personnel with the highest cardiorespiratory fitness scores was below those found in other studies carried out with active duty military personnel, such as the one conducted by Oliveira & Anjos (2008) who evaluated 50,523 Brazilian Army soldiers with a mean age of 25.8 years, of which approximately 75.6% had VO_{2MAX} between 48 and 82.9 ml/kg/min, which is very good to excellent cardiorespiratory fitness. Other studies carried out with Brazilian military personnel also demonstrated that around 70% of the samples involved had a cardiorespiratory fitness level between “good” and “excellent” scores (Rocha et al., 2017; Silva et al., 2020). To a certain extent, this difference can be explained by the fact that the sample consisted of recruits recently admitted to the *FAB*, since previous studies state that one of the factors that influence military physical training programs is the initial physical fitness of the subjects (Orr & Pope, 2015; Campos et al., 2017), which was not evaluated in the case of this study. Another explanation may lie in the fact that this variable has an important genetic component (Malina, 2001), although physical training, especially in moderate and vigorous forms, can produce significant responses in cardiorespiratory fitness levels (Lang et al., 2018).

Despite approximately 63% of the sample having been classified as “good” and “excellent” cardiorespiratory fitness, the average presented in the 12-minute test (2765 ± 231.8 m) shows acceptable indexes for cardiorespiratory fitness, constituting a superior result to others found in the literature. As an example, higher values were observed in the 12-minute test in this study when compared to *FAB* military personnel from a Military Organization located in southern Brazil (2485.3 ± 322.4 m) (Pereira & Teixeira, 2006), as well as being superior to those presented by Finnish military personnel (also recruits), who presented an average of 2661 ± 191 m (Vaara et al., 2020). When compared with

subjects with similar ages to those in the present study, similar values to those of *FAB* recruits in the final training period were identified (2752 ± 217 m) (Campos et al., 2017).

The average of 50.5 ± 5.2 of Relative VO_{2MAX} (ml/kg/min) achieved in the present study indicates an excellent level of physical conditioning, which is very important since, as already mentioned, cardiorespiratory fitness is of fundamental importance for the military given the operational function of performance, in addition to the fact that low fitness is closely associated with high levels of cholesterol and triglycerides (Eisenmann et al., 2007), greater risk of obesity (Kim et al., 2005) among other deleterious factors related to health. Therefore, it is an intermediary variable between physical activity behaviors and health, as it reflects the ability of various body organs (e.g., heart, lungs, and muscles) to assist in energy production during physical activity and exercise.

Recommendations regarding the frequency and duration of habitual physical activity practice vary. As an example, according to the recommendations of the American College of Sports Medicine (ACSM), people should practice 150 minutes of moderate physical activity per week (Thompson, 2019). However, it should be noted that the physical aspect of military personnel is essential for fulfilling operational missions, and so these recommendations should be even higher. Even the initial levels of physical fitness at the beginning of training periods can be of paramount importance in reducing injuries that occur during military training (Orr et al., 2020).

The fact that approximately 37% of the sample did not present from “good” to “excellent” fitness could be explained by low levels of habitual physical activities, since these have an important role in their maintenance at higher levels (Michelin et al., 2011). However, this does not hold, at least for the sample in this study, since no significant correlation was observed between these variables. This statement is corroborated by the fact that there is no significant difference between the levels of habitual physical activity among the sample subjects when they were grouped by the physical conditioning level. One of the possible explanations for the low correlation between the investigated variables may be related to the data collection period, which took place in the final phase of the adaptation course to military service. The soldier training course is comprised of 16 weeks of grueling physical training. Thus, the results of practicing previous physical activity, which according to the questionnaire used analyzes the last twelve months (Kravchychyn et al., 2015), may have been influenced due to the supposed sudden increase in cardiorespiratory fitness during the internship, as observed in other studies with young military personnel (ISAK, 2001; Campos et al., 2017).

It should also be noted that the low correlation between the results of the application of habitual physical activity questionnaires and the cardiorespiratory fitness results may be related to the difficulty in understanding the instrument used, as evidenced in previous studies with military personnel (Glaner & Rosario, 2004) and with young adults, recommending the application of physical tests such as the 12-minute test applied (Glaner, 2007).

Finally, it should be noted that this study has some limitations, such as a low number of subjects for the study type, but mainly the collection time, the training level of the military involved, and the possible decrease in cognitive ability to understand the questionnaire, which may have especially influenced the low correlation between the investigated variables. Despite the observed limitations, the results presented herein have practical relevance in the military environment, possibly due to the effects of physical training promoted by military organizations on the cardiorespiratory component of recruits undergoing training.

5. Conclusion

It is concluded that military recruits have adequate cardiorespiratory fitness levels, but these are not influenced by the usual practice of physical activity, specifically by indices related to physical exercise/sport and leisure/locomotion. New interventions that can measure the habitual practice of physical activity with other equipment such as accelerometers or wearable devices are suggested.

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Conflicts of Interest Statement

The author reports that there are no competing interests to declare.

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