

Is self-perception enough to predict cardiorespiratory fitness?

A autopercepção é suficiente para prever a aptidão cardiorrespiratória?

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ABSTRACT

Introduction: This study investigated the validity of self-perceived cardiorespiratory fitness as a tool for assessing physical fitness in military personnel of the Brazilian Air Force. **Objectives:** The objective was to determine the correlation between self-reported fitness and objectively measured VO_{2max}, exploring its potential as an alternative or complement to traditional methods. **Methods:** The study employed a cross-sectional design, using a convenience sample of 72 aspirants to the officer cadre of the Brazilian Air Force (47 females, 25 males). Data were collected using a self-report questionnaire to assess perceived cardiorespiratory fitness and a 12-minute Cooper run test to measure VO_{2max}. Statistical analyses included descriptive statistics, t-tests, ANOVA, correlation analysis, and k-means clustering. **Results:** The results showed a significant positive correlation between self-reported fitness and VO_{2max}, suggesting that self-report and objective measures are in reasonably good agreement. However, the analyses revealed some discrepancies, with potential biases in self-report observed at different fitness levels and between genders. Although self-report showed promise as a complementary tool, it was not a perfect substitute for objective assessment. **Conclusion:** The study concluded that self-perceived cardiorespiratory fitness has potential as a large-scale, cost-effective screening tool for the Brazilian Air Force..

Keywords: surveys and questionnaires; physical fitness; cross-sectional studies; exercise test; military personnel

RESUMO

Introdução: Este estudo investigou a validade da aptidão cardiorrespiratória autopercebida como uma ferramenta para avaliar a aptidão física de militares da Força Aérea Brasileira. **Objetivos:** O objetivo foi determinar a correlação entre aptidão autorrelatada e VO_{2max} medido objetivamente, explorando seu potencial como uma alternativa ou complemento aos métodos tradicionais. **Métodos:** O estudo empregou um delineamento transversal, utilizando uma amostra de conveniência de 72 Aspirantes ao Quadro de Oficiais da Força Aérea Brasileira (47 mulheres, 25 homens). Os dados foram coletados usando um questionário de autorrelato que avaliou a aptidão cardiorrespiratória percebida e um teste de corrida de Cooper de 12 minutos para medir o VO_{2max}. As análises estatísticas incluíram estatísticas descritivas, testes t, ANOVA, análise de correlação e agrupamento de k-means. **Resultados:** Os resultados demonstraram uma correlação positiva significativa entre aptidão autorrelatada e VO_{2max}, sugerindo que a autopercepção se alinha razoavelmente bem com medições objetivas. No entanto, as análises revelaram algumas discrepâncias, com potenciais vieses observados na autoavaliação em diferentes níveis de aptidão e entre gêneros. Embora a autopercepção tenha se mostrado promissora como uma ferramenta complementar, ela não foi um substituto perfeito para a avaliação objetiva. **Conclusão:** O estudo concluiu que a aptidão cardiorrespiratória autopercebida tem potencial como uma ferramenta de triagem de grande escala e custo-benefício para a Força Aérea Brasileira, complementando, mas não substituindo totalmente, os métodos de avaliação direta. Pesquisas adicionais com amostras maiores e mais diversas são necessárias.

Palavras-chave: inquéritos e questionários; aptidão física; estudos transversais; teste de exercício; militares.

Introduction

Cardiorespiratory fitness “is the capacity to execute dynamic exercises involving large muscle groups at moderate to high intensity for prolonged durations” [1], with maximal oxygen uptake ($\text{VO}_{2\text{max}}$) serving as the most valid and extensively accepted measure representing the capacity of the cardiorespiratory system [2].

Traditionally, to obtain $\text{VO}_{2\text{max}}$, the scientific and professional community in the health area uses tests classified as direct, indirect, and effortless methods [2,3]. Direct evaluation methods involve using an ergometer (treadmill, bicycle, among others) and a gas analyzer capable of quantifying in real-time, breath by breath, the amount of oxygen metabolized during the test [1,4]. Generally, these methods involve gradually increasing the intensity of the exercise (speed and/or incline) until the volunteer is exhausted [2-4].

Indirect methods can be performed using ergometers or in the field, but generally at submaximal intensities [2]. These methods use the heart rate (HR) response to a submaximal intensity [5] (e.g. Åstrand test) or, in some cases, the distance traveled in a unit of time in equations that predict $\text{VO}_{2\text{max}}$ [1,2] (e.g. 1-mile test). The indirect method is related to using $\text{VO}_{2\text{max}}$ prediction equations without subjecting the individual to exercise [1,2].

Although direct assessment methods are considered more valid and reliable for obtaining $\text{VO}_{2\text{max}}$, indirect methods offer advantages such as lower cost (acquisition and maintenance of equipment), greater practicality, and less need for trained personnel to operate equipment [6], in addition to allowing large-scale assessments.

Another method with potential for estimating general physical fitness (cardiorespiratory fitness, strength, localized muscular endurance, flexibility, and body composition) is the measurement of self-perception. In practice, self-perception consists of asking the individual to declare how he or she perceives his or her general physical fitness. There are different approaches to measuring general physical fitness based on self-reports. Some use a single general question [7,8], such as “How do you perceive your general physical fitness?”. Other approaches use several questions separated by component (cardiorespiratory fitness, strength, localized muscular endurance, flexibility, and body composition) [9,10].

The Brazilian Armed Forces conduct periodic physical fitness assessments of their military personnel to ensure health and adequate professional and operational performance [11-13]. Applying these assessments requires distinct planning and logistics, considering the different infrastructure realities (facilities and equipment) among the military organizations distributed throughout the Brazilian territory.

This diversity of situations demands flexibility and adaptations in implementing physical assessment programs, ensuring that all military personnel can be assessed effectively and consistently, regardless of location and existing conditions. In particular, in the Brazilian Air Force, the Physical Fitness Assessment Test [11] is carried out twice a year, involving two stages. The PAR-Q Questionnaire is completed,

the resting heart rate, body mass, height, and waist circumference are measured in the first stage. In the second stage, the military personnel perform the Ground Push-Up Test, Abdominal Test, and the 12-minute Run. In other words, carrying out these tests requires time and the presence of a large number of specialized professionals to meet the needs of all military organizations [14].

Aandastad [6] highlights that self-perception instruments are practical and economical tools for collecting data on physical fitness in large groups. These instruments are particularly useful in population surveys, health assessments, and selection processes for demanding physical activities, as in the Armed Forces.

Considering this scenario, self-perception of cardiorespiratory fitness emerges as a promising alternative. Rather than relying exclusively on a standardized physical test, it would be possible to use the assessment that military personnel themselves make of this component of physical fitness. Since military personnel are familiar with the criteria for passing physical tests, they may have a more appropriated perception of their cardiorespiratory capacity. This hypothesis suggests that self-perception could complement traditional tests, optimizing the evaluation process and allowing military personnel to dedicate more time to their support or operational duties. Given the above, the objective of this study was to evaluate the feasibility and accuracy of self-perception of cardiorespiratory fitness as an alternative or complement to direct testing in military personnel.

Methods

Type and design of the study

According to Thomas, Nelson & Silverman [15] this is an observational study with a cross-sectional design.

Sample

This study was conducted with a group of Aspirants to the temporary officer cadre of the FAB who were completing the Technical Adaptation Internship (EAT) at the Guarnição de Aeronáutica dos Afonsos (GUARNAE-AF) in the first half of 2024. The sample group comprised 72 military personnel of both sexes (47 women and 25 men). All individuals who voluntarily agreed to participate in the research participated. At the same time, those who did not fill out the form or did not take the physical fitness test were excluded.

Procedures and instruments

In the first stage, the Candidates were gathered to answer a questionnaire about their self-perception of cardiorespiratory fitness. After presenting the research and signing the free and informed consent form, the participants answered, "How do you perceive your cardiorespiratory fitness?". The answers were recorded on a 5-point Likert scale, ranging from "very bad" to "very good". For analysis purposes, the op-

tion “very good” was considered 100%, and the other options were proportionally adjusted.

In the second stage, 24 and 48 hours after the first stage, the Aspirants performed the 12-minute Cooper test on the official GUARNAE-AF athletics track. In this test, participants ran the longest distance possible in 12 minutes, maintaining a constant speed. With two minutes remaining, the Aspirants were notified that the time was nearing the end. At the end of the test, the Aspirants remained on the spot, and the distance covered was recorded.

To convert the distance into VO_{2max} the following equation [16] was used:

$$VO_{2max} = (504 - \text{distance (m)}) / 45$$

The table proposed by Heardy and Caixeta [17] was used to classify the level of cardiorespiratory fitness. For men and women, the classification considered the average age corresponding to the age group and sex. Furthermore, as an alternative to the classification proposed by Heardy & Caixeta [17], the VO_{2max} values were categorized using the k-means test, stratified by sex. The data were tabulated and validated using a spreadsheet software (Excel, Microsoft Corporation, USA).

Statistical analysis

Data analysis involved the application of descriptive and inferential statistics. Student's t-test and Cohen's effect size calculation were used to compare demographic characteristics between genders. The relationship between self-perception of cardiorespiratory fitness and VO_{2max} was investigated using Pearson's correlation coefficient. For analysis purposes, the “very good” option was considered 100% (1.0), and the other options were proportionally adjusted using a simple rule of three.

To verify whether there were significant differences in the mean values of VO_{2max} between the different categories of self-perception, a one-way ANOVA with Scheffé's post hoc test was performed. The simple agreement measure assessed the agreement between self-perception and the categories generated by the k-means method. The criteria proposed by Mukaka [18] and Cohen [19], respectively, were adopted to interpret the magnitude of Pearson's correlation and Cohen's effect size.

All statistical analyses were performed using JASP (JASP Team. 2024. ver. 0.19.3) and Knime software (Bertold *et al.* [20]), while graphs were constructed using GraphPad Prism 9.0 (GraphPad Software. San Diego. CA). A significance level of 5% ($p < 0.05$) was considered for all statistical tests.

Ethics committee

This study was submitted to the Galeão Air Force Hospital Research Ethics Committee and approved under Protocol No. 2.486.972.

Results

Table I shows the general characteristics of the sample. All the variables showed homogeneous values except for VO_{2max} .

Table I - Sample characteristics (n = 72)

	Mean $\pm$ DP	Min	Max	CV
Age (year)	34.6 $\pm$ 4.1	25.0	44.0	11.8%
Body mass (kg)	71.5 $\pm$ 10.9	52.0	96.0	15.3%
Stature (cm)	168.7 $\pm$ 7.8	155.0	189.0	4.7%
BMI (kg.m ⁻²)	25.0 $\pm$ 2.9	18.5	31.9	11.9%
VO_{2max} (mL.kg ⁻¹ .min ⁻¹)	37.0 $\pm$ 6.9	18.8	54.8	18.8%

BMI = body mass index

Table II shows the characteristics stratified by gender. Significant mean differences were observed between men and women for the variables body mass, height, and VO_{2max} , according to the t-test, with the effect size considered high for body mass, height, and VO_{2max} .

Table II - Sample characteristics stratified by gender

	Women (n = 47)				Men (n = 25)				
	Mean $\pm$ DP	Min	Max	CV	Mean $\pm$ DP	Min	Max	CV	Effect size
Age (year)	34.8 $\pm$ 3.9	25.0	40.0	11.2%	34.2 $\pm$ 4.4	25.0	44.0	12.9%	0.158
Body mass (kg)	66.5 $\pm$ 8.9*	52.0	89.0	13.4%	81.0 $\pm$ 7.9	60.0	96.0	9.8%	1.700
Stature (cm)	164.5 $\pm$ 5.7*	155.0	179.0	3.5%	176.6 $\pm$ 4.8	169.0	189.0	2.7%	-2.250
BMI (kg.m ⁻²)	24.5 $\pm$ 3.1	18.7	31.9	12.7%	26.0 $\pm$ 2.4	18.5	29.7	9.2%	-0.462
VO_{2max} (mL.kg ⁻¹ .min ⁻¹)	33.9 $\pm$ 5.4*	18.8	42.8	16%	42.8 $\pm$ 5.8	30.58	54.8	13.6%	-1.606

BMI = body mass index. *significant difference between groups; p < 0.05

Figure 1 shows the correlations between VO_{2max} and self-perceived cardiorespiratory fitness for both sexes (Figure 1a) and stratified by sex (Figure 1b and 1c). Significant values were found for all correlations. For the overall relationship, the correlation values were considered high (r = 0.717; p < 0.001) (Figure 1a) and moderate for women (r = 0.690, p < 0.001) (Figure 1b) and men (r = 0.573; p < 0.05) (Figure 1c).

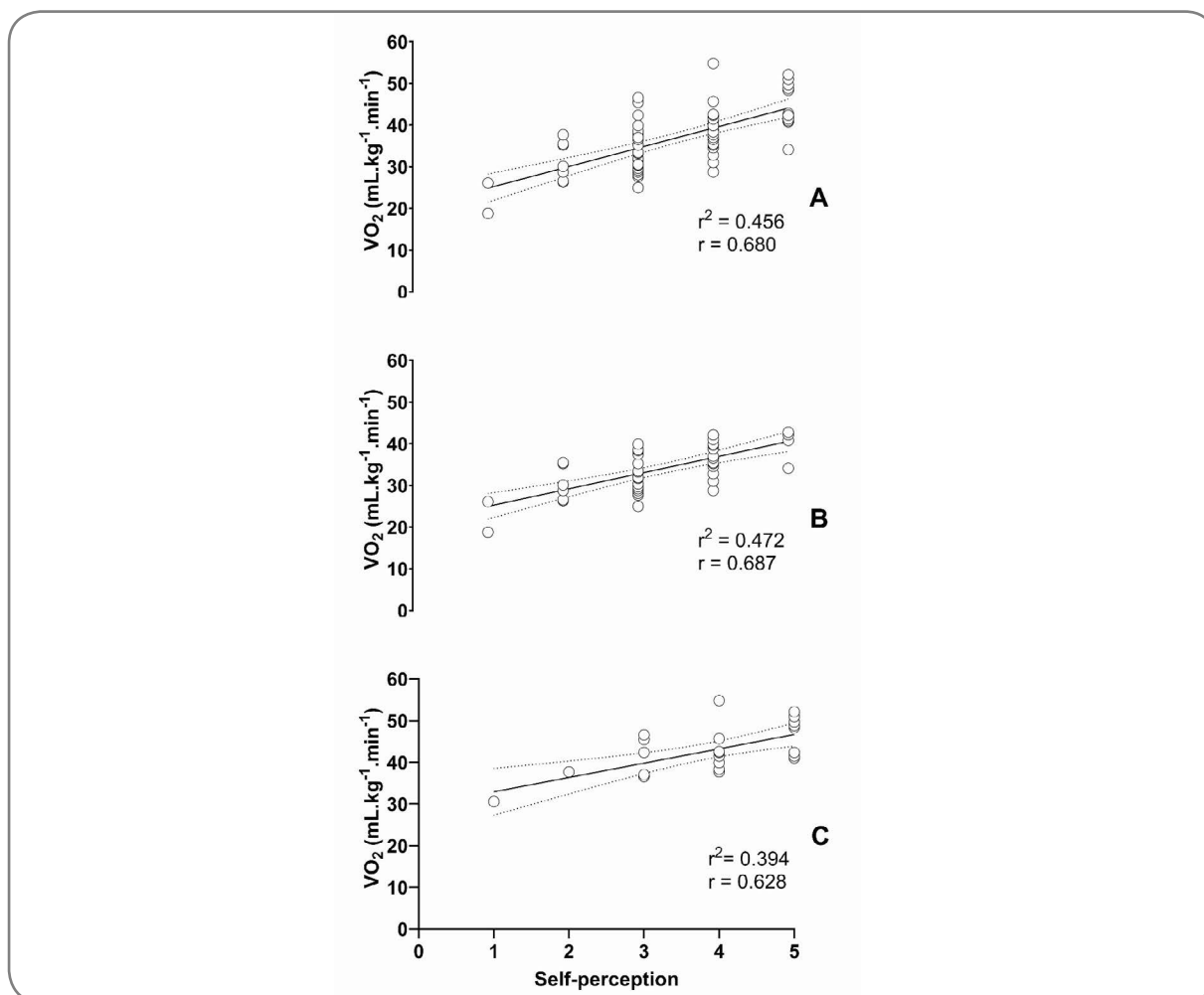


Figure 1 - Correlation between VO_{2max} and self-perceived cardiorespiratory fitness, total sample (a), female (b), male (c)

Figure 2 shows the mean VO_{2max} values grouped by categories of self-perceived cardiorespiratory fitness. In Figure 2a, no significant differences were found between groups 2 and 3. In Figure 2b, a significant difference was found between groups 3 and 4, while in Figure 2c, no significant differences were found between groups 4 and 5.

Figure 3 shows the distribution of VO_{2max} values grouped by self-perceived cardiorespiratory fitness. In Figure 3a (female), the group that rated themselves as “excellent” had the highest VO_{2max} values, confirming the classification proposed by Heardy and Caixeta [17]. On the other hand, the other groups showed a distribution of values that exceeded the limits established for the classification of VO_{2max} . In Figure 3b (males), all groups showed distributions that exceeded the limits proposed for the classification of VO_{2max} .

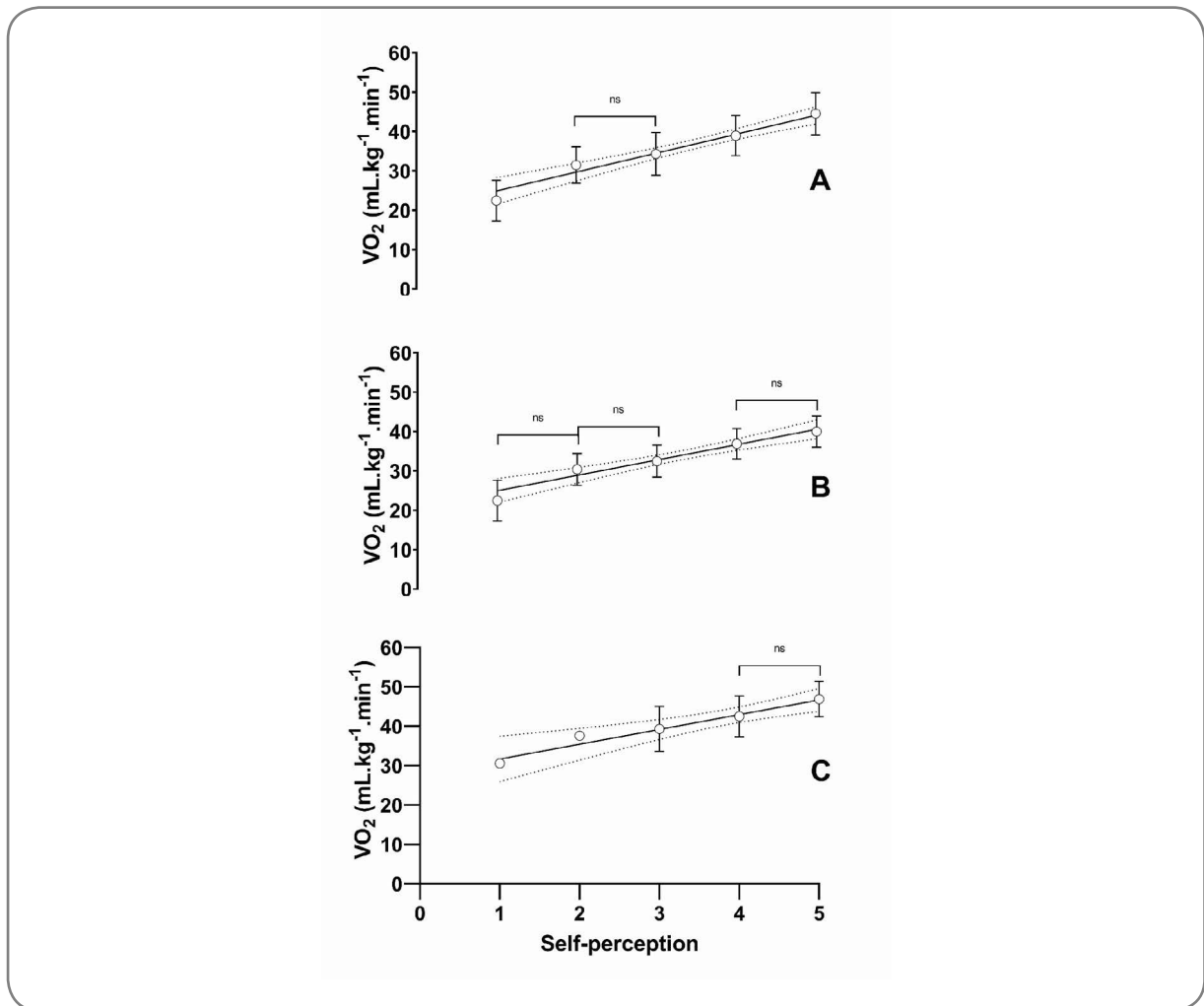


Figure 2 - Mean $\text{VO}_{2\text{max}}$ values grouped by categories of self-perceived cardiorespiratory fitness, general (a), female (b), male (c)

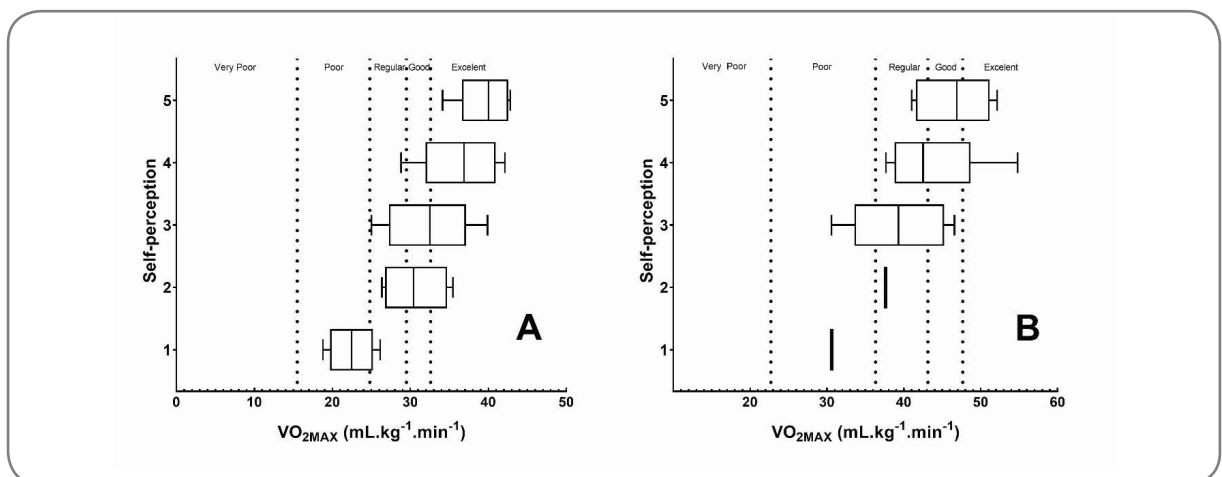


Figure 3 - Distribution of $\text{VO}_{2\text{max}}$ values grouped by self-perception and classified according to Hardy; Caixeta [17], female (a) and male (b)

Figure 4 shows the dispersion between cluster classification and self-perceived cardiorespiratory fitness, separately for women (Figure 4a) and men (Figure 4b). In both groups, approximately half of the aspirants ($\approx 53\%$ of women and 44% of men) showed agreement between the two assessments. Women tended to overestimate

their cardiorespiratory fitness in clusters 2 and 4, whereas men tended to overestimate in cluster 1 and underestimate in clusters 3 and 4.

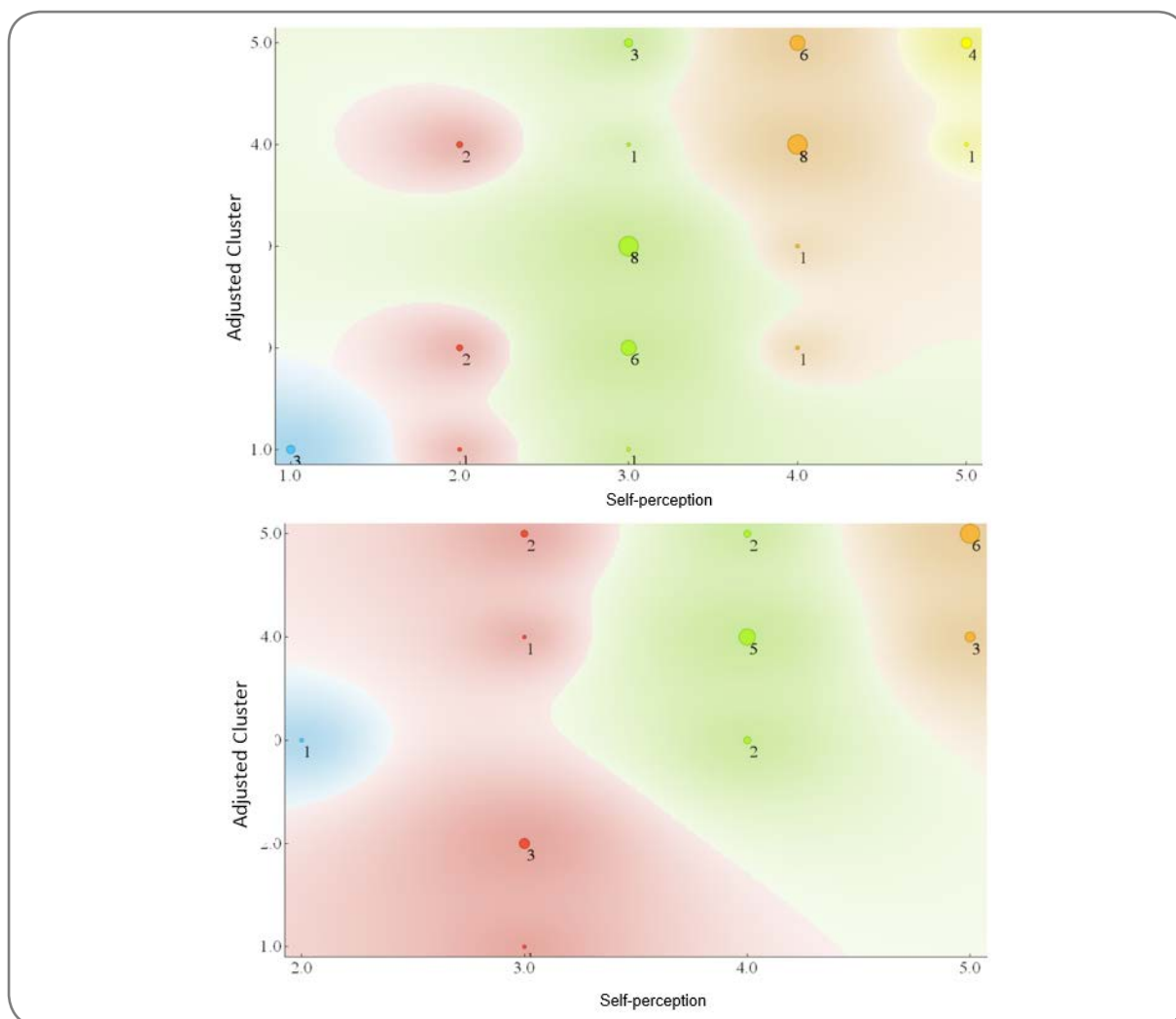


Figure 4 - Scatter plot between adjusted cluster and self-perception, female (a) and male (b)

Discussion

The main objective of this study was to analyze the validity of self-perception of cardiorespiratory fitness as a measurement instrument in a sample of candidates for the Temporary Officers' Cadre of the Brazilian Air Force. To this end, a comparison was made between the self-perception data and an objective indicator of cardiorespiratory fitness, being, to date, the first study to explore this relationship in this specific context.

This research showed positive and significant correlations between self-perception of cardiorespiratory fitness and VO_{2max} in a sample of Military Candidates. Specifically, a moderate correlation was observed between these variables in both the female and male groups. These findings suggest that the participants demonstrated considerable coherence in the self-assessment of their cardiorespiratory capacity since the increase in VO_{2max} was related to the elevation of the individual perception of

physical fitness (Figure 1). It is important to highlight that the scientific literature presents few studies that investigated the relationship between objective and subjective measures of cardiorespiratory fitness, with emphasis on the works of Aandstad [6], Petersen *et al.* [7], Martin *et al.* [21] and Knapik *et al.* [22].

Of the five studies identified in the literature, only the study by Petersen *et al.* [7] has a similar methodology but with some important differences. This study [7] included a sample with a wide age range (18 to 85 years) and used a general question about general physical fitness, whereas the present study focused specifically on self-perceived cardiorespiratory fitness. Participants ($n = 3,441$) answered a question about their self-rated physical fitness on a five-point Likert scale, and objective physical fitness was assessed using a submaximal test on a bicycle ergometer. Comparing the results, the correlation coefficients between self-rated and objective cardiorespiratory fitness were higher in this study for both women ($r = -0.52$ vs. $r = 0.69$) and men ($r = -0.52$ vs. $r = 0.57$). This discrepancy may be due to differences in sample characteristics, measurement devices, and cultural issues.

Studies conducted with non-military populations but with an age range similar to that of the sample in this study, such as those by Petersen *et al.* [7], Obilling *et al.* [23], Jensen *et al.* [24], and Jones *et al.* [25] also presented correlation coefficients similar to those found in the present study. These results support that self-perceived physical fitness is moderately related to objective physical fitness in different populations.

In comparison, the method used in the studies by Aandstad [6], Martin *et al.* [20], and Jones *et al.* [25] differs somewhat from the current one. Although all studies aimed to compare objective and subjective measures of cardiorespiratory fitness in military personnel, the way subjective data were collected differed. While the present study used Likert-type scales, the aforementioned studies asked participants to report their fitness test results in a quantitative manner, such as the exact time in minutes for the 3-mile test.

Aandstad [6] assessed 14,166 Norwegian military personnel using a 3,000-meter running test and then asked the participants to estimate online the time they would be able to complete the same test. The results showed a strong negative correlation between self-perception and actual performance on the running test, with correlation coefficients similar to those found in the present study for the total group ($r = -0.73$ vs. $r = 0.71$) and the male group ($r = -0.60$ vs. $r = 0.57$). However, compared to our results, the correlation was slightly lower for the female group ($r = -0.51$ vs. $r = 0.69$). It is important to note that the negative sign of the correlation is because the shorter the time, the higher the $\text{VO}_{2\text{max}}$.

The studies by Martin *et al.* [21] and Jones *et al.* [25], which included only male military personnel, showed even higher correlation coefficients between self-perception and actual performance ($r = 0.87$ and $r = 0.85$, respectively). These results suggest a high degree of agreement between self-report and objective performance in these specific groups of male military personnel.

When VO_{2max} values were analyzed by self-perception category (Figure 2), significant differences were observed between groups 1 (very poor) and 2 (poor) ($F(4,67) = 14.71$, $p < 0.001$; $t(67) = -2.15$; Scheffé $p = 0.34$) and between groups 2 (poor) and 3 (moderate) ($t(67) = -1.28$; Scheffé $p = 0.80$). However, when the analysis was performed separately by gender, it was found that women did not show significant differences between the self-perception categories, indicating homogeneity in VO_{2max} values between the female groups.

On the other hand, males showed significant differences only between groups 4 (good) and 5 (very good) ($F(2,36) = 8.78$, $p < 0.001$; $t(36) = -1.38$; Scheffé $p = 0.40$). Although the analysis of variance indicated significant differences between these two groups, the post hoc tests revealed no significant differences between the means. The results suggest that despite the tendency for VO_{2max} to increase with increasing self-perception category, there were no statistically significant differences between the means of the adjacent male groups.

These results suggest that men and women may be biased in their self-perceptions of cardiorespiratory fitness. Both men and women may tend to overestimate their ability in the lower self-perception groups (“very poor” and “poor”) and underestimate it in the higher self-perception groups (“good” and “very good”). This tendency may explain the higher dispersion of the data in these groups and the lack of significant differences between the means of adjacent groups. Data analysis did not reveal a consistent pattern of underestimation or overestimation of cardiorespiratory fitness between men and women. The results suggest that the discrepancy between the perception and reality of physical fitness may be more related to the self-perception category selected by the participants than to biological sex [26].

Contrary to the results found here, the scientific literature presents divergent results on the self-perception of physical fitness between men and women, with some studies suggesting that men overestimate their abilities compared to women [27,28].

This study examined the agreement between self-perceived cardiorespiratory fitness and the criteria proposed by Hardy and Caixeta [17]. When analyzing the female gender, it can be seen that all participants who rated themselves as having “very good” cardiorespiratory fitness (group 5) were classified as “excellent” according to the external criteria. However, for the other levels of self-perception, the distribution of results was wider, with participants falling into two or three different categories. A similar pattern was found for males, except Group 5, where 50% of the participants were classified as “very good” according to the objective criteria.

To further analyze the relationship between self-perception and cardiorespiratory fitness, k-means clustering was used to create more homogeneous categories based on VO_{2max} values. When these categories were compared with participants’ self-perceptions, agreement was moderate, with approximately 53% of women and 44% of men correctly classifying themselves. This analysis highlights the complexity of self-perception, which is influenced by various cognitive and emotional factors and individual physiological characteristics.

Recognizing the inherent error in objective and subjective measures is imperative. Although objective measures are expected to have a smaller margin of error, both random and systematic, compared to subjective measures and gold standards, it is important to emphasize that all measuring instruments are subject to error, quantified by the standard error of estimation. Given this scenario, the question arises as to whether it would be equally appropriate to consider a standard error of estimate for subjective measurements. For example, if it were possible to assign a standard error to a Likert scale of 1 to 5, it would theoretically be possible to achieve levels of agreement between self-perception and objective classification of around 100% for women and 96% for men. Using more detailed visual scales, such as a 0 to 10 scale, could significantly contribute to a better understanding of the magnitude of error in self-reporting and, consequently, to identify effective strategies for improving the accuracy of self-reporting.

One of the main limitations of this study is the small sample size and possibly the homogeneity of the $\text{VO}_{2\text{max}}$ values, which limits the robustness of the statistical analyses. In addition, the estimation of cardiorespiratory fitness using a submaximal field test, such as the 12-minute Cooper test, which has a correlation coefficient between 0.29 and 0.90, may affect the accuracy of the results.

However, proposing a substantial increase in sample size and using direct methods to measure cardiorespiratory fitness is a contradiction. Therefore, it is prudent to propose maintaining the current sample size combined with using a direct measure of cardiorespiratory fitness in a group that is homogeneous in terms of age and has a wide variability in fitness. This scenario would be the most appropriate approach for further analysis.

Conclusion

This study investigated the validity of self-perceived cardiorespiratory fitness as an alternative or complement to direct testing in a sample of aspirants to the temporary officer cadre of the Brazilian Air Force. High positive and significant correlations were observed between self-perceived fitness and $\text{VO}_{2\text{max}}$, suggesting a considerable degree of consistency in self-assessment of cardiorespiratory capacity. This finding suggests that as $\text{VO}_{2\text{max}}$ increases, so does the individual's perception of their fitness level.

Although significant differences were found between some categories of self-perception in the overall analysis and the male group, analyses stratified by gender revealed nuances. Women showed no significant differences between self-perception categories about $\text{VO}_{2\text{max}}$, indicating group homogeneity. Men showed significant differences only between the “good” and “very good” categories, but post hoc tests revealed no statistically significant differences between adjacent groups. The current results highlight potential biases in self-perception: both men and women may overestimate fitness in lower self-perception groups and underestimate it in higher groups.

The k-means cluster analysis showed moderate agreement between self-perceived and objectively assessed cardiorespiratory fitness in about half of the participants (53% of women and 44% of men), demonstrating that self-perceived and objective measures correlate well but do not overlap perfectly. More research is needed to explore the reasons for these discrepancies, which may be due to factors other than physiological ability, such as cognitive and emotional factors.

Conflict of interest

None

Sources of funding

None

Authors' contributions

Conception and design of the research: Damasceno VO, Fanaro GB; **Data collection:** Fanaro GB, Rezende HG, Silveira LCCL, Sá PM; **Data analysis and interpretation:** Damasceno VO; **Statistical analysis:** Damasceno VO; **Writing of the manuscript:** Damasceno VO, Sá PM, Fanaro GB, Rezende HG, Silveira LCCI; **Critical revision of the manuscript for important intellectual content:** Damasceno VO

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