

## Cardiovascular behavior in obese individuals undergoing different training intensities

### Comportamento cardiovascular em obesos submetidos a diferentes intensidades de treinamento

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#### ABSTRACT

**Objective:** This study aimed to evaluate the cardiovascular behavior in obese individuals submitted to different intensities of aerobic training on a treadmill. **Methods:** Seventeen eutrophic and 20 obese individuals were selected, classified by body mass index. The  $VO_{2max}$  was evaluated through the Bruce Protocol Stress Test and the sample was submitted to an aerobic training protocol with speeds equivalent to 50%, 60% and 70% of the  $VO_{2max}$  for the cardiovascular behavior evaluation. **Results:** The results showed significant differences in the chronotropic parameters and the double product, in the protocols of 60% and 70% of the  $VO_{2max}$ , however indifferent compared between the groups. There were no significant blood pressure changes between groups. **Conclusion:** there were no differences in the cardiovascular behavior of obese individuals about eutrophic individuals evaluated in this study, submitted to different aerobic training protocols.

**Keywords:** obesity; exercise; endurance training.

#### RESUMO

**Objetivo:** Este estudo teve como objetivo avaliar o comportamento cardiovascular em obesos submetidos a diferentes intensidades de treinamento aeróbico em esteira ergométrica. **Métodos:** Foram selecionados 17 indivíduos eutróficos e 20 obesos, classificados pelo índice de massa corporal. O  $VO_{2max}$  foi avaliado através do teste de Bruce e a amostra submetida a protocolo de treinamento aeróbico com velocidades equivalentes a 50%, 60% e 70% do  $VO_{2max}$  para avaliação do comportamento cardiovascular. **Resultados:** Os resultados mostraram diferenças significativas dos parâmetros cronotrópicos e no duplo produto, nos protocolos de 60% e 70% do  $VO_{2max}$ , todavia indiferentes quando comparadas entre os grupos. Não houve alterações pressóricas significativas entre os grupos. **Conclusão:** Não houve diferenças no comportamento cardiovascular dos obesos em relação aos eutróficos avaliados neste estudo, submetidos aos diferentes protocolos de treinamento aeróbico.

**Palavras-chave:** obesidade; exercício físico; treino aeróbico.

## Introduction

Obesity is a problem that affects low and middle-income countries, both sexes and all age groups. It is specifically caused by the imbalance between caloric consumption and energy expenditure, being considered a multifactorial disease that causes high costs for public health [1]. When associated with a sedentary lifestyle, it can cause serious damage to health, besides promoting limited motor performance and frequently increasing the chances of developing several chronic diseases. Excessive accumulation of body fat impairs the functioning of the cardiovascular and respiratory systems, negatively influencing health-related physical fitness, in addition to enabling the development of cardiovascular diseases [2].

These diseases cause heart and blood vessels disorders and are responsible for high mortality rates worldwide [3]. Ishitani *et al.* [4] point out cardiovascular diseases as the leading cause of death in Brazil, aggravated by the absence of a healthy lifestyle, with cerebrovascular diseases, myocardial ischemia, and hypertension being the most common.

For Santa-Clara *et al.* [5], the practice of physical activities, besides being a very effective treatment that does not demand high economic costs, is also capable of sharply reducing mortality rates from cardiovascular diseases and improving the quality of life of practitioners. Sasaki and Santos [6] report that aerobic exercise is one of the most efficient non-pharmacological methods for preventing disorders involving the cardiovascular system. In addition, Arruda *et al.* [7] add that aerobic training can promote a significant weight reduction of its practitioners.

The practice of aerobic exercises triggers a series of physiological adaptations in the human body, mainly affecting the circulatory system [8]. They can present from acute responses, which are those observed during the performance of the activity, to chronic responses that only appear after a few exercise sessions [9].

From this, Sousa *et al.* [2] stated that the heart of an obese individual undergoes several changes in its structure. For this fact, they need a more detailed cardiorespiratory assessment. Thus, the analysis of probable cardiorespiratory limitations in overweight people during aerobic training on a treadmill, based on an essential health status indicator, can broaden the understanding of cardiovascular behavior in these relationships, supporting reflections and safer strategies and efficient in combating obesity.

Given these factors, this research aimed to evaluate the acute cardiovascular behavior in obese individuals undergoing different intensities of aerobic training on a treadmill.

## Methods

This is a cross-sectional field study with a quantitative approach, consisting of a sample of 37 individuals, of both sexes, 20 obese, with a mean age of  $26.7 \pm 5.73$  years, (five men and 15 women) and 17 eutrophic, with a mean age of  $28.29 \pm 7.77$  ye-

ars (seven men and ten women). This study followed the norms that regulate research on human beings of the National Health Council - Ministry of Health, Resolution No. 510/2016 and was approved by CEP/IFCE under opinion no. 2.823.010.

Participants in this research were obese subjects, who had body mass index (BMI) equal to or greater than 30 kg/m<sup>2</sup>, and eutrophic subjects (control group), who had BMI equal to or below 25 kg/m<sup>2</sup>, aged over 18 years, who did not present comorbidities and/or diseases limiting ergometric exercise and had been assiduous in the gym for a minimum of three months. Those who did not meet the aforementioned inclusion criteria, those with cardiovascular diseases limiting exercises such as ischemia and cardiac arrhythmias, those who used drugs, those who were absent from any evaluation stage, and those who did not accept participation in the study were excluded from this research.

Among the obese, 14 (70%) had a BMI between 30 and 34.9 kg/m<sup>2</sup>, classified as grade I obesity, 5 (25%) between 35 and 39.9 kg/m<sup>2</sup>, with grade II obesity and one volunteer (5%) above 40 kg/m<sup>2</sup>, grade III obesity. The eutrophic presented an average of 23.63 ( $\pm$  0.96) kg/m<sup>2</sup>. These parameters follow the norms established by the World Health Organization [10].

Body composition was evaluated by calculating the BMI, obtained through the quotient of body mass (in kg) by the square of height in meters (kg/m<sup>2</sup>). The weighing was performed with the subjects barefoot and wearing light clothing, using an Omron body control scale, model HBF-514C, with a capacity to record 150 kg, using the tetrapolar bioelectrical impedance method, following the protocol described by Machado *et al.* [11].

The maximum aerobic capacity (VO<sub>2max</sub>) evaluation was performed through the Bruce test on a treadmill model KT 10200 ATL, which aimed to establish the percentage of intensity applied during the experimental protocol. Heart rate (HR) was continuously recorded using a Polar heart rate monitor, Vantage NV model.

Based on the VO<sub>2max</sub> determination, the groups were submitted to a training protocol performed on a treadmill, without inclination, at a speed equivalent to 50%, 60%, and 70% of VO<sub>2max</sub>, for 10 minutes. All (obese and eutrophic) were submitted, in a randomized order, to different aerobic training intensities, on different days, with 24-hour intervals, performing a different protocol each day. To calculate the speed on the treadmill that could be used for both walking and running without incline, and thus to facilitate the control of speed on the treadmill during aerobic exercise, the regression equation was used: Speed (km/h) = 1.8182 + 0.2266 x VO<sub>2max</sub> proposed by Dos Santos [12].

The cardiovascular behavior assessment was performed by analyzing the HR, blood pressure (BP), and the double product (DP) of these individuals. The measurement of cardiovascular parameters was performed before and after each training protocol. HR was assessed using a digital frequency meter, BP using the auscultatory method, and DP through a mathematical calculation, multiplying HR by systolic blood pressure.

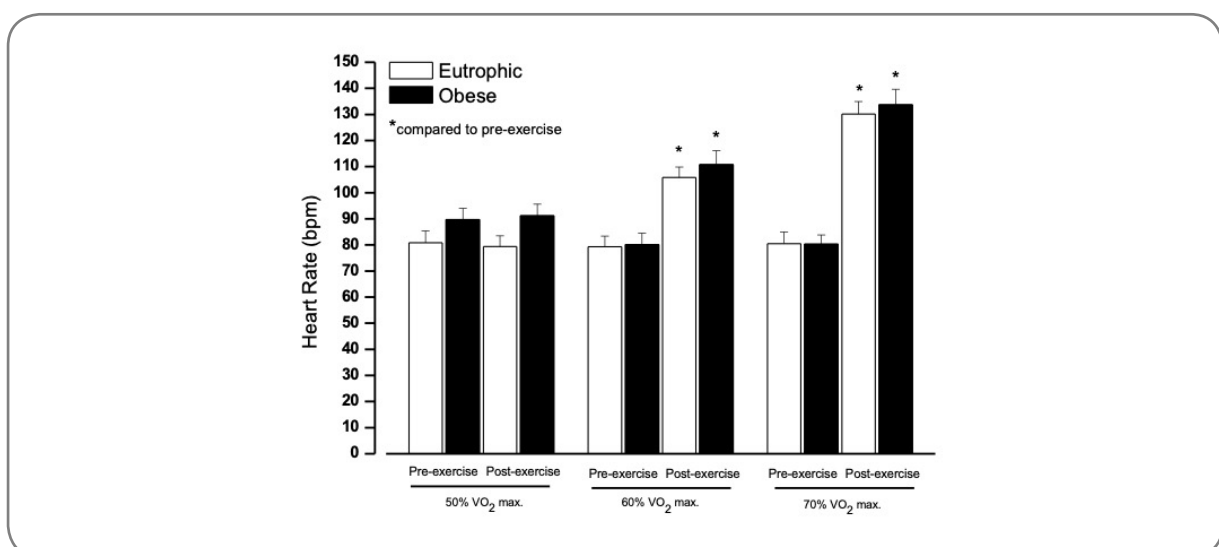
For data analysis, individuals were initially grouped according to gender, age and BMI, and then a comparison between the groups was performed. From this, the results were tabulated in an Excel spreadsheet (*Windows Office 2016*), then analyzed using SPSS software - *Statistical Package for Social Sciences - version 20.0*, expressed as mean and standard error of the mean. The level of significance established was  $p < 0.05$ .

## Results

The results showed no statistically significant difference between the means of eutrophic compared to obese in the parameters of cardiovascular behavior evaluated in protocol 1 (50% of  $VO_{2max}$ ). However, they showed significant ( $*p < 0.05$ ) chronotropic and double product differences in protocols above 60% of  $VO_{2max}$  when compared to their mean pre-effort values, being statistically indifferent when comparing these responses between eutrophic and obese (Table 1).

When comparing the absolute values of HR pre and post-protocol 1, we can observe that the eutrophic group presented a difference of 8.82 bpm (9.83%) and the obese group 11.81 bpm (12.95%). Thus, the absolute difference due to the increase in intensity in the  $VO_{2max}$  in this protocol was 2.99 bpm for the obese group in relation to the eutrophic group. In this trajectory, it can be observed that the eutrophic group presented a difference of 26.53 bpm (25.07%) and the obese group of 30.71 bpm (27.71%) in protocol 2. Thus, the group of obese individuals presented an absolute difference of 4.18 bpm compared to eutrophic individuals. In protocol 3, it is observed that the eutrophic group presented a difference of 49.64 bpm (38.15%) and the obese group of 53.38 bpm (39.93%), an absolute difference of 3.74 bpm for the obese group compared to the eutrophics evaluated.

Graph 1 illustrates this chronotropic increment and highlights heart rate performance compared to pre-exercise values ( $p < 0.05$ ).



Source: Prepared by the author  
Graph- Heart rate analysis

**Table I** - Cardiovascular behavior of the sample in different exercise protocols

Protocol 1 (50% VO <sub>2max</sub> )								
Eutrophic				Obese				
Pre-Effort		Post-Effort		Pre-Effort		Post-Effort		
M	SD	M	SD	M	SD	M	SD	
HR	80.88	4.48	89.70	4.25	79.38	4.11	91.19	4.43
SBP	128.05	12.72	130.41	11.76	130.19	8.82	132.52	9.06
DBP	80.17	3.48	81.23	3.21	83.42	4.33	84.38	4.91
DP	10360.94	1228.39	11707.29	1295.45	10353.47	1111.64	12103.66	1243.08
Protocol 2 (60% VO <sub>2max</sub> )								
Eutrophic				Obese				
Pre-Effort		Post-Effort		Pre-Effort		Post-Effort		
M	SD	M	SD	M	SD	M	SD	
HR	79.29	4.11	105.82*	4.01	80.09	4.40	110.80*	5.26
SBP	126.58	10.48	135.23	9.99	129.66	8.31	139.90	8.59
DBP	79.23	3.13	83.82	2.94	82.52	3.48	86.61	3.33
DP	10050.76	1149.52	14328.52*	1421.23	10401.14	1074.12	15520.47*	1448.18
Protocol 3 (70% VO <sub>2max</sub> )								
Eutrophic				Obese				
Pre-Effort		Post-Effort		Pre-Effort		Post-Effort		
M	SD	M	SD	M	SD	M	SD	
HR	80.47	4.57	130.11*	4.82	80.28	3.53	133.66*	6.01
SBP	126.88	10.63	141.05	10.69	130.04	8.23	146.23	8.36
DBP	80.11	3.31	86.70	3.45	82.42	3.65	88.76	3.65
DP	10214.29	1098.08	18360.94*	1676.01	10458	1033.63	19578.71*	1850.17

HR = Heart rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; DP = Double product; M = Mean; SD = Standard Deviation; \*p < 0.05

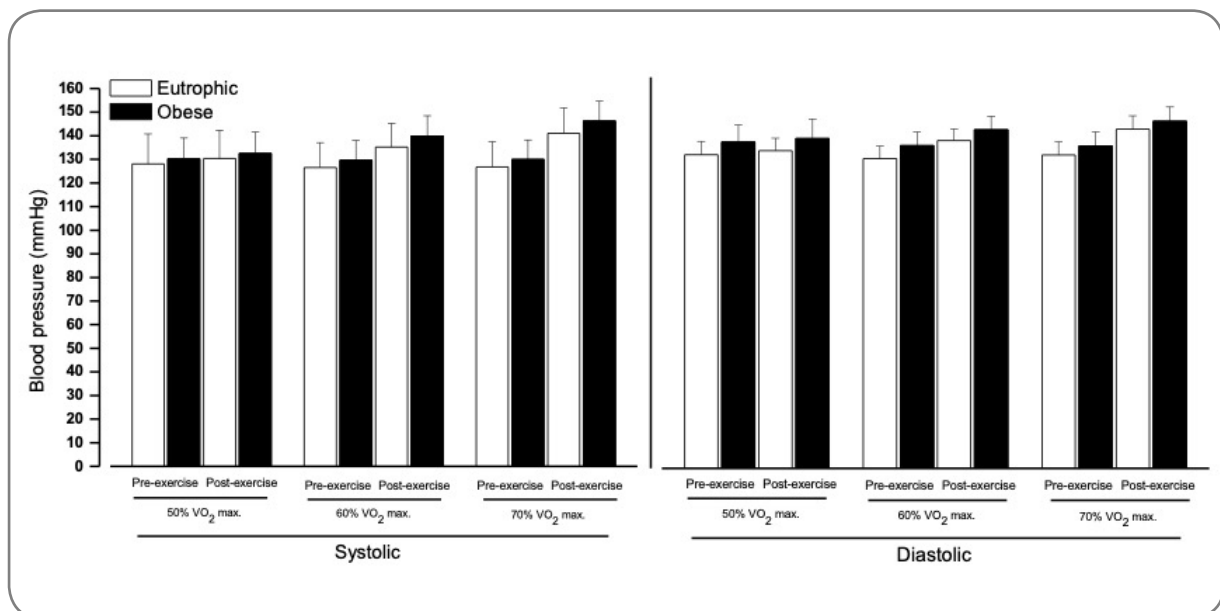
When comparing the mean absolute values of SBP pre- and post-protocol 1, it can be observed that the eutrophic had a difference of 2.36 mmHg (1.80%) and the obese 2.33 mmHg (1.75%), an increase practically similar between the groups. Similarly, when comparing the mean DBP values obtained before and after training, there is a difference of 1.06 mmHg (1.30%) for eutrophics and 0.96 mmHg (1.13%) for the obese.

However, when comparing the absolute values between pre and post-protocol 2, eutrophic individuals showed a difference of 8.65 mmHg (6.39%) and obese individuals a difference of 10.24 mmHg (7.21%), demonstrating an absolute difference of 1.55 mmHg between obese and eutrophic individuals. When observing the DBP, the eutrophic individuals showed a difference of 4.59 mmHg (5.57%) and the obese

4.09 mmHg (4.72%), an increase in blood pressure without significant relationships, especially when compared with each other.

In the pressure evaluation of protocol 3, the eutrophic individuals showed an absolute difference of 14.17 mmHg (10.04%) and the obese group of 16.19 mmHg (11.07%) after training concerning the initial state. When compared to each other, these groups did not show a statistically significant difference. In the analysis of DBP, there is a difference of 6.59 mmHg (7.60%) in the eutrophic group and 6.34 mmHg (7.14%) in the obese group, a greater response when compared to the protocols above, but still without a significant difference when compared between groups.

Graph 2 illustrates the pressure variations in the different intensity protocols and highlights the performance of systolic and diastolic blood pressure in the comparison between groups and pre-exercise values



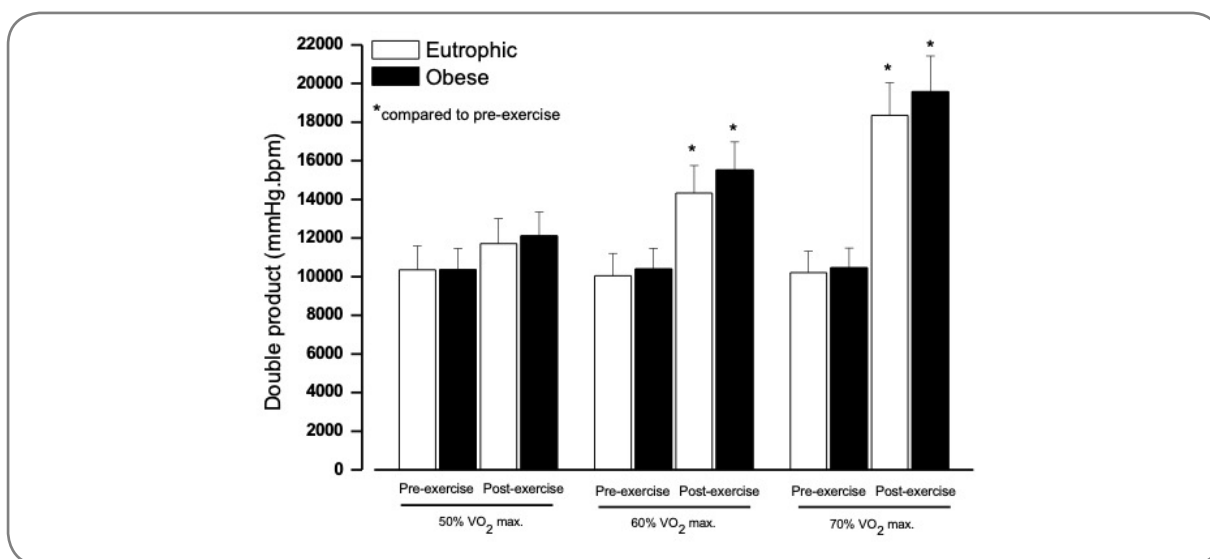
Source: Prepared by the author  
Graph 2 - Heart rate analysis

When comparing the pre and post-protocol 1 DP data, it is observed that the eutrophic group presented a difference of 1346.35 mmHg.bpm (11.50%) and the obese group of 1750.19 mmHg.bpm (14.46%). An absolute difference of 403.84 mmHg.bpm of obese compared to eutrophic. Although a difference is perceived in the analysis of the absolute values of protocol 1, as well as in the chronotropic and pressure analyses, the double product did not present a significant difference between the groups in this percentage of intensity.

However, in protocol 2, it was noticed that both eutrophic and obese individuals showed statistically significant differences between post-training and pre-training, although they did not show statistical differences when compared to each other. When comparing the pre and post-training values, the eutrophic showed a difference of 4277.76 mmHg.bpm (29.85%) and the obese 5119.33 mmHg.bpm (32.98%), a difference of 841.57 mmHg.bpm of obese individuals about the eutrophic group.

Similarly, the analysis of protocol 3 showed that both eutrophic and obese individuals presented statistically significant differences between the mean values obtained in the post-training comparing to the pre-training. However, they were indifferent when compared to each other. In this analysis, eutrophic individuals showed a difference of 8146.65 mmHg.bpm (44.36%), and obese individuals showed a difference of 9120.71 mmHg.bpm (46.58%). With that, the obese presented a difference of 974.06 mmHg.bpm, when compared to the eutrophic ones.

Graph 3 illustrates the changes in the double product in the different intensity protocols and highlights the cardiac work comparing between groups and pre-exercise values ( $p < 0.05$ ).



Source: Prepared by the author  
Graph 3 - Analysis of the double product

## Discussion

This study evidenced a similar cardiovascular behavior among the eutrophic compared to the obese evaluated, although presenting significant differences in the chronotropic and double product parameters, in the protocols from 60% of the VO<sub>2max</sub> compared to each other.

Corroborating our findings, Souza *et al.* [2] compared obese and non-obese sedentary individuals undergoing treadmill testing and did not identify differences in chronotropic and double product responses. These authors point out that HR is a variable that depends on exogenous factors and, in addition, obesity requires a probable adaptation of the intrinsic cardiac innervation, which may justify these similar cardiovascular behaviors between the groups and our results.

Santos and Ribeiro [13] evaluated the cardiovascular behavior in the pediatric exercise test on a cycle ergometer among eutrophic and obese children, highlighting HR as the only variable that showed a difference between the groups and only in the last stage of the test, with no changes significant in pressure responses and the

double product. These authors suggested that this result may be related to a possible redirection of blood flow in favor of thermoregulation and the sympathetic response given mainly by the obese.

Also, along this line, Barbosa *et al.* [14] compared the double maximum product (DPmax) of aged people with different body mass indexes (BMI) and demonstrated that the BMI of the elderly does not influence the result of the DPmax obtained in the effort test with the Bruce protocol. They evidence that although there is a direct association between BMI and the increase in HR and SBP, these increases do not have enough impact on the DPmax, as seen in our results.

Thus, it is noted that factors such as the level of physical fitness, body temperature, and chronological age can influence the cardiovascular behavior of obese patients. However, these parameters were not analyzed in our study.

Nevertheless, Aquino [15], when evaluating the pressure responses in the protocols of 50%, 70%, and 90% of  $VO_{2max}$ , noticed that only training on the treadmill with an intensity of 90% of  $VO_{2max}$  presented a statistically significant pressure difference, suggesting that only high-intensity activities can promote significant pressure changes, which would justify the pressure behavior found in our study.

In contrast to our findings, Gustafson *et al.* [16], when investigating morbidly obese women, showed that plasma catecholamines showed a significantly smaller increase in obese women. They argue that obesity constitutes a hyperinsulinemic and hypoadrenergic state, thus reducing the cardiovascular response and promoting a reduction in metabolic activity, contributing to exercise intolerance, a characteristic of the sedentary individual with excess weight. However, this study promoted an investigation under a classificatory relationship of morbidity and in sedentary women, characteristics that are different from our study.

Afferent information of central and peripheral origin during exercise promotes the adjustment of physiological functions to the cardiovascular system, causing the skeletal muscle to receive sufficient oxygen and necessary nutrients during muscle contraction. Therefore, all changes observed during exertion are associated with the intensity with which it occurs. These changes are modulated by the autonomic nervous system on the circulatory system and are directly related to the increase in sympathetic activity and inhibition of parasympathetic activity [17]. This occurs because muscle contraction activates chemoreceptors and muscle and joint mechanoreceptors, and this mechanism ends up causing the cardiovascular behavior to change gradually [18].

The cardiovascular behavior identified in this study, reflecting the chronotropic increment promoted by the HR with the increase in intensity, and consequently by the DP, represents the physiological response of the body submitted to effort in an attempt to meet the metabolic need of that intensity moment.

It is noteworthy that the obese group showed cardiovascular behavior similar to the eutrophic group in the intensity protocols evaluated. However, it is necessary to recognize the similar sample characteristics between the groups, such as age, hei-



ght, and, probably, the level of physical fitness, since they are regular practitioners of physical activities. These relationships can promote adaptive responses that reflect similar cardiovascular behavior between obese and eutrophic individuals.

Thus, these findings lead us to recognize that in the case of trained young adults, obese, without associated comorbidities, aerobic training protocols can be established at a constant pace with the same relationships established for eutrophic individuals.

Among future investigative possibilities, the intensity percentages expansion to 80% and 90% of  $VO_{2max}$  can be listed, as well as the evaluation in other aerobic training protocols and their relationship with resistance and/or intermittent training.

Finally, a vast and current approach is identified around aerobic training in obese children and adolescents and, in particular, comorbidities associated with obesity. However, there is still a limited scientific production that addresses cardiovascular responses in obese patients undergoing aerobic training at a steady pace, especially with characteristics similar to our sample, which limited us to the bibliographic strengthening of this discussion.

## Conclusion

There were no differences in the cardiovascular behavior of obese individuals about eutrophic individuals evaluated in this study, submitted to different aerobic training protocols on a treadmill.

### Conflict of interest

No conflict of interest with relevant potential.

### Financing source

There were no external funding sources for this study.

### Author's contributions

**Conception and design of study:** Pinto, NV. **Acquisition, analysis and/or interpretation of data:** Pinto, NV, Ferreira JC, Dantas, RT; **Drafting the manuscript:** Pinto, NV, Ferreira JC; **Revising the manuscript critically for important intellectual content:** Pinto, NV, Dantas, RT.

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