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Evaluation of anaerobic threshold by heart rate variability in type 2 diabetics

Avaliação do limiar anaeróbio pela variabilidade da frequência cardíaca em diabéticos tipo 2

Jamile de Jesus Pinto Ferreira[1], Yago Alves Lima[2], Erika Ramos Silva[3], Carlos José Oliveira de Matos[4]

[1]Federal University of Sergipe. Lagarto, Sergipe, Brazil. ORCID: 0000-0003-4012-254X. jferreira@gmail.com
[2]Corresponding author. Federal University of Sergipe. Lagarto, Sergipe, Brazil. ORCID: 0000-0003-2995-6308. allvesyaago@gmail.com
[3]Federal University of Sergipe. Lagarto, Sergipe, Brazil. ORCID: 0000-0002-0634-976X. erikasilva@gmail.com
[4]Federal University of Sergipe. Lagarto, Sergipe, Brazil. ORCID: 0000-0002-2168-7839. cjomatos@yahoo.com.br

RESUMO | INTRODUÇÃO: A diabetes é um problema de saúde pública devido a sua alta prevalência, morbidade e mortalidade. O tipo 2 é mais prevalente e representa de 90 a 95% dos casos, sendo as complicações mais comuns o acúmulo de gordura no músculo esquelético e a resistência à insulina. O exercício físico regular contribui para regulação da glicemia, destacando-se o limiar anaeróbio como importante marcador para prescrição de exercícios físicos. **OBJETIVO:** Avaliar o limiar anaeróbio de indivíduos com diabetes tipo 2 através da variabilidade da frequência cardíaca. **MATERIAIS E MÉTODOS:** Estudo de caráter transversal, recrutou 18 participantes de ambos os sexos em uma unidade básica de saúde do município de Lagarto-SE, esse foram divididos em 2 grupos de 9 indivíduos. Na análise estatística utilizou-se o teste de Shapiro-Wilk para avaliação da normalidade e posteriormente Anova com pós teste de Tukey para comparação dos grupos. O grupo 1 composto de indivíduos diabéticos tipo 2 e o grupo 2 de indivíduos saudáveis. Também foi avaliada a média da frequência cardíaca em repouso e após o teste de esforço progressivo. **RESULTADOS:** As características de idade foram homogêneas sendo o grupo 1 com média de 62,1 (±13,9) anos e grupo 2 de 62,0 (±7,0) anos. A média da frequência de repouso foi de 79,8 bpm do grupo diabéticos e 78 bpm do grupo comparação, no limiar anaeróbio foi de 111,5 no grupo 1 e 119 no grupo 2. O tempo para atingir o L.A foi similar entre os grupos, 9,5 min no grupo experimental e 8 min no grupo comparação. **CONCLUSÃO:** Os valores do limiar anaeróbio de ambos os grupos foram considerados de baixo condicionamento físico, estes não apresentaram diferença estatística.

PALAVRAS-CHAVE: Limiar anaeróbio. Variabilidade da frequência cardíaca. Diabetes 2.

ABSTRACT | INTRODUCTION: Diabetes is a public health problem due to its high prevalence, morbidity and mortality. Type 2 is more prevalent and accounts for 90 to 95% of cases, with the most common complications being the accumulation of fat in skeletal muscle and insulin resistance. Regular physical exercise contributes to glycemic regulation, highlighting the anaerobic threshold as an important marker for prescribing physical exercises. **OBJECTIVE:** To assess the anaerobic threshold of individuals with type 2 diabetes through heart rate variability. **MATERIALS AND METHODS:** A cross-sectional study, recruited 18 participants of both sexes in a basic health unit in the municipality of Lagarto-SE, which were divided into 2 groups of 9 individuals. In the statistical analysis, the Shapiro-Wilk test was used to assess normality and subsequently Anova with Tukey's post-test to compare the groups. Group 1 consisted of type 2 diabetic individuals and group 2 of healthy individuals. The mean heart rate at rest and after the progressive exercise test was also evaluated. **RESULTS:** Age characteristics were homogeneous, with group 1 averaging 62.1 years (± 13.9) and group 2 62.0 years (± 7.0). The mean resting frequency was 79.8 bpm in the diabetic group and 78 bpm in the comparison group, at the anaerobic threshold it was 111.5 in group 1 and 119 in group 2. The time to reach the LA was similar between groups , 9.5 min in the experimental group and 8 min in the comparison group. **CONCLUSION:** The values of the anaerobic threshold of both groups were considered of low physical conditioning, these did not present statistical difference.

KEYWORDS: Anaerobic threshold. Heart rate. Diabetes.

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Introduction

Diabetes mellitus (DM) refers to a heterogeneous group of metabolic disorders having in common to hyperglycemia resulting from defects in insulin action or insulin secretion or ambas[1]. This pathology is a public health problem due to its high prevalence, morbidity and mortality, as well as the high costs involved in its management[2]. The type 2 diabetes mellitus (T2DM) is the most prevalent, present in 90% to 95% of cases, is usually diagnosed after the age of 40 and relates to the increase in the elderly population, greater urbanization, the increasing prevalence of obesity, physical inactivity and increased survival of patients with DM2[1].

A major cause of death and funcional[3] disability, is related to fat accumulation in skeletal muscle, which inhibit insulin signaling and decreased translocation of GLUT4 is a key enzyme responsible for the uptake of circulating glucose, resulting in hyperglycemia, the main characteristic of the disease[4]. Basically the symptoms of diabetes are caused by too much glucose in the blood and a lack of glucose in the cells[5] occurs insulin resistance, leading to decreased action in target tissues especially liver, muscle and adipose tissue[6]. Thus regular exercise helps to regulate glycemic levels[3], has benefits on cardiovascular risk, metabolic control, reduction of blood pressure (BP) and heart rate (HR), improved glucose uptake and increased sensitivity to insulin[6].

One of the most common complications DM2 is neuropathy autonomic cardiovascular which is a common type of autonomic dysfunction, and is associated with abnormalities in the control of heart rate is one of several microvascular diabetic complications, is a major cause of cardiovascular morbidity and mortality in patients diabéticos[7].

So it highlights the use of anaerobic threshold, as this is highly correlated with the aeróbio[3] performance, and is effective in clinical and functional evaluation of diverse populations by offering valuable about information of the metabolic state of the practitioner during physical exertion, being considered an effective parameter for prescribing aeróbios[8] exercises.

The anaerobic threshold (AT) is defined as the level of work or oxygen consumption above the aerobic energy production is supplemented by anaerobic metabolism, leading to increased lactate sanguíneo9. This can be evaluated directly by the blood lactate kinetics, for ventilation parameters, the threshold blood glucose and heart rate variability (HRV)[8].

Studies on heart rate variability (HRV) stand out for being an effective, easy-to-use and low-cost strategy for estimating LA[8], in addition to allowing the recognition and characterization of diseases that affect autonomous control. Decreased HRV, for example, relates to the increased cardiovascular morbidity and mortality. The visceral body functions are controlled by the autonomic nervous system, which has tonic reflex and influence on blood pressure, peripheral resistance, frequency and output cardíaco[7].

Given the above this study is to evaluate the anaerobic threshold of individuals with type 2 diabetes by variability heart rate during exercise on a stationary bike in order to contribute to better security in the exercise prescription for these patients.

Methods

This is a cross-sectional study, with comparison group. Eighteen subjects were evaluated in two groups; an experimental group and one comparison group. The first group was formed per 9 volunteers diagnosed with type II diabetes, and the comparison group with 9 healthy volunteers recruited in a Primary Health Care Unit in the interior of Sergipe. All included were over 40 years old, of both sexes, linked to a basic health unit and hemodynamically stable. Patients with disabling orthopedic changes for the test and without using any regular medication were excluded. The study period was from March to May 2016.

All volunteers, previously contacted, were asked to attend the laboratory of physiotherapy, Federal University of Sergipe, Lagarto campus, with comfortable clothes, using tennis, have done the last meal at least 2 hours prior to testing; maintain their daily living activities and continue to take your usual medications the indicated dosages. At the time of the test participants who happens presented malaise, shortness of breath, dizziness, chest pain, headache and stomach cramps, oxygen saturation (SpO2)≤ 88%, the perceived exertion test (PSE) ≥ 8 the test should was stopped immediately.

Was collected from the participants, the name, age, gender, medications used. the International Physical Activity Questionnaire short version was applied (IPAQ), which aims to estimate the weekly time spent in physical activity of moderate intensity and vigorous in everyday situations such as labor, transportation, housekeeping and leisure and also the time in passive activity, carried out in a sitting position[9]. Other variables were used, blood pressure (BP) in mmHg, HR in beats per minute, heart rate variability in bpm, SpO2% PSE, LA through time in minutes and speed. The instruments used were a sphygmomanometer and stethoscope Premuim® mark, a pulse oximeter RS® a frequency meter Polar RCX3® a 361c professional exercise bike Empresa® mark, a timer application available for mobile (Nokia Brazil).

The exercise test was applied on the exercise bike once each volunteer individual basis. Before the test was evaluated at rest condition placed on a polar and a sitting position were recorded for 15 minutes FC in 5 minute intervals 3 totaling records.

In the exercise step in exercise bike, volunteers continue with the polar and was also put the oximeter digital to monitor SpO2. Every 2 minutes' HR, SpO2 and perceived exertion the Borg scale were measured and properly recorded. The intensity of the exercise bike goes from level 1 to level 16 in accordance with the progression of charge in the method used participants began at level 6, and every 2 minutes added a reference load level plus 1. At the time when the anaerobic threshold was reached was added 2 minutes with one more load and thus completed the test.

The study was approved by the Research Ethics Committee (CEP) the Federal University of Sergipe (CAAE 51014715.0.0000.5546) all volunteers were properly oriented when all procedures and after having read and agreed, signed the Consent Agreement and Informed according to Resolution 466/12 and its complementary of the National Health Council.

The data were tabulated by Windows Excel 2010 and analyzed by Bioestat 5.0. The Shapiro-Wilk test was used, normal distribution of data was identified, where parametric tests, Student t test, ANOVA one-way with Tukey post-test were used. 95% confidence interval was used, considering $p < 0.05$.

Results

We evaluated 18 subjects 9-diabetics, and the group without diabetes. As can be seen in table 1, which shows general characteristics of each group. Using the t-test, not checked in the table there was statistically significant differences for age, SBP, DBP and HR at rest (p> 0.05) difference in glucose alone (p <0.05), confirming the diagnosis of diabetic specific group.

Table 1. The study was conducted between March and May 2016, and in the table below is the characterization of sample with average values described in±standard deviation

	diabetic group	experimental group	P
Age years)	62.1±13.9	60.0 ±7.05	0.370
Fasting Glycemia (mg / dl)	222.8±96.4	81.7±10.6	0.002
HR rest (bpm)	79.8±20.9	78 ± 10.8	0.820
Very active% (n)		-	11.1 (1)
Active% (n)		33.3 (3)	44.4 (4)
Irregularly active% (n)		55.5 (5)	44.4 (4)
Sedentary% (n)		11.1 (1)	-

FC heart frequency.

In the diabetic group was 55.5% of the sample composed by female persons and in the comparison group this population was 88.8%. Regarding associated diseases, hypertension stands; 66.6% in the group were diabetic hypertensive already in the comparison group the percentage was 44.4%. The study participants were assessed referring to the level of physical activity by the IPAQ, the classification is given according to the orientation of the questionnaire itself. As shown in table 2 with percentage values obtained through the IPAQ.

Table 2. The study was conducted between March and May 2016, and the table below presents the values of mean and standard deviation of HR before and after the moment LA

	FC pre LA	FC in LA	FC LA post	SBP / DBP home	SBP / DBP posttest	Medium to achieve LA
diabetics	99.72±21.5	115.66 ± 17.7	109.33 ± 20.4	113.3± 11.1 / 71.1 ± 12.6	133.3± 8.6 / 83.3 ± 5.0	9.5 ± 3.9
nondiabetic	104.1±13.9	119 ± 17.55	114.22 ± 19.1	121.1± 6.0 / 77.7 ± 4.4	125.5± 8.8 / 80.0 ± 8.6	8.0 ± 3.1
P				0.11 / 0.11	0.11 / 0.39	

FC heart frequency. LA anaerobic threshold. SBP, diastolic blood pressure. PAD-diastolic pressure.

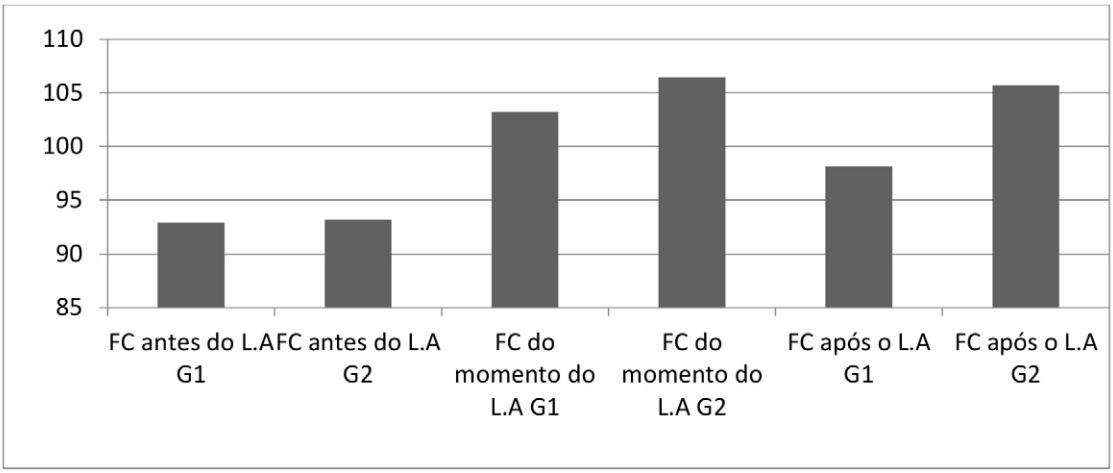
The anaerobic threshold is shown in Table 3, in which you can see the FC at the time estimated to have reached the anaerobic threshold, and the HR after LA measured after 2 min even in the stress test. ANOVA among groups with Tukey post test between groups with p <0.05 (there was no statistical difference).

Table 3. Representation mean and standard deviation of effort perceived by the Borg scale

Perceived exertion (BORG)				
Home LA Before Upon LA After LA				
diabetics	2.6 ± 1.3	4.6 ± 1.5	5.8 ± 1.7	5.6 ± 1.4
ÇOMPARISON	3.4 ± 1.5	4.4 ± 1.4	5.3 ± 1.4	5.6 ± 1.5

The chart below shows the average HR in diabetic groups and comparison group at different times.

Graphic 1. The study was conducted between March and May 2016 and graph represents HR before, when and after LA



Blood pressure, the mean time in which individuals reached the HR of the anaerobic threshold of both groups are shown in Table 2, divided into two measurement moments before and after the exercise test. Comparing the average time to reach LA found that there was no statistical difference between the groups (p> 0.05). Each FC scouting was also measured the effort by PSE.

Discussion

In the present study, HR variation was similar in both groups. It's important make sure that the anaerobic threshold by heart rate variability sets in a simple strategy to assess functional capacity[12]. The prior literature few studies have evaluated the variation of the heart rate, thus hindering the correlation with this research, for that reason will be compared studies analyzing HR variability.

According to Yoshida and Andrade[13] mortality in chronic diseases, the most prevalent type 2 diabetes is most frequently in men, but the presence of male individuals in the health services, especially in primary care, is smaller; which explains the higher prevalence of women in the study since the volunteers were recruited in a basic health unit.

Carreira et al.[14] in a study to assess the decrease of heart rate during exercise testing in type 2 diabetics showed that there is an influence of age on the heart rate peak exercise (anaerobic threshold), since there is a reduction in HR with increasing age. In the same study the results suggest that sedentary lifestyle also influences the self-commitment, is an important risk factor. In this research, the group of diabetic disease beyond the diagnosis variable had a larger number of irregularly active individuals (55.5%) and inactive (11.1%) compared to 44.4% active and any inactive improperly group COMPARISON, Data evaluated by IPAQ. These data lead us to induce the heart rate at the anaerobic threshold was lower in the diabetic group, possibly by the interference level of physical activity.

More than half of this study had diabetic hypertension, coinciding with that found by Columbié et al.[15]. And can be explained by insulin resistance accompanying type 2 diabetes. Hyperinsulinemia increases blood pressure causing arteriolar vasoconstriction, smooth muscle hypertrophy, the sympathetic nervous system activation and renin-angiotensin-aldosterone system.

The difference in HRV between trained and untrained individuals have been widely investigated. trained individuals have CF in LA now higher than sedentary individuals also take longer to reach the anaerobic threshold, indicating that HRV is higher in individuals treinados16. When comparing to the study of Leal Junior et al.[17]. Where we used a graded exercise protocol on a treadmill, the time that a group of football and futsal athletes took to reach the threshold was 14 minutes and 11 minutes respectively, suggests a greater aerobic endurance compared to the time that both the group of this study led to achieve the LA it is noteworthy that these studies does not show range age next at 60, such as sample of this study, Besides that should be considered insulin resistance that contributes to the reduction of aerobic capacity.

The first level of effort, when there is a destabilization of the heart rate, is identified as anaerobic threshold, indicating predominance of sympathetic activity on the node sinusal[12]. While for Zagatto et al.[18] and Son and Salles[19] aerobic capacity (anaerobic threshold) corresponding to higher intensity exercises that include aerobic predominance and is identified by the highest intensity occurs a balance between the production and removal of lactate, since the maximum FC would theoretically be the corresponding FC power aerobic peak.

According observed by Sankako et al.[20] LA of the identification by means of the heart rate response behavior is related to the abrupt increase has been attributed to inhibition of vagal tone on the sinus node. Sequentially inhibition of vagal tone, is the reduction in HR due to the slow return of parasympathetic activity, considering low levels of effort. It is observed that above the anaerobic threshold increment HR becomes slower and more gradual, due to the dominance of the sympathetic stimulation of the sinus node explaining the decrease in CF after LA in both groups of this study.

Some limitations are observed in this study, the sample number was restricted. As for the intensity level of the exercise bike, it was limited as to the power of each level used, without a precise value in unit of measurement for each level, preventing the parameterization of the power used accurately

Despite the negative results regarding LA, it is suggested to continue research in diabetics, as a way of assessing physical fitness, which favors the prescription of a safe program of regular physical training for this population, which will promote control and prevention of complications.

Conclusion

It was concluded that the group of diabetics studied presented a HR variation close to the comparative group, a fact that inferred a low level of physical conditioning in this population.

Author contributions

The authors declare to have participated from the study conception to the writing of the paper.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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