Comparison of methods for the determination of the intensity of the aerobic training for young individuals

ABSTRACT: Introduction: In order to determine the intensity of aerobic exercise the anaerobic threshold and the respiratory compensation are used as referential; respectively, these physiologic markers are, generally, located at 50% and 80% of the maximal oxygen uptake (VO$_2$max). To compare the values to the percentages of 50, 60, 70 and 80%, calculated through the HRR and VO$_2$R equations corresponding to the oxygen consumption obtained by direct method. Materials and Methods: The sample was composed by 11 men and 10 women: mean age, 21.43 ± 2.82 years, body weight, 64.86 ± 12.17kg; and stature, 170.05 ± 9.12cm, performing maximal treadmill test, and the oxygen consumption obtained by the metabolic analyzer. To determine the percentages, we have used the mean values corresponding to the studied intensities according to the respective interval time relative to the percentage of oxygen consumption. Results: The measured intensities showed significant difference (p > 0.05) for every reference values. The mean values calculate by HRR showed a tendency to underestimate the intensities, while the values calculated by VO$_2$R showed a tendency to overestimate the intensities. Conclusion: Both intensity determination methods of aerobic training showed significative difference, but they need to be adjusted in the equations. Thus, it is recommended the use of HRR in the determination of the intensities.

Keywords: oxygen consumption, heart rate, aerobic exercise.

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Comparação de métodos para a determinação da intensidade do treinamento aeróbico para indivíduos jovens

Introdução: A determinação da intensidade dos exercícios aeróbicos tem como referencial o limiar anaeróbico e o ponto de compensação respiratória; esses marcadores fisiológicos em geral estão situados aproximadamente a 50% e 80% do consumo máximo de oxigênio (VO2máx) respectivamente. O presente estudo teve por objetivo comparar os percentuais de 50, 60, 70 e 80%, calculados pelas equações FCR e VO2R com os percentuais de correspondência do VO2máx em indivíduos jovens ativos. Materiais e Métodos: Foram avaliados 11 homens e 10 mulheres com 21,43 ± 2,82 anos, massa corporal de 64,86 ± 12,17kg; e estatura de 170,05 ± 9,12cm, que foram submetidos a teste de esforço incremental em esteira rolante com análise direta de gases de circuito aberto até a exaustão. Resultados: As intensidades estudadas apresentaram diferença significativa (p > 0,05) para todos os percentuais do VO2máx. Os valores calculados pela FCR subestimaram as intensidades, enquanto que as intensidades determinadas pelo VO2R tenderam em superestimar. Conclusão: Conclui-se que, os dois métodos para a determinação das intensidades de treinamento aeróbico necessitam de ajustes nas equações, em razão das diferenças observadas para os percentuais do VO2máx.

Palavras-chave: consumo de oxigênio, frequência cardíaca, teste cardiorrespiratório.

INTRODUCTION

According to the guidelines of (ACSM) 1 1998 the determination of the physical exercises should be based in functional parameters that allow adaptation of the training loads at the level of the individual’s physical fitness.

Usually the intensities are certain for indirect methods. In the end of ninety decade is incorporate to guidelines of ACM the indirect method, that recommends the use of the reservation of the consumption of oxygen (VO2R). Being that, appropriate for the determination of the intensities of the aerobics exercises for sedentary individuals and/or special groups.

However, subsequent studies in active individuals and in patients with heart diseases present divergences. Swain et al. mention that the percentile of VO2R present better equivalence with the percentile of HRR, opposing to the previous studies that describe the correlation among the percentile of VO2R the percentile estimated for HRR.

The purpose of the present study is to compare the relative heart frequency the percentile of 50, 60, 70 and 80% of VO2máx with the corresponding heart frequency made calculations by the indirect methods of VO2R and of HRR in active healthy individuals.

MATERIALS AND METHODS

This research has a traverse characteristic of comparative descriptive approach, seeking to verify the relationship among indirect methods in the determination of the intensity of aerobic exercise having as reference the VO2máx obtained in test of effort maximum incremental with direct analysis of gasses

21 students volunteers of the Physical Education Course were selected, men = 11 and women = 10 healthy engaged in weekly physical exercises programs with intensity varying from moderate to vigorous. A questionnaire was used to selection, and as criterion of inclusion was adopted, the individuals that didn’t relate health problems. The volunteers received the information regarding the risks involved in the accomplishment of the maximum effort test and were requested to them to sign the term of free and informed participation in accordance with the resolution 196/96. This study was approved by the ethics committee of the University White Castle.

All the volunteers were submitted to the rest (ECG) electrocardiogram, seeking to verify possible heart disturbances. For so much, the individuals stayed lying for five minutes, being checked the rest blood pressure soon afterwards, for so much, the sphygmomanometer Becton Dickinson was used.

The ECG was accomplished by the electrocardiogram Marquette Hellige, Medical Systems, model: Cardio Smart, version 3.0 CS-MI). After the clinical exam the volunteers were liberated by the doctor. The determination of the body mass it was through the digital balance Toledo with acuity of 50g; the measurement of the stature was for the stadiometer Country Tecnology model 67034 (INC, Gays Mills, WI) with scale in centimeters.

For determination of VO2máx the volunteers were submitted to test of effort incremental in mat rolling model Super ATL (Inbramed, Porto Alegre, RS), with initial speed of 4 km/h for an inclination equal to 0% and final speed of 16 km/h for an inclination of 6% the interval between the stages was one minute. For the analysis of the breathing changes the analyzer VO2000® (Aerosport Medgraphics -USA) was used, with collections and analyze of the exhaled gasses accomplished in the interval of time of 10 seconds.

The analyzer of gasses was calibrated with a gas of knowing composition O2 of 17% and CO2 of 5%, with balance of nitrogen, before the tests, following the manufacturer’s specifications. For the monitoring of the heart frequency the electrocardiogram Micromed
© was used in a channel CMS. Both the rolling mat, the analyzer of gasses and the electrocardiogram were connected and controlled by the software ERGOPC Elite® version 2.0 Micromed®.

For analysis of the possible differences among the percentile studied, the following statistical treatments were adopted: a) variance analyzes tests One-Way ANOVA with Post Hoc of Tuke; b) correlation of Pearson and; c) residual scores analyzes of Bland and Altman and of the Estimate Standard Error (ESE). For a level of significance of < 0.05; with the results presented by the measure of Medium central tendency Average and for the variability of the data Standard Deviation. PD (average±sd).

RESULTS

The volunteers’ group presented a normal body mass index (BMI) for the sex and age. The physiologic answers to the effort were compatible to the effort loads imposed during the maximum test, where the volunteers obtained excellent results for VO₂max in relation to the sex and age group, physiologic alterations were not observed by the physician, table 1.

The analyze for the percentile of VO₂max studied didn’t present significant statistical difference F (2.60) = 8.966; p = 0.01; for calculated by the equation of VO₂R when compared. However, the values of the relative frequency heart to the estimated percentile for the methods HRR and VO₂R when compared to the corresponding values HR_ VO₂ presented difference statistically significant (p > 0.05).

The percentile calculated by HRR underestimated the intensities, while, the ones determined by VO₂R started to overestimate the studied intervals. The percentile calculated by RHR stayed inside of the same confidence interval for 95% of the reference values HF_VO₂; while all of the intervals calculated by VO₂R were above the confidence interval, table 2. Being the behavior confirmed by the constant error calculated by the residual scores where on average the percentile calculated by the method of HRR present a difference of 6 bpm and calculated them by VO₂R in -4 bpm.

The result of ESE of the average observed for the percentile studies was inferior of 10 bpm when estimated by the method of VO₂R (SES = 2 bpm), and for the percentile calculated by the method FCR was of 1 bpm on average, demonstrating a good estimation.

| Table 1 - General characteristics of the sample (n = 21) |
|---------------------------------|---------|---------|
| age(years)                      | 22.45±2.07 | 20.30±3.20 |
| stature (cm)                    | 176.72±5.61 | 162.71±6.03 |
| body mass (Kg)                  | 73.58±10.07 | 55.27±4.62 |
| BMI (kg/m²)                     | 23.33±1.96 | 20.74±1.19 |
| HR rest (bpm)                   | 76±11.50 | 82.90±4.70 |
| Ventilation max (L)             | 170.73±23.00 | 104.15±13.85 |
| VO₂max (ml.kg⁻¹.min⁻¹)          | 60.99±8.42 | 50.58±3.74 |
| HR_VO₂_50% (bpm)                | 143.0±10.1 | 2.2 | 138.4 | 147.5 |
| HRR_50% (bpm)                   | 136.6±5.3 | 1.2 | 134.2 | 139.0 |
| VO₂R_50% (bpm)                  | 148.9±11.7 | 2.6 | 140.1 | 145.5 |
| 60% VO₂ (ml.kg⁻¹.min⁻¹)         | 33.62±5.03 | ----- |
| 60% VO₂R (ml.kg⁻¹.min⁻¹)        | 155.4±10.0 | 2.2 | 150.9 | 160.0 |
| HR_VO₂_60% (bpm)                | 148.1±5.4** | 1.2 | 145.7 | 150.6 |
| HRR_60% (bpm)                   | 158.9±11.2** | 2.4 | 153.8 | 164.0 |
| 70% VO₂ (ml.kg⁻¹.min⁻¹)         | 39.22±5.87 | ----- |
| 70% VO₂R (ml.kg⁻¹.min⁻¹)        | 165.7±8.7 | 1.9 | 161.7 | 169.6 |
| HR_VO₂_70% (bpm)                | 159.7±5.7** | 1.2 | 157.1 | 162.3 |
| HRR_70% (bpm)                   | 168.6±9.3** | 2.0 | 164.4 | 172.8 |
| 80% VO₂ (ml.kg⁻¹.min⁻¹)         | 44.83±6.70 | ----- |
| 80% VO₂R (ml.kg⁻¹.min⁻¹)        | 176.5±8.0 | 1.8 | 172.9 | 180.2 |
| HR_VO₂_80% (bpm)                | 171.2±6.2 | 1.3 | 168.4 | 174.0 |
| HRR_80% (bpm)                   | 178.5±9.1 | 2.0 | 174.3 | 182.6 |

VO₂ (ml.kg⁻¹.min⁻¹) = consumption of relative oxygen; HR_VO₂ = relative heart frequency to the consumption of oxygen to the intensity; HRR = heart frequency of relative reservation the intensity; HR_VO₂R = relative heart frequency to the consumption of reservation oxygen to the intensity; sd =standard deviation; ESE = estimated standard error; * * p > 0.001.
The present study could compare two indirect methods for determination of the intensities of the aerobic exercise with the \( \% \text{VO}_2 \text{max} \). Being limiting factors of the study the number of volunteers, the physical fitness level, as well as the age group, reduced what disables the extrapolation of the results for other groups.

The relationship between the consumption of oxygen and the effort accomplished during the physical exercise was described thoroughly by Hill, Lupton in 1923, making possible to relate the work loads to the physical effort, this relationship, propitiated the bases for the determination of the intensities of the aerobic exercises as it is knowing today 14.

However, one of the largest problems concerning prescription, consists of the determination of the training loads so that the biological individuality is preserved15; in way that the training doesn’t overload the individual’s physiologic capacities, that concern, in the current days becomes latent due to the epidemiologic aspects observed for the degenerative conical diseases not infectious16,17,18.

The results obtained in the present study demonstrated that the determination of the intensities for the method of \( \text{VO}_2 \text{R} \) overestimates the studied intensities, opposing the recommendations of Swain & Leutholtz9 and Swain et al.11 that indicate that procedure for sedentary individuals. The results presented by Brawner et al.10 corroborate with the results observed in this study, where the authors describe that the certain intensities for \( \text{VO}_2 \text{R} \) overestimate the loads of training of individuals with heart diseases.

Policarpo et al.9 when compared the percentile calculated by \( \text{VO}_2 \text{R} \) with the percentile of \( \text{VO}_2 \text{max} \) observed the same tendency in overestimating the intensities.

It is observed that relative HR to the consumptions of estimate oxygen for \( \text{VO}_2 \text{R} \) presents the tendency in it overestimates on average 3.12% the intensities when analyzed residual scores, while the residual scores for the heart frequency relative to the intensities calculated by HRR demonstrated a tendency in underestimating around of 5.45% the intensities.

The results observed in the present study corroborate with the ones presented by29, demonstrating that value estimate for HRR tend in underestimating the percentile of \( \text{VO}_2 \text{max} \) even when it presents a significant correlation. Although previous studies pointed a linear relationship among the percentile12, what could explain that tendency if use the equation 220-age for the estimate of HRmax that would provide increase in calculation of the chronotropic reservation, due to equation to overestimate HRmax5,21.

Although the results had demonstrated that the two studied methods present differences for the method in reference the ESE showed low, what would not be a problem for sedentary individuals, however, it would not be recommended the use of the percentile of \( \text{VO}_2 \text{R} \) in special groups before complementary studies. The HRR is indicated for these groups as previous recommendations.

**REFERENCES**