

Effects of High Intensity Interval Training on Body Composition: a Review

Raoni Science Oliveira e Silva², Ana Patrícia Ferreira Gomes⁵, Matheus Santos de Sousa Fernandes^{1,2*}, Jeronimo Ramos de Lima Silva², Mateus Jurema Cavalcanti Rino², Gabriela Carvalho Jurema Santos², Thaliane Mayara Pessoa dos Prazeres³, Adelmo José de Andrade², Morgana Alves Correia da Silva⁴ and Camila Tenório Calazans de Lira^{1,2,3}

Abstract

Considered a major public health problem, obesity is the accumulation of excess body fat in such a way that it can cause health problems to individuals, being caused mainly by the mismatch between the number of calories consumed and spent, that is, a consequence of sedentary lifestyle and poor diet. Due to its countless consequences, an increasing number of studies show the benefits of a high intensity interval training program (HIIT) for obese practitioners, since a large part of the population does not practice physical exercises due to lack of time due to their hectic routines, HIIT being a practice proposal with less time. Therefore, the objective of this work is to analyze the studies that investigated the effects of high intensity interval training (HIIT) on the body composition of its practitioners. From a literature review in the SciELO, Lilacs and PubMed databases, eleven articles were selected to compose the results, which showed a significant improvement in the body composition of HIIT practitioners. Thus, it is possible to conclude that these protocols are shown as alternatives for the treatment of obesity, since they can promote significant reductions in body composition and improvements in aspects such as the increase in lean mass. The literature review samples were from elderly diabetic women with excess weight and obesity, sedentary adults with excess weight and associated with metabolic syndrome.

Keywords: High intensity interval training; Body composition

Received with Revision on: September 08, 2021, **Accepted:** September 22, 2021, **Published:** September 29, 2021

Introduction

Obesity is one of the most serious health problems that must be faced today. According to the Ministry of Health, obesity now affects more than 650 million people worldwide and, according to recent data from the Brazilian Institute of Geography and Statistics (IBGE), the percentage of the population aged over 20 years considered obese reached a value greater than double between the years 2013 and 2019. In addition, it is estimated that currently about 25.7% of Brazilians in this age group are considered obese, that is, one in four people are affected by this comorbidity [1-16].

According to the World Health Organization (WHO), obesity is the accumulation of excess body fat, which in large amounts can cause various damages to individuals. For Nahas [17], obesity is a public health problem, as it can compromise health, such as changes in the locomotor system, respiratory difficulties, dermatological problems, in addition to favoring the emergence of cardiovascular diseases, diabetes, cancer and even promoting a premature death. According to Barbieri and Mello [2], the main cause that can cause excessive accumulation of body fat is the mismatch between the number of calories consumed and expended, that is, an inadequate eating pattern, which, added to a sedentary lifestyle, promotes development of obesity [18].

- 1 Neuropsychiatry and Behavior Science Postgraduate Program, Federal University of Pernambuco -UFPE, Recife, PE, Brazil
- 2 Faculty of Communication, Tourism and Technology of Olinda, Brazil
- 3 Physical Education Postgraduate Program, Universidade of Pernambuco – UFPE, Recife, PE, Brazil
- 4 Federal University of Pernambuco, Brazil
- 5 Pernambuco Secretary of Education, Brazil

*Corresponding author:

Matheus Santos de Sousa Fernandes

✉ matheus.sfernandes@ufpe.br

Neuropsychiatry and Behavior Science Postgraduate Program, Federal University of Pernambuco - UFPE, Recife, PE, Brazil

Citation: Silva RSO, Gomes APF, Fernandes MSS, Silva JRL, Rino MJC, et al. (2021) Effects of High Intensity Interval Training on Body Composition: a Review. Health Sci J. 15 No. 9: 878.

For Dos Santos et al. [5], the regular practice of physical exercise is able to promote direct effects in the maintenance of lean body mass and helps to obtain an energy deficit. Still, for Ravnholt et al. [19], one of the biggest reasons that lead a large part of the

population not to exercise regularly is the lack of time due to the demands of their routines. Therefore, new physical exercise modalities have been proposed to promote efficient interventions for weight loss and/or body fat.

Therefore, the High Intensity Interval Training (HIIT), the acronym in English for High Intensity Interval Training has been gaining ground for its effectiveness in the loss of abdominal fat, total fat, and cardiorespiratory improvement [6]. This form of training works on the development of maximum to moderate effort, involving repeated bursts of great cardiorespiratory and muscular effort, in which the Maximum Heart Rate (HRmax) must vary between 80% and 95%, with low intensity recovery between 40% to 50% of Fcmax [12]. In this sense, studies show the benefits of HIIT such as improvement in metabolic physical fitness (fat oxidation, glycemic control, triglyceride reduction, mitochondrial biogenesis, reduction of visceral and subcutaneous fat) and cardiorespiratory benefits (reduction of blood pressure, increase in volume and oxygen consumption, Maximum VO₂) [1,9-12].

It was also shown that HIIT can be more effective in promoting an increase in VO₂max, in addition to being more effective in relation to the time needed to promote cardiometabolic adaptations like continuous training of moderate intensity. According to the American College of Sports Medicine (ACSM) [13] the recommended physical activity for adults is at least 30 minutes of moderate intensity five times a week. When it comes to HIIT, the recommendation is 20 minutes of vigorous intensity, three days a week to promote benefits in body composition for its practitioners.

However, the literature related to HIIT and changes in body composition are still controversial. Boutcher in his review reports that high intensity interval exercises can be more effective in fat loss when compared to other exercises. However, three meta-analytic reviews did not demonstrate significant differences between interventions for composition modification [11,12]. Therefore, this study aimed to analyze, through a literature review, the effects of HIIT on the body composition of its practitioners [20].

Methods

A literature review was carried out, based on the bibliographical research of original articles on the effects on body composition provided by HIIT [21].

Participants and types of interventions

Adult male and female individuals with overweight and obesity; children also of both sexes and overweight; diabetic elderly; and patients with metabolic syndrome. Studies in which participants had been entered into a high-intensity interval training (HIIT) group were included.

Types of outcomes

Studies that examined at least one of the anthropometric markers related to body composition, total body mass, body fat percentage, body mass index, lean mass, and waist circumference were included.

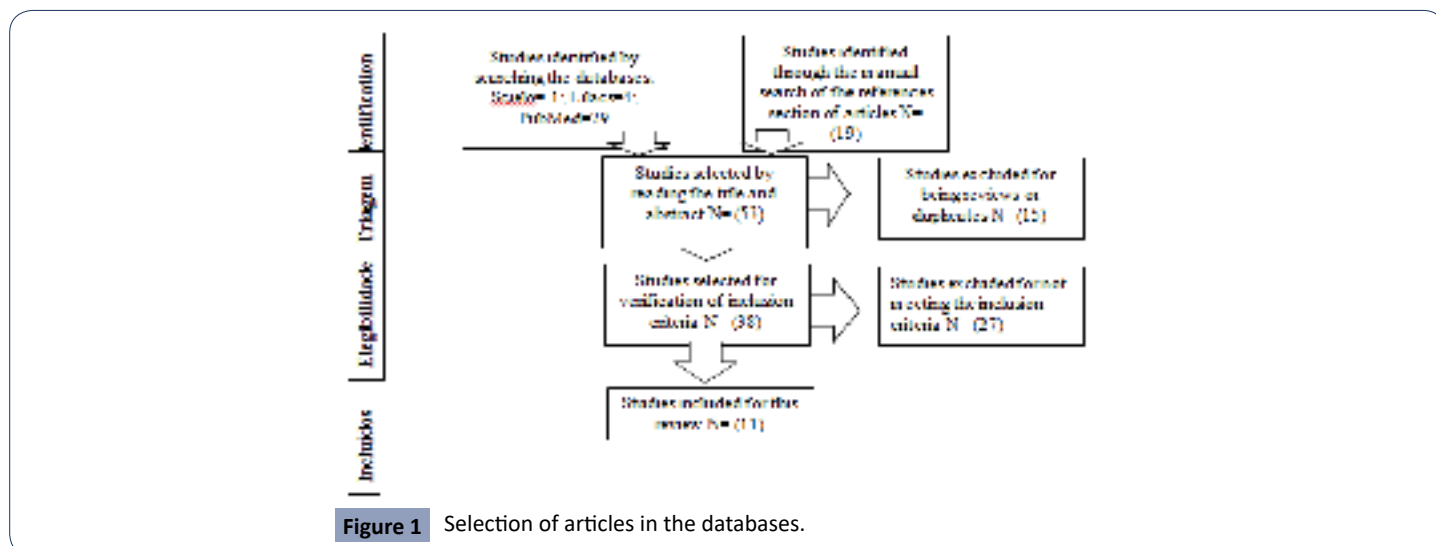
Inclusion criteria

The following were used to carry out this investigation: 1) Articles published in Portuguese and English; 2) Published in the last 10 years (2010 to 2020); 3) Articles from field research/original studies. And as exclusion criteria: 1) Articles that are not related to the theme.

Search strategy

To carry out the research, the health descriptors "High Intensity Interval Training" and "Body Composition" were used, as well as their equivalents "High Intensity Interval Training" and "Body Composition" with the Boolean operator "and".

The literature review refers to the theoretical foundation that will be adopted to address the theme and research problem. Through the analysis of published literature, a theoretical framework will be drawn which will make the conceptual structuring that will support the development of the research." [16]. The selection and inclusion of articles were performed through a search in the following databases: SciELO, PubMed and Lilacs, configured as shown in Organization (Figure 1).



Results

The research was based on the analysis of scientific articles, presented below, related to the theme of physical physiological and phenotypic benefits, promoted by high-intensity interval training in the body composition of individuals suffering from comorbidities physiologically associated with overweight, which were mentioned in the presentation of the methods, topic 2.

Duration

Some studies had the same duration, namely: Drigny et al. [7] and Gremeaux et al. [11], which lasted for 9 months; in addition to the studies by Keating et al. [12], Astorino et al. [1] and De Araujo et al. [4], reporting a duration of 12 weeks. The study by Louzada Junior et al. [14] lasted for 60 days; Sperlich et al. [20] performed a 9-week protocol; The work of Ravnholt et al. [19] used a 7-week protocol; Fernandes et al. [9] performed an 8-week protocol. In the study by Whyte et al. [22] the duration of 2 weeks; Finally, De Bacco Geremia and Brodt [8] performed an intervention for 6 weeks.

Characteristics of high intensity interval training

High-intensity interval training, abbreviated by the acronym (Hiit) can be characterized by relatively brief and intermittent repeated exercise sessions, usually performed with maximum or sub-maximum effort, or with an intensity close to that which provokes $VO_2\max$; Depending on the intensity of the training, an effort can last from a few seconds to several minutes, followed by an active or passive rest interval, depending on the exercise prescription that was created.

Body composition and anthropometry

In the study by Sperlich et al. [20] the height was measured with a folding ruler with the subjects barefoot. Body fat and fat-free mass were measured to 0.1 kg accuracy with a four-electrode bioimpedance scale (Model 1609N; Tanita Corp, Tokyo, Japan) and body mass index (BMI; in $kg \cdot m^{-2}$) then calculated. As dehydration can affect the bioimpedance analysis, the women were instructed to consume 500 mL of water 1 hour before the measurement.

In the work of DE Araujo et al. [4] Body mass was measured by an electronic body mass scale with children dressed in a light t-shirt and shorts. Height was measured by a stadiometer. Waist circumference was measured at the navel height with non-elastic adhesive tape.

Astorino et al. [1] used the following protocol to collect anthropometric data: height and body mass were measured to determine BMI. Body composition was determined by the sum of three skinfold models. Following standardized procedures, subcutaneous fat was measured twice in rotational order in the triceps, suprailiac and thigh, and these values were used to calculate body density, which was used to estimate the percentage of body fat. In addition, circumferences were measured twice in rotational order at the waist (narrowest portion of the trunk), navel and hip to determine the waist-hip ratio and central adiposity.

In the work of Ravnholt et al. [19], changes in pulmonary performance, marked bone in fasting blood (osteocalcin), and lactate were assessed using a bidirectional analysis of variance for repeated measurement with a mixed linear model approach. To assess the correlation between training volume and changes in performance, VO_2 , body composition, bone mineral density, blood markers of oestrogen and blood lactate, the Chi-square distribution test was used.

In the study by Louzada Junior et al. [14], blood assessments were performed before the start of the intervention period and also four and eight weeks later. Glucose, total cholesterol, triglycerides, HDK, LDL, lactate dehydrogenase levels were also measured at the beginning and after four and eight weeks of training protocol application, using a Konelab 60i. Anthropometric and performance assessments were only performed 60 days after the start of the intervention; body composition, as well as total and visceral fat were obtained using an in body digital, octapolar platform. Waist circumference was measured at the smallest point on the circumference between the iliac crest and the last rib and hip, with a flexible metallic measuring tape, with precision of 0.1 cm; through these measurements, the corporal mass index and waist-hip ratio were calculated.

In the study by Fernandes et al. [9], the anthropometric assessment consisted of measurements of total body mass, total height measured on an anthropometric platform scale with a precision of 100 grams, height was determined with a portable stadiometer with a precision of 0.1cm. The body mass index was calculated by dividing the weight in kilograms by the square of height, measured in meters, (kg/m^2). Waist circumference assessment was performed using a 2m-long tape with 0.1cm precision, and the measurement was taken at the height of the umbilical scar.

Keating et al. [12] used the following methods: Total and regional body fat distributions were measured by dual energy X-ray absorptiometry (DEXA); height was measured to the nearest 0.1 cm by stadiometer; Waist circumference was measured in the horizontal plane, midway between the lower margin of the ribs and the upper margin of the iliac crest in deep expiration; Blood pressure was measured manually in each arm after 10-15 minutes sitting still with a second reading taken when there was a difference >10 mmHg.

De Araujo et al. [4] used the following methods: Body mass was measured by an electronic body mass scale with children dressed in a light t-shirt and shorts. Height was measured by a stadiometer. Waist circumference was measured at the navel height with non-elastic adhesive tape. Body composition was analyzed by the bioelectrical impedance method using a standardized body composition analyzer. The percentage of body fat was estimated using a validated equation adjusted for sex, age, weight and height, following procedures previously described. Children were instructed not to drink and eat for 4 hours before the test and to exercise for at least 12 hours before the test. Finally, in the study by De Bacco Geremia and Brodt [8], the participants underwent an initial assessment that collected body weight using a digital scale, skinfolds: middle axillary, suprailiac, thigh, medial calf with an adipometer, to calculate the percentage of body fat

from the formula of Petroski (1995). In addition to the skinfolds belonging to the formula, the abdominal skinfold was collected. Body perimeters were also evaluated with a measuring tape: waist, abdomen and thigh. In the group of sedentary individuals and obese children, there was a different result in the articles by Ravnholt et al. [19] regarding the reduction of body fat, proving to be significant, in addition to the increase in lean mass and bone mineral density. In the study by de Araujo et al. [4] The peaks of relative and absolute VO_2 increased in both groups, but the increase was greater in GHIIT, as well as insulinemia and the decrease in body mass (Table 1).

The study by Louzada Junior et al. [14] used as a continuous moderate training protocol a walk for 40 minutes, with 50% to

60% of the F_{cmax} with 5 minutes of cooling using yoga practices, even so, the HIIT training was applied three days a week with an average duration of 40 minutes per meeting, with all exercises performed without equipment, using their own body weight. The work of Sperlich, et al. [20] performed 3 weekly sessions of the HIIT Circuit indoors or outdoors, while the Combined Circuit involved two sessions of the same nature and a third of low-intensity resistance exercises targeting 65% of F_{cmax} .

In the study by Ravnholt et al. [19] subjects conducted training from 5-10-15 with alternating sessions of high-intensity exercise for 2 minutes at 50%-85% of F_{cmax} . Fernandes et al. [9] monitored the participants during a HITT training class that lasted from 17 to 20 minutes and from the heart rate, the EPOC and the total

Table 1 Survey of articles included in the review.

Title/Author	Objetive	Methods/HIIT protocol	Main Results
Junior AL [14]	Identify the effect of high intensity multimodal interval training on body composition, lipid profile and glucose metabolism in elderly diabetics.	Sample of 48 individuals divided into a Sedentary Group (GS) of control, a Moderate Ongoing Training Group (MICT) and a Group of HIIT. The GMCT and the GHIIT performed the protocol for 60 days, 3 times a week, 40 minutes of walking between 50% and 60% of F_{cmax} , with 5 minutes of cool-down using yoga practices.	GHIIT achieved significant improvements in cholesterol and triglyceride levels, with a reduction in glucose levels in the blood. HIIT is more effective than MICT in improving lipid and glycemic profiles, decreasing fat body and improve fat distribution.
Sperlich B [20]	Evaluate the effects of circuit-type HIIT alone or in combination with high-volume, low-intensity exercise in parameters cardiorespiratory and metabolic, body composition, functional the quality of life of women with strength and overweight.	The protocol lasted for 9 weeks, with 3 sessions each week. The sample was divided into two groups: HIIT Circuit (11 participants) and Combined Circuit (8 participants). 3 weekly sessions of the HIIT circuit, and two sessions of the combined circuit, aiming at 65% of F_{cmax} .	Oxygen consumption, general perception of health had improvements in the Circuit group HITT. Both groups had decreased mass body, BMI and proportion waist hip.
Ravnholt T [19]	It aimed to observe the effect of the HIIT Race with "Sprints" of 5 seconds, in the body composition level of conditioning and performance in untrained individuals.	For 7 weeks, subjects performed 3 days per week training 5–10–15, consisting of 3-9 blocks of 4 repetitions 15, 10 and 5 s of running at low, moderate, and high speed, between 50% and 85% of F_{cmax} .	The reduction in mass body weight was significant, in addition to the increase in lean mass and bone mineral density.
Fernandes NA [9]	Analyze the behavior of total body mass and circumference of overweight/obese women who performed HIIT.	The sample consisted of 8 women aged between 21 and 25 years that did not practice regular physical activity. 8 weeks of training were carried out. The HITT training lasted between 17 to 20 minutes	The main result was a significant reduction in body mass, in addition to a decrease in the circumference measurement abdominal as well a higher energy expenditure.
Astorino TA [1]	This study aimed to main determine the effect of two sessions chronic training weekly HIIT in fat oxidation maximum and body composition	The sample consisted of 23 sedentary women aged between 18 and 30 years. A HIIT protocol (80% -90% maximum workload) and a moderate intensity intervention (60% -80% of the maximum workload) were performed on a cycle ergometer, 3 times a week for 12 weeks, consisting of 6 to 10 episodes of sixty seconds interspersed with active recovery.	Increased body fat oxidation.
Keating SE [12]	This study was carried out to examine the effect. 12 weeks of HIIT x continuous aerobic exercise on body composition and in the risk factors in previously inactive overweight adults. previously inactive overweight adults.	The authors used 38 overweight adults as a sample, 7 men and 31 women. Divided into 3 groups: HIIT Group, Control Group, Placebo Group. 12 weeks evidencing a HIIT protocol with 120% VO_2 with 4 to 6 intervals of 60 minutes each; on the other hand, the continuous exercise protocol used 50% to 65% of VO_2 lasting from 30 to 45 minutes without a break.	Decrease fat

Title/Author	Objetive	Methods/HIIT protocol	Main Results
Whyte LJ [22]	The aim of this study was to investigate the effects of very high intensity interval sprint training (SIT) on metabolic and vascular risk factors in sedentary men with overweight/obese.	10 individuals aged between 23 and 41 years performed 2 weeks of intervention with 6 sessions of 4-6 repetitions of 30 seconds each.	Fat reduction body and hip and waist circumference.
Gremeaux V [11]	The aim of this study was to study the impact of a lifestyle long-term combined and high-intensity interval training intervention in body composition, risk cardiometabolic and tolerance exercise in overweight and obese individuals.	The sample consisted of 62 overweight or obese individuals aged between 43 and 53 years. The program lasted for 9 months with completion of the training protocol, nutritional guidance and resistance training.	Reduction of body fat.
de Araujo ACC [4]	Compare two types of training (TR and HIIT) in obese children.	30 children were divided (GTR and GHIIT). A 12-week protocol was carried out. One group performed continuous exercises for 30 to 60 minutes at 80% of F _{cmax} , and the other performed 3 to 6 sets of 60 s of sprint at 100% of maximum speed interspersed with active recovery at 50% of initial speed	The relative and absolute VO ₂ peaks increased in both groups, but the increase was greater in GHIIT, as well as the insulinemia and decreased body mass.
Drigny J [7]	Describe the long-term effects of MICE (continuous exercise of moderate intensity) and HIIT.	65 aged individuals between 44 and 62 years old, divided into two groups, underwent GMICE and GHIIT for 9 months.	Fat reduction body and decreased circumference of waist.
de Geremia AB [8]	The aim of the study was to compare the effects of different volumes of high-intensity interval training in cycle ergometer on reduction of body fat in women.	Eight women aged between 16 and 41 years divided into two groups, the G20 (20 minutes of HIIT) and the G30 (30 minutes of the same HIIT protocol). Two sessions were held weekly for 6 weeks.	Redução da gordura corporal e diminuição da circunferência abdominal.

energy expenditure of the activity were determined. Astorino et al. [1] performed a HIIT protocol (80%-90% maximum workload) and a moderate intensity intervention (60% -80% maximum workload) on a cycle ergometer, 3 times a week for 12 weeks, consisting of 6 to 10 episodes of sixty seconds interspersed with active recovery. The study by Keating et al. [12] shows the HIIT protocol with 120% VO₂ with 4 to 6 intervals of 60 minutes each, while the continuous exercise protocol used 50% to 65% of VO₂ with a duration of 30 to 45 minutes without an interval. Whyte et al. [22] performed a 2-week HIIT intervention, comprising 6 sessions of 4 to 6 repetitions of 30-second wingate anaerobic sprints in an electromagnetically braked cycle ergometer, with recovery of 4.5 minutes between each repetition.

Gremeaux et al. [11] carried out a nine-month program that consisted of individualized nutritional counseling, a HIIT protocol, and resistance training two to three times a week. The study by De Araújo et al. [4] performed a continuous exercise of 30 to 60 minutes at 80% of HR_{max}, while the training of the HIIT group performed 3 to 6 sets of 60 s of sprint at 100% of the peak speed interspersed by an active recovery period of 3 minutes at 50% exercise speed, with HIT sessions ~70% shorter in duration than continued exercise sessions.

Finally, De Bacco Geremia and Brodt [8] performed a HIIT intervention following a 1:3 ratio, starting with 4 minutes of

warm-up on the ergometric bicycle, with adjusted overload and following the training of 15s:45s when the volunteers performed 15s of maximum sprint and 45s of active recovery, with the G 20 being chosen to perform 20 minutes of this formation, and the G 30, 30 minutes of the same formation. After identifying the protocols used in the reviewed studies, we can verify that the articles [1,7,8,9,11,12,14, 20,22]. had similar results with respect to reduction in body fat, reduction in body mass, in addition to a decrease in the measurement of waist circumference, as well as a greater energy expenditure and increased oxidation of body fat.

Discussion

This integrative review aimed to investigate the effects of high intensity interval training (HIIT) on the body composition of its practitioners; such training method can promote several benefits related to body composition, such as a significant decrease in body mass, BMI values, measurements and waist-hip ratio, body fat and waist-height ratio, cholesterol, blood glucose and blood pressure. In addition, an increase in body fat oxidation, endurance and lean mass can be seen; considering, therefore, the intervention through HIIT, as a strong alternative to reduce the body fat of its practitioners compared to other possible training protocols.

Thus, the selected articles were analyzed seeking to identify these

parameters through the following data collection instruments: anthropometric measurements, blood lipidogram test, BMI and WHR measurements; having as main findings the significant decrease in body mass, BMI values, measurements and waist-hip ratio, body fat and waist-height ratio, cholesterol, blood glucose and blood pressure. Furthermore, an increase in body fat oxidation, endurance and lean mass can be evidenced.

It is known that HIIT is worked in zones of maximum or sub-maximum effort, providing several benefits for practitioners as an alternative that requires less training time, this factor being the key point for greater adherence for most of the population that does not have free time for more prolonged exercise. Since this training involves repeated explosions of great cardiorespiratory and muscular effort, with altered intensity and volume according to each protocol that will be applied, seeking to identify the particularities of each individual or a group of individuals [15].

For Thums [21], high-intensity interval training is able to promote improved physical and metabolic fitness (fat oxidation, glycemic control, triglyceride reduction, mitochondrial biogenesis, visceral and subcutaneous fat reduction) and cardiorespiratory benefits such as blood pressure reduction, volume increase and VO_2 maximal oxygen uptake, factors that are consistent with the results achieved in this review. Still, for Kravitz [13] and Bossi [3], the recommendations of the American College of Sports Medicine [13] are 150 minutes per week, with moderate loads, and 120 minutes per week for more vigorous loads of physical activity. High-intensity interval training is a more attractive proposition to practitioners due to the interval after high-intensity stimulus, making its practice more pleasant when compared to continuous exercise. One of the most important factors for reducing fat percentage is the basal metabolic rate, which also benefits from the practice of high-intensity interval training, contributing to metabolic functions, including EPOC (excess post-exercise oxygen consumption), thus corroborating the results shown in this review. Mitochondria have the ability to produce energy in its matrix through the Krebs cycle, considering that the resting metabolic rate can remain elevated for up to 48

hours. Fact evidenced by Kravitz [13] and Bossi [3]: "The lungs are primary excretory organs for weight loss and they represent about 84% of the loss of calories". Thus, the promotion of benefits in cardiorespiratory capacity are initial factors for long-term effects on body composition, also evidenced in the results of this review. In this sense, high-intensity interval training is a training method that has been shown to be effective in reducing the percentage of fat [7,8], effect caused by (lipolysis), and a low energy consumption that is determined by the nutritionist according to each individual. Lipolysis is the oxidation of fat molecules through the first gluconeogenesis via lipid, which reduces "bad" cholesterol (LDL-C and VLDL-C) and fat deposits. The practice of HIIT in this review was shown to be a form of training capable of contributing to the process of acceleration of metabolism in the post-exercise [1].

High-intensity interval training can promote several benefits related to the body composition of its practitioners, such as the reduction of fat mass, through high energy expenditure, which can acutely generate a caloric deficit, stimulating lipolysis; the intervention through HIIT being an alternative to the possible training and monitoring protocols carried out to control overweight or obesity, metabolic syndromes, and diabetes.

Conclusions

From the reviewed works, it is possible to measure the importance of well-designed HIIT programs, respecting the individuality of each patient and with a follow-up by a Physical Education professional along with other health professionals; it is extremely important to evaluate the body composition to measure the data of individuals, identifying which variables were changed at the beginning and after the end of the research, having as main body composition data the percentage of fat, the body mass index, the maximum VO_2 and other factors that are of notable relevance for a comparison of results in the analysis. Thus, the present study is of great importance for correlating important aspects of HIIT and the promotion of benefits in the body composition of its practitioners.

References

- 1 Astorino TA, Schubert MM, Palumbo E, Stirling D, McMillan DW (2013) Effect of two doses of interval training on maximal fat oxidation in sedentary women. *Med Sci Sports Exerc* 45: 1878-1886.
- 2 Barbieri AF, Mello RA (2012) The causes of obesity: an analysis under the historical materialist perspective. *Connections* 10: 121-141.
- 3 Bossi LC (2020) HIIT: Fitness and Wellness. Phorte Editora, Brazil.
- 4 de Araujo ACC, Roschel H, Picanço AR, do Prado DML, Villares SMF, et al. (2012) Similar health benefits of endurance and high-intensity interval training in obese children. *PloS one* 7: e42747.
- 5 dos Santos BV, dos Santos MN, Maia HP (2009) The benefits of regular physical activity for people with obesity. *Connections* 7: 103-113.
- 6 de Belmiro WO, Navarro AV (2016) The Effects of High Intensity Interval Training for Weight Loss. *RBONE - Brazilian Journal of Obesity, Nutrition and Weight Loss* 10: 224-230.
- 7 Drigny J, Gremeaux V, Guiraud T, Gayda M, Juneau M, et al. (2013) Long-term high-intensity interval training associated with lifestyle modifications improves QT dispersion parameters in metabolic syndrome patients. *Ann Phys Rehabil Med* 56: 356-370.
- 8 de Geremia AB, Brodt GA (2014) Effects of different volumes of high-intensity interval training cycle ergometer on body fat reduction in women. *DO CORPO: ciências e artes* 4.
- 9 Fernandes NA, Ribas MR, Azevedo F (2016) High-intensity interval training in overweight and obese women. *RBONE-Revista Brasileira de Obesidade, Nutrição e Emagrecimento* 10: 295-302.
- 10 Ferreira MS, da Cruz AM (2018) High Intensity Interval Training in Obese Adults for Weight Loss. *Annals of the Journey of Physical Education of the State of Goiás* 1: 267-271.
- 11 Gremeaux V, Drigny J, Nigam A, Juneau M, Guilbeault V, et al. (2012) Long-term lifestyle intervention with optimized high-intensity interval training improves body composition, cardiometabolic risk,

- and exercise parameters in patients with abdominal obesity. *Am J Phys Med Rehabil* 91: 941-950.
- 12 Keating SE, Machan EA, O'Connor HT, Gerofi JA, Sainsbury A, et al. (2014) Continuous exercise but not high intensity interval training improves fat distribution in overweight adults. *J Obes* 2014: 834865.
 - 13 Kravitz L (2020) High-Intensity Interval Training. *American College of Sports Medicine*.
 - 14 Junior AL, Da Silva JM, Clodoaldo A, De Freitas RE, Cavalcante B, et al. (2020) Multimodal HIIT is More Efficient Than Moderate Continuous Training for Management of Body Composition, Lipid Profile and Glucose Metabolism in the Diabetic Elderly. *Int J Morphol* 38: 392-399.
 - 15 Lutherek P, Cezar MA (2019) Physical Exercise Program for Weight Loss Using the HIIT Method. *Scientific Initiation Seminar and Integrated Teaching, Research and Extension Seminar* e21703.
 - 16 Moresi E (2020) Research methodology. *Série didática*.
 - 17 Nahas MV (2001) Physical Activity, Health Quality of Life. Concepts and Suggestions for an active lifestyle. Londrina: Midiograf.
 - 18 do Couto MB, Filho NN, Guimarães M, Uchôa PES, de Oliveira CL, et al. (2018) Benefits of High Intensity Interval Training in the Weight Loss Process in Obese. *Revista de Trabalhos Acadêmicos-Campus Niterói* 1.
 - 19 Ravnholt T, Tybirk J, Jørgensen NR, Bangsbo J (2018) High-intensity intermittent "5–10–15" running reduces body fat, and increases lean body mass, bone mineral density, and performance in untrained subjects. *Eur J Appl Physiol* 118: 1221-1230.
 - 20 Sperlich B, Wallmann-Sperlich B, Zinner C, Von Stauffenberg V, Losert H, et al. (2017) Functional high-intensity circuit training improves body composition, peak oxygen uptake, strength, and alters certain dimensions of quality of life in overweight women. *Front Physiol* 8: 172.
 - 21 Thums IA, Antunes FR (2019) The HIIT Method and Its Benefits for the Quality of Life in the 21st Century. *SAJES*.
 - 22 Whyte LJ, Gill JMR, Cathcart AJ (2010) Effect of 2 weeks of sprint interval training on health-related outcomes in sedentary overweight/obese men. *Metabolism* 59: 1421-1428.