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1º SIMPÓSIO INTERNACIONAL de DOHaD e Pandemia: LIÇÕES DO COVID-19
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AGE AND OBESITY INTERFERES IN MUSCLE HYPERTROPHY IN RATS UNDERGOING HIIT TRAINING

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Abstract

Sarcopenic obesity is a condition characterized by the simultaneous presence of obesity and sarcopenia, which is the loss of muscle mass and function. Is a growing concern, especially among the elderly population, and it is important to address both obesity and sarcopenia through lifestyle modifications, such as exercise and proper nutrition, to improve overall health and quality of life. Our study aimed to evaluate the effect of HIIT training on the muscle fiber area of the EDL muscle in obese rats of different ages. For that, Wistar rats, 7 and 12 months old, submitted or not to a HFD diet were subjected to HIIT training, 3 times a week, on alternate days, for 8 consecutive weeks. After the euthanasia EDL muscles was collected and processed histologically. Our data showed that HIIT training was able to promote muscle hypertrophy even with consumption of this diet, indicating that practicing this exercise can stimulate protein synthesis even under conditions of obesity.

Keywords: High-Intensity Interval Training, Hyperlipidic Diet, Sarcopenic Obesity

1. Introduction

Sarcopenic obesity is a condition characterized by the coexistence of obesity and low muscle mass, strength, and/or physical function. This condition affects a large portion of the aging population, with prevalence rates ranging from 3% to 22% depending on the population studied. Obesity sarcopenia has been associated with numerous negative health outcomes, including falls, disability, frailty, and mortality. It is therefore crucial to identify effective interventions to prevent or treat this condition (1).

Exercise has been identified as a promising intervention for obesity sarcopenia. Physical activity can help increase muscle mass, strength, and physical function, while also promoting weight loss and improving metabolic health. Regarding the types of training, in resistance

training, other types of exercise, such as aerobic and combined training, may also have benefits for individuals with obesity sarcopenia (2).

Additionally, High-intensity interval training (HIIT) involves short bursts of intense exercise alternated with periods of rest or low-intensity exercise. The HIIT has been gaining attention as an effective exercise strategy for improving muscle hypertrophy and metabolic health in sarcopenic individuals. Studies have shown that HIIT can lead to significant improvements in muscle size and oxidative metabolism in obese individuals (3,4).

Considering that obesity sarcopenic is a prevalent and serious health condition that can lead to negative health outcomes and, the exercise, has been identified as a promising intervention for improving muscle mass, strength, and physical function in individuals with obesity sarcopenia, our study aimed to evaluate the effect of HIIT training on the muscle fiber area of the Extensor digitorum longus (EDL) muscle in obese rats of different ages.

2. Material and methods

Animals Male Wistar rats (Rattus norvegicus) were obtained from the central animal bioterium of the State University of Maringá (UEM) at 25 days of age, when they were weaned and sent to the animal bioterium of the Department of Morphological Sciences (DCM) of the UEM. The animals were divided into 4 groups (n=7) 7 7 and 12 months: T-SD (trained standard diet), S-SD (sedentary standard diet), T-HFD (trained group receiving a high-fat diet - HFD), and S-HFD (sedentary group with HFD). To induce obesity, a high-fat diet was offered ad libitum for 16 weeks (8 months before the HIIT and more 8 during the HIIT) to the T-HFD and S-HFD groups. This diet contained, in addition to essential nutrients, a high-fat content (35% lard).

2.1 HIIT training protocol

After a 7-day adaptation period and the application of effort test to determine peak velocity (Vpeak), the T-SD and T-HFD groups were subjected to HIIT training, 3 times a week, on alternate days, for 8 consecutive weeks. The training was preceded by a 5-minute warm-up

at 40% Vpeak. Subsequently, the rats ran for 4 minutes between 85-90% Vpeak, followed by 3 minutes between 50-60% Vpeak. This sequence was repeated 6 times, totaling 42 minutes per session (5).

2.2 Euthanasia

At the end of the experimental period, the animals were euthanized with a lethal dose of Tiopental® anesthetic (120 mg/kg body weight, intraperitoneal route). It is worth noting that all procedures in this project were previously approved by the UEM Animal Use Ethics Committee (CEUA-UEM) under opinion no. 52300506204. The EDL muscle was remove and submitted to the histological processing routine.

2.3 Muscle analyses

EDL muscles semi-serial sections of 5 µm were cut and distributed on silanized slides and stained with Hematoxylin/eosin H.E technique. Subsequently, the images were captured at 10x magnification using an optical microscope (Olympus) for analysis of cross-sectional area (CSA) (~1,200 images per group).

2.4 Statistical analyses

The data were presented as mean ± standard deviation and were analyzed by three-way analysis of variance (ANOVA) only for the comparison of Age, Training and Diet effects. Then, Tukey's post-test was used for comparison between groups using GraphPad Prism 8® software, with $p<0.05$ considered significant.

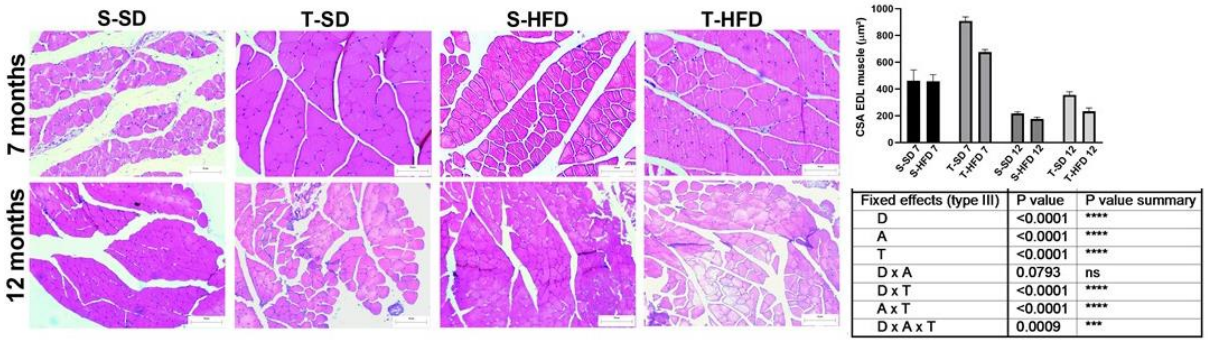
3. Results and discussion

The data shows (Figure 1) significant differences for all variables adopted in this study. The practice of HIIT training promoted muscle hypertrophy in the trained groups, where they showed a greater cross-sectional area of muscle fibers when compared to sedentary groups ($p<0.0001$). Furthermore, the diet factor exerted a great influence on the cross-sectional area.

Trained groups fed with HFD diet presented lower muscle hypertrophy when compared to trained groups fed with standard diet for both 7-month and 12-month-old animals ($p<0.0001$). Additionally, age was also able to exert a hypotrophic role in muscle fibers, where 12-month-old animals showed a smaller cross-sectional area compared to 7-month-old animals ($p<0.0001$).

In according with CUI et al. (6), HIIT is more effective than MICT (moderate training) in altering the expression of muscle RING-finger protein-1 and muscle atrophy F-box, and enhancing the autophagic flux in rat soleus muscle. Additionally, a large effect of diet on muscle AST can be observed, where animals subjected to HFD showed a smaller area of muscle fibers compared to control animals. In fact, research shows that obesity can lead to greater lipid deposition in skeletal muscle tissue, triggering sarcopenic obesity and affecting protein synthesis (7).

Moreover, Brown et al. (8) highlight that consuming HFD contributes to the development of sarcopenia by affecting the expression of the IGF-1 (Insulin-like Growth Factor) gene, which is related to reduced protein synthesis and muscle homeostasis deficit. However, our data showed that HIIT training was able to promote muscle hypertrophy even with consumption of this diet, indicating that practicing this exercise can stimulate protein synthesis even under conditions of obesity.



Fixed effects (type III)	P value	P value summary
D	<0.0001	****
A	<0.0001	****
T	<0.0001	****
D x A	0.0793	ns
D x T	<0.0001	****
A x T	<0.0001	****
D x A x T	0.0009	***

Figure 1. Photomicrographs of the EDL muscle from the experimental groups, using a 10x objective lens. Mean ± standard deviation graph of AST (µm²). Fixed effects: Diet (D), Age (I), and Training (T). Three-way ANOVA with Tukey's post-test, (****) $p<0.0001$

4. Conclusion

In conclusion, consuming a high-fat diet and consequently developing obesity, along with aging, can negatively influence muscle fiber size. However, practicing HIIT has been shown to be effective in promoting EDL muscle hypertrophy, even under these conditions. In addition, HIIT can be an excellent strategy for gaining muscle mass and preventing sarcopenic obesity, but it should always be performed with well-established goals and adequate periodization.

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