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Original Article

CARDIORESPIRATORY FITNESS LEVEL INFLUENCES THE VENTILATORY THRESHOLD IDENTIFICATION

NÍVEL DE APTIDÃO CARDIORRESPIRATÓRIA INFLUENCIA A IDENTIFICAÇÃO DO LIMIAR VENTILATÓRIO

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RESUMO
O objetivo deste estudo foi analisar a influência do nível de aptidão cardiorrespiratória (ACR) entre os métodos Equivalente Ventilatório (VEq) e V-slope para determinação do Limiar Ventilatório 1 (LV1). 22 homens corredores (32,9 ± 9,4 anos) foram divididos em dois grupos: G1 - grupo com menor aptidão cardiorrespiratória (ACR:VO_2máx 40 a 51 ml·kg^{-1}·min^{-1}) e G2 - maior ACR (VO_2máx 56,4 a 72 ml·kg^{-1}·min^{-1}), divididos pelo percentil 50. Foi aplicado um teste incremental cardiopulmonar para identificar o LV1 através dos métodos VEq e V-slope, comparando as seguintes variáveis: Frequência Cardíaca (FC), Consumo de Oxigênio (VO_2) e velocidade. Para comparações entre FC, VO_2 e velocidade (grupos vs. métodos) empregou-se ANOVA de duas vias. O tamanho do efeito foi calculado utilizando d'Cohen. Para verificar a confiabilidade e a concordância, foram aplicados o coeficiente de correlação intraclasse, coeficiente de variação, erro típico e Bland Altman. Não foram encontradas diferenças significativas ($p < 0,05$) entre métodos para G1 (VO_2, FC e velocidade) e Bland Altman revelou boa concordância (diferença média: VO_2 0,35ml·kg^{-1}·min^{-1}; FC 2,58bpm; velocidade 0,33km·h^{-1}). Contudo, G2 apresentou diferenças estatísticas entre métodos (VO_2 e velocidade) e maior diferença média (VO_2 2,68ml·kg^{-1}·min^{-1}; FC 6,87 bpm; velocidade 0,88km·h^{-1}). Tamanho de efeito pequeno foi encontrado no G1 entre os métodos (VO_2: 0,06; velocidade: 0,20; FC: 0,14) e efeitos Pequenos e moderados foram encontrados no G2 entre os métodos (VO_2: 0,39; velocidade: 0,43; FC: 0,51). Conclui-se que corredores com menor ACR apresentam melhor concordância para os métodos V-slope e VEq em comparação aqueles com maior ACR.
Palavras-chave: Limiar Anaeróbio. Aptidão Física. Consumo de Oxigênio. Rendimento Esportivo.

ABSTRACT
We aimed to analyze the influence of cardiorespiratory fitness (CRF) on ventilatory threshold identification (VT1) using the Ventilatory Equivalents (VEq) and V-slope methods. Twenty-two male runners (32.9 ± 9.4 years) were divided into two groups: G1 - group with less cardiorespiratory fitness (CRF: VO_2max 40 to 51 ml·kg^{-1}·min^{-1}) and G2 - higher CRF (G1; VO_2max ≤56,4 to 72 ml·kg^{-1}·min^{-1}) divided by the 50th percentile. An incremental cardiopulmonary exercise test was applied to identify VT1 using VEq and V-slope methods to compare heart rate (HR), oxygen consumption (VO_2), and speed. Two-way ANOVA was used to compare HR, VO_2, and speed (groups vs. methods). The Effect size was calculated using Cohen's d. The intraclass correlation coefficient, variation coefficient, typical error, and Bland Altman were applied to verify reliability and agreement. No significant differences ($p < 0.05$) were found between methods for G1 (VO_2, HR, and speed), and Bland Altman showed good agreement (mean difference: VO_2 0.35ml·kg^{-1}·min^{-1}; HR 2.58bpm; speed 0.33km·h^{-1}). However, G2 presented statistical differences between methods (VO_2 and speed) and a more significant mean difference (VO_2 2.68ml·kg^{-1}·min^{-1}; HR 6.87 bpm; speed 0.88km·h^{-1}). The small effect size was found in G1 between methods (VO_2: 0.06; speed: 0.20; HR: 0.14), and small and moderate effects were found in G2 between methods (VO_2: 0.39; speed: 0.43; HR: 0.51). In conclusion, runners with lower CRF have a better agreement for the V-slope and VEq methods than those with a higher CRF.
Keywords: Anaerobic Threshold. Physical Fitness. Oxygen Consumption. Sports Performance.

Introduction

Different physiological markers have been used to find correspondence to Anaerobic Threshold's identification such as blood lactate, glucose[1], catecholamine and ammonia analysis[2], electromyography analysis[3], heart rate (deflection point and heart rate variability)[4], infrared spectroscopy (oxy and deoxyhemoglobin)[5] or gas exchange threshold[6].

The anaerobic threshold (AT) proposed by Wasserman e McIlroy (1964) was used as one of the main parameters used in exercise prescription, training effects control, and performance prediction[7]. It is characterized as the intensity of exercise where oxygen consumption, at which anaerobic mechanisms supplement energy production from aerobic metabolism. This point reflects the increase in lactate and the lactate/pyruvate ratio in arterial muscle or blood[8]. There is a ventilation linearity break-in and excess carbon dioxide elimination at this intensity, resulting from the buffering reaction with H^+ ion by sodium bicarbonate ($NaHCO_3^-$)[6].

The AT can also be measured by gas exchange analysis, being called ventilatory threshold (VT1) or gas exchange threshold (GET) because it is independent of ventilation. For its identification, different methods are proposed: 1) Computerized, through a linear regression by the relation between the increase of VCO_2 concerning VO_2, called V-slope[6], and 2) visual method characterized by an increase in ventilatory equivalents (VEq) for O_2 (VE/VO_2) without raising the VEq for CO_2 (VE/VCO_2)[8]. In addition, additional criteria such as increased respiratory exchange rate (RER) and increased end-tidal oxygen pressure ($PetO_2$) were used to confirm VT1 by visual method[8].

VT1 reliable identification by VEq is not always possible. Measurement errors due to irregular breathing, an inappropriate workload rate, or an inadequate ventilatory response to metabolic acidosis stimulation are understood as measurement biases. In this sense, lactate and $NaHCO_3$ analysis reduce these error types[9]. Physical fitness level is another essential factor to consider because athletes may have a more attenuated ventilatory response at submaximal exertion intensities[10]. Despite VEq determination difficulties, it is still widely accepted[11] because it is a "simple" method that relies only on visual inspection. On the other hand, the V-slope method consists of a computerized method that does not depend on the ventilatory pattern of the individual, as it considers the inclination of VCO_2 concerning VO_2, reducing the error in identifying VT1 when changes in the sensitivity of the chemoreceptors are present[6].

The VEq method allows to identify of VT1 visually, and it has a strong correlation with lactate threshold and $NaHCO_3^-$ reduction, while VT1 identification by V-slope was not different from the time preceding the increase in blood lactate[6], demonstrating the agreement to lactate threshold with both methods (VEq and V-slope). However, the same results were not observed in other studies in the VT1 identification; they show a statistical difference between V-slope e VEq identification using cycle ergometer[12] and treadmill[13]. However, the mechanisms that justify this controversial response are not precise, although there is some evidence to support the hypothesis that the misalignment between ventilation and VO_2 or irregular breathing pattern may compromise the identification of VT1 by VEq in clinical populations. However, for athletes of different cardiorespiratory fitness (CRF) levels, it is unknown whether this could also be a factor due to the high ventilation values. By the way, in the daily routine of the laboratory, the identification of ventilatory thresholds in runners with different levels of CRF has been controversial, presenting different results depending on the method to be used, making it difficult to identify the intensity domains correctly.

Factors that could directly influence the agreement or not of VT1 intensity through VEq and V-slope methods are not evident in the literature. Pathological conditions[14], factors such as obesity[15] or the type of training[16], may influence the ventilatory function of individuals, interfering in threshold identification. In addition, the level of performance with different cardiorespiratory fitness is not precise. It has not been verified in literature if it may be a factor that influences the accuracy of ventilatory threshold identification using the V-slope or VEq methods. The purpose of this study was to analyze the influence of cardiorespiratory fitness on ventilatory threshold identification using the Ventilatory Equivalents and V-slope methods. We hypothesized that VEq and V-slope would be distinct for different CRF groups.

Methods

Sample

Twenty-two male runners (thirty-three tests - statistical power of 0.93, F Test/ANOVA, and 0.25 effect size f by G*Power 3.1), trained for at least six months in street racing, 32.9 ± 9.4 years; body mass 70.9 ± 11.6 kg; height 1.74 ± 0.1 cm; and BMI of 23.4 ± 3.0 $kg·m^{-2}$, non-smoker, who did not have any type of heart, muscle or joint disease and who completed the cardiopulmonary exercise test (CPx) with a maximum test characterization were included. Subjects with cardiometabolic or uncontrolled musculoskeletal illnesses that would prevent them from performing the trials were excluded. The volunteers were informed to abstained drink coffee, alcohol, and exhaustive exercise almost 24h before the visit to the lab. According to CRF level, the runners were divided into two groups (G1; n:17 and G2; n=16). The CRF classification was performed from the calculation by 50th percentile (P_{50}) to separate two groups with different CRF levels, lowest and highest (P_{50} = 51 $ml·kg^{-1}·min^{-1}$; G1: 40 to 51 $ml·kg^{-1}·min^{-1}$; G2: 56.4 to 72 $ml·kg^{-1}·min^{-1}$). The CRF score was classified by age and sex, according to the Tenth Guideline of the ACSM[17]. In G1, 82.35% were classified as good and fair in CRF, and in G2, 100% were classified as excellent and superior in CRF.

This cross-sectional study was developed at the Exercise Physiology Laboratory (LAFEX). The runners were selected for convenience. They were invited to undergo an eligibility check for the study by completing a form on personal and health information. Then, evaluations were performed: anthropometry and cardiopulmonary exercise test (CPx). The Ethics Committee approved the study of the Health Sciences Center - Federal University of Espírito Santo (UFES) (CAAE 76607717.5.0000.5542).

Anthropometric measurements

Height was assessed with a stadiometer (Seca, model 216, Germany), and body mass was verified using a 0.01 kg precision scale (Toledo, model 2096PP, Brazil). Body mass index was calculated ($kg·m^{-2}$).

Cardiopulmonary Exercise Test (CPx)

The instructions to the volunteers included did not performing any physical exercise 48h before the tests. Trained professionals applied the tests with the support of a cardiologist. The CPx was performed on a motorized treadmill (Inbrasport Super ATL, Porto Alegre, Brazil) with a fixed 1% slope, following a ramp protocol with an estimated test duration of 10 to 12 minutes. The speed increased gradually until exhaustion[18]. All participants were already familiar with this type of test. All volunteers were informed to abstained drink coffee, alcohol almost 24h before the visit to the lab. Thirty-three evaluated incremental tests were analyzed; runners who did two tests had more than six months between tests. In a private room, kept at room temperature between 21° e 22° C, the tests always took place in the morning, they were instructed to eat 2 hours before, and hydration was offered before the trial. The volunteers were sent to the treadmill for the test, where they were equipped with a turbine-connected silicone mask for airflow measurement and expired gas analysis. The subjects were oriented on the test procedures to be performed. Strong verbal encouragement was provided throughout the test to ensure maximum cardiorespiratory effort. Heart rate was collected using Micromed digital electrocardiograph equipment, with the electrodes in the MC5 position.

The initial speed started with a 7 $km·h^{-1}$ with gradual increments of 1 $km·h^{-1}$ every minute with no changes. Therefore, the ramp increments were smooth (about 0.25 km/15sec). The speed increased automatically until the individual reported inability to continue (voluntary exhaustion) or presented uncoordinated disability to perform the test. To the test be considered maximum, it was necessary to meet at least 3 of 4 criteria: RER >1.05, HRmax ≥ 90%, voluntary exhaustion, and VO_2max plateau or peak[19]. A metabolic gas analyzer (Cortex Metalyzer 3B, Germany) was used, with breath-by-breath collection and calibration with ambient and known gases (11.97% O_2 and 4.95% CO_2). The volume calibration used a 3-L syringe. Before the test, the resting electrocardiogram (ECG) was recorded, and blood pressure was measured in the orthostatic position on the treadmill using a mercury column sphygmomanometer in the pedestal model (UNITEC brand, São Paulo, Brazil). Breath-by-breath O_2 data were transformed into 10 s values for further analysis, and VO_{2max} was defined as the highest 30 s average achieved during test[20].

Ventilatory threshold identification

Three evaluators analyzed the results blindly and independently, and the agreeing points of at least two of them were considered in the visual method. The intraclass correlation coefficient was used with values varying between (0.89 – 0.97). Agreement values between the three evaluators were considered. After two minutes of testing, data were analyzed to avoid errors due to delayed cardiorespiratory adjustments at the beginning of exercise[9]. The increase in VCO_2 in VO_2 (V-slope) was used as a criterion to identify the computerized method (Metasoft^{TM}.) shown in Figure 1B. While the visual identification method employed was the increase in the VEq for O_2 (VE/VO_2) without increasing the VEq for CO_2 (VE/VCO_2) (Figure 1A). Both methods are validated in the literature as an alternative to the lactate threshold[6,21]. The pressure of end-tidal O_2 ($PetO_2$) rise behavior, without falling in pressure of end-tidal CO_2 ($PetCO_2$), was used as a secondary criterion in VT1 identification (Figure 1A). From CPx, it was possible to identify VT1 by the V-slope and VEq criteria. The time in which the threshold was identified was used to select the running speed, HR, and VO_2 for VT1. It is known that the VO_2 identified after VT1 suffers a delay in the mean response time (MRT)[22]; however, considering that the threshold identifications occurred in the same test, it was not deemed necessary to correct the VO_2 values for the applied comparisons and correlations in the present study.

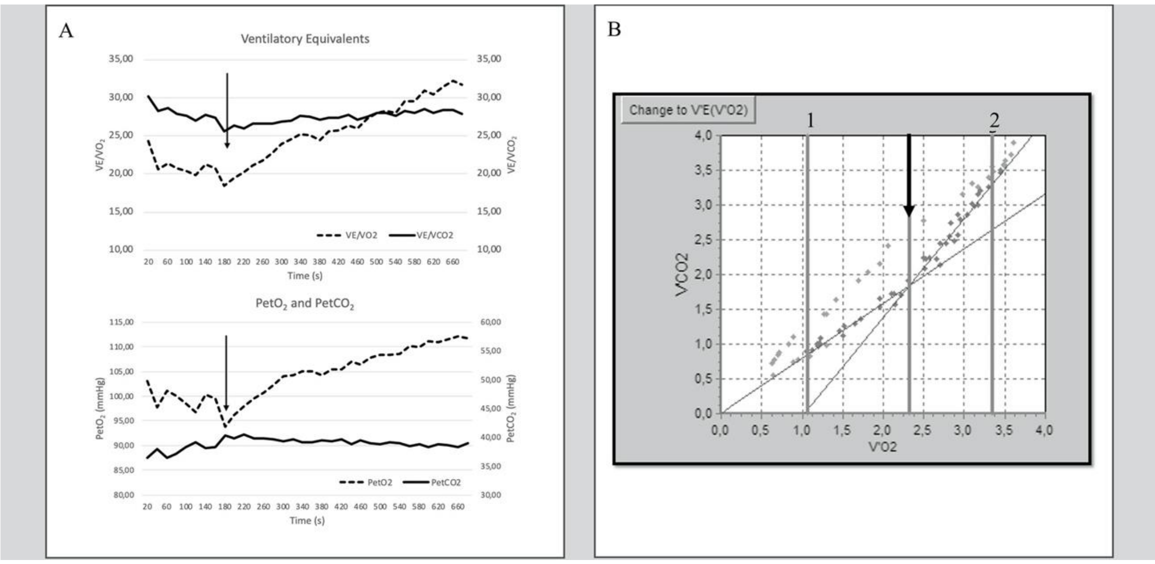

Figure 1. Ventilatory threshold identified by VEq (A) and V-slope (B)

Note: Dashed line corresponds to VE/VO_2 and continuous line VE/VCO_2 (top Fig. 1A). The dashed line corresponds to $PetO_2$ and continuous line $PetCO_2$ (bottom Fig. 1B). Black arrows correspond to the ventilatory threshold (Fig.1A). Ventilatory threshold identified by V-slope (Fig. 1B). The central line with a black arrow represents the Ventilatory Threshold. Line 1 and line 2 represent the start and the end of the test – Fig.1B from Metasoft^{TM}

Source: Authors

Statistical analysis

The results were expressed by mean ± standard deviation for G1 and G2, respectively. The distribution of the normality was tested by the Shapiro-Wilk test. The comparison between the maximum values (VO_2max, vVO_2max, HRmax, RERmax) at CPx for the groups was made by independent Student's t test or Mann-Whitney test. A two-way ANOVA test was applied to compare HR, VO_2, and speed (groups vs. methods) with a Sidak post hoc. To determine the meaningfulness of the difference, the effect size (ES – Cohens'd) was used, small (d = 0.2), moderate (d = 0.5), and large (d = 0.8) interpretations[23,24]. Typical error (TE), which will be interpreted with absolute values, and coefficient of variation (CV) ($CV = (SD/\overline{X})\cdot 100$) expressed in a percentage was used[25]. Bland Altman dispersion analysis was used to evaluate the agreement between the methods and physical fitness level interference and to assess the agreement dimension, intraclass correlation coefficient (ICC: <0.5 (poor), 0.5-0.75 (moderate), 0.75-0.90 (good), and ≥ 0.90 (excellent) was used[25]. Software SPSS version 25.0 was used for this analysis.

Results

The CPx maximum values were provided in Table 1 as mean ± SD for groups 1 and 2. G1 showed VO_2max and vVO_2max statistically lower than G2 ($p<0.05$).

Table 1. Maximum values of participants reached CPx

		VO_2max ($ml\cdot kg^{-1}\cdot min^{-1}$)	vVO_2max ($km\cdot h^{-1}$)	HRmax (bpm)	RERmax
G1	**Mean ± SD**	46.84 ± 3.58*	16.16 ± 1.05*	187 ± 15	1.07 ± 0.05
	Min	40.00	14.40	167.00	0.98
	Max	51.00	18.20	214.00	1.17
G2	**Mean ± SD**	66.40 ± 3.94	20.88 ± 1.51	182 ± 13	1.07 ± 0.05
	Min	56.42	17.80	157.00	1.00
	Max	72.00	23.80	198.00	1.18

Note: Values in Mean ± SD. *Statistical difference between groups (p< 0.05). Group 1 (G1), Group 2 (G2), Maximum speed at VO_2max (vVO_2), Maximum Oxygen Consumption (VO_2max), Maximum Heart Rate (HRmax), Maximum Respiratory Exchange Rate (RERmax)
Source: Authors

G2 was superior statistically for VO_2 and speed when compared to G1 in both methods (Table 2), but no difference was found to HR between groups in both methods (VO_2: $p < 0.01$(both methods); Speed: $p < 0.01$ (both methods); HR: $p = 0.071$ (V-slope), $p = 0.264$ (VEq).

On average, the V-slope showed values statistically higher than the VEq in both groups (G1 and G2) for VO_2, Speed, and HR (Table 2). Statistical difference was observed within G2 to VO_2 and speed (VO_2: $p = 0.050$; Speed: $p = 0.040$) between the V-slope and VEq methods, except for HR ($p = 0.054$). No statistical differences were found within G1 (VO_2: $p = 0.784$; Speed: $p = 0.412$; HR: $p = 0.443$). Small ES was observed for speed in G1. Small ES was observed for VO_2 and speed, and a moderate ES for HR in G2. For Speed, G1 showed a TE very close to 1 $km.h^{-1}$ (1.04 $km\cdot h^{-1}$), G2 was higher (1.27 $km\cdot h^{-1}$). The CV was below 15% in all measures, except for speed in G1. The ICC had a good rating in G1 but moderate in G2 (Table 2).

Table 2. Ventilatory threshold data and statistical analysis of participants in groups 1 and 2 for VO_2, Speed, and HR

		V-slope	VEq	Effect Size	TE	CV (%)	ICC
Group 1	**VO_2**	30.7 ± 5.9	30.3 ± 5.1	0.06	3.16	14.67	0.82[a]
	Speed	9.8 ± 1.9	9.4 ± 1.4	0.20	1.04	15.25	0.76[a]
	HR	143 ± 19	141 ± 18	0.14	9.66	9.63	0.84[a]
Group 2	**VO_2**	51.5 ± 7.1*#	48.8 ± 6.5*#	0.39	4.23	11.93	0.74[a]
	Speed	15.3 ± 2.3*#	14.4 ± 1.8*#	0.43	1.27	12.14	0.73[a]
	HR	153.8 ± 12.7	146.9 ± 14.1	0.51	9.75	9.17	0.60[a]

Note: Data are mean ± standard deviation for groups 1 and 2. Two-way ANOVA test. *Statistical difference between groups 1 to 2 ($p \leq 0.05$). #Statistical difference between methods (V-slope and VEq) within the group. [a]Statistical differences for Intraclass Correlation Coefficient ($p \leq 0.05$). Oxygen Consumption (VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$), speed ($km \cdot h^{-1}$), Heart Rate (HR bpm), Respiratory Exchange Rate (RER). Ventilatory Equivalent (VEq), Typical Error (TE), coefficient of variation (CV), Intraclass Correlation Coefficient (ICC).
Source: Authors

Bland Altman's analysis (Figure 2) revealed good agreement for G1 when compared to G2, due to lower bias (mean difference) and narrower limits of agreement, except for HR. In contrast, G2 showed bias and limits of agreements higher than G1, except for HR.

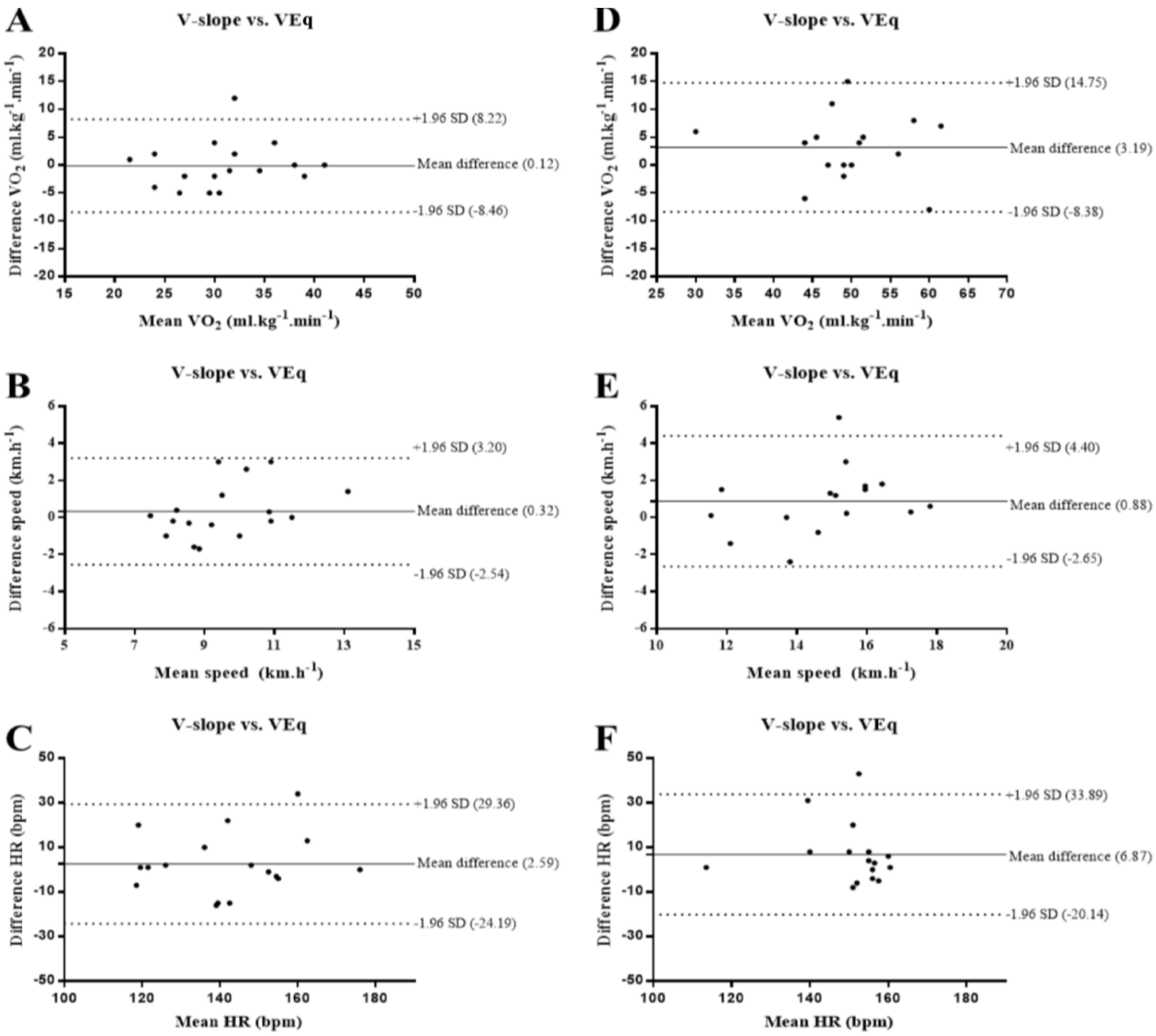

Figure 2. Bland Altman plots for comparing groups 1 and 2 of the V-slope and VEq

Note: Figures A, B, and C (left) represent group 1. Figures D, E, and F (right) illustrate group 2. The dashed lines represent the limits of agreement (1.96 SD). The dark central lines represent the mean difference (bias)

Source: Authors

Discussion

It's the first study to use different levels of cardiorespiratory fitness (CRF) to identify Ventilatory Threshold using VEq and V-slope methods. Our findings showed the group with the lower CRF was revealed to have fewer problems in using both methods. However, the group with the higher CRF presented a difference in using the V-slope and VEq methods, confirming our hypothesis, showing the importance of stratification by the CRF level, allowing to make the groups more homogeneous. Also, VT1 intensity prescribed by percentages of VO_2max, speed, and heart rate (no difference was found) is used mainly for cardiac rehabilitation, athletes[26–28]; therefore, it is important to prescribe correctly.

The difference found in G2 for both methods does not appear to be related to the increment in CPx load, as it was adjusted according to the cardiorespiratory fitness level of the runners. In addition, the increments were smooth and ranged from 0.23 km to 0.28 km/15 s. This may have facilitated the alignment of VO_2 to speed and the increase in the reliability to reflect the parameters for determining thresholds[22]. Another fact that must be taken into consideration is the specificity of the muscles involved in the movement. Methods comparison during a maximal arm ergometer test for inexperienced climbers demonstrated statistical differences in mean VO_2 between the VEq and V-slope criteria (V-slope > VEq) [29]. This difference may be due to the specificity of the test, and the size of the muscle group used that may influence the ventilatory responses in which a V-slope displacement was observed close to the second VT. The disagreement between the VT identification methods can also be monitored by researchers[13] (inactive men), and this difference may have been influenced by the incremental rate of speed in the CPx protocol, which was not gradual[13] because it was reported that large load increments or speed might lead to a delay of up to 45 seconds in VT1 identification[30]. The present study, however, demonstrated smooth increments in speed, avoiding this delay.

The comparison of methods for VT1 identification was more clarify by Gaskill et al.[31] that compared V-slope, VEq, and excess carbon dioxide ($ExCO_2$) with lactate threshold. These authors observed that the combination of these methods demonstrated the best agreement with the lactate threshold. Although the authors did not compare the VEq and V-slope criteria, these data partially corroborate our findings, showing a slight difference for relative VO_2[11,32].

Furthermore, researchers analyzed the thresholds with different levels of CRF (sedentary, active, and endurance athletes), showed a higher mean difference between the VEq and V-slope in the athlete group according to the functional group[31]. This is consistent with our finds in comparing VEq with V-slope. The agreement between methods is better in G1 (lower ACR) than in G2[31], showing VEq method appearance before V-slope. This can be explained because the V-slope method depends only on the physicochemical reaction of the H^+ buffer by bicarbonate and does not depend on the sensitivity of the respiratory chemoreceptors or the ventilatory response to exercise[21]. On the other hand, VEq is easy to use and apply when the ventilatory control mechanisms respond appropriately to increase CO_2 production[21]. However, some normal individuals have insensitive chemoreceptors, which hinders ventilation in keeping with the increase in VCO_2. Besides that, the irregular breathing pattern can be another factor that may interfere with the reliable identification[6,21], making our findings important. Because of this, some authors prefer to use the V-slope method than the VEq[21].

Another essential variable is the speed, which in the present study showed a mean difference of a maximum of 1 $km \cdot h^{-1}$ for both groups, but G2 presented a higher mean difference when compared to G1, which clearly showed good agreement. However, it is essential to note that for runners, this difference may not bring changes in the short term. Still, precise training can be necessary in the long run, which requires a good exercise prescription[33] and caution with which method used, corroborating our findings. In addition, in sedentary or physically impaired individuals, a 0.5 $km \cdot h^{-1}$ shift can be sufficient to exit the walk-to-run transition and becoming a limiting factor in prescribing exercise intensity. So it needs to be prescribed with caution when using one of the methods, although we find different only for G2[34]. Even so, it is known that the prescription of speed with accuracy less than 1$km.h^{-1}$ is often challenging to perform and control in gyms and outside. Still, it's essential for individuals who participate in competitions because a slight difference in ventilatory threshold can make a difference in the outcome of a competition, for example, reducing running time in a 5km race[35], making our discovery important.

With the separation of the groups by cardiorespiratory fitness, it was possible to perceive better agreement between methods in G1 when compared to G2. Although heart rate didn't have a present difference between methods, the mean difference and limits of understanding in the present study were higher in G2 than other studies[36] that presented a small mean difference (1 bpm) and narrow limits of agreement (+10.2bpm and -21.4bpm) and homogeneous dispersion[36], different from our findings.

In addition, our volunteers are runners with experience without disease, and the results of this study cannot be extrapolated to sedentary individuals or with any pathology. So, the present study demonstrated good agreement and no difference in the G1, which can be identified by both methods independently. However, it is essential to highlight that the use of HR determined in VT1 by the V-slope and VEq criteria did not present statistical difference, although it may have been due to wide variation in HR. Furthermore, it is necessary to consider the age, the level of training, and the type of exercise to be used in prescription. In this sense, future studies are required to show which method is the best to identify Ventilatory Threshold for higher CRF. However, when it is possible to use more than one identification variable and methods, it is suggested to combine all to the identification of VT1, mainly for athletes, in street runners, to provide an adequate prescription of physical exercise by trained professionals[31].

Conclusion

We concluded that the V-slope and VEq present better agreement for individuals with lower CRF than with higher CRF, suggesting that the CRF level can influence the agreement between the methods.

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