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THE INFLUENCE OF EXERCISE ON BODY COMPOSITION AND HEALTH EXPENDITURE IN OVERWEIGHT YOUNG PEOPLE

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Abstract

Aim. Our research aims to emphasize the link between HIIT exercise, body composition, and health expenses in overweight young adults.

Objectives. Overweight individuals face higher financial expenses and there are also identified intangible costs like suffering and psychological implications. (HIIT) is a time-efficient strategy for improving body composition.

Methods. This study collected data from overweight students at the Faculty of Kinesiology at UNEFS and included 10 Caucasian participants aged 19-28 years, with a BMI of ≥ 25 kg/m² and adipose tissue percentages of $\geq 25\%$ in men and $\geq 32\%$ in women (eight males and two females). Participants completed 8 months (3 sessions/week) of HIIT (7×30 sec at 90% HRmax, 1-minute active recovery; n=10). The EQ-5D-5L questionnaire was used to assess the general health status and costs. Anthropometric measurements of selected subjects to determine indices to which excess weight is related (weight and height measurement, measurement of skin folds for the application of the caliper method); The intensity of the effort that allows us to identify the priority energy chain is expressed by heart rate indicator (HR), oxygen consumption, perception of effort. The maximum exercise HR is variable and is established based on the theoretical maximum HR. Functional measurements aimed at determining heart rate (HR) and VO₂MAX; The method of tests to determine the intensity of the workout at which fat burning is maximum (POLAR, AEROSCAN). In order to assess body composition mathematical formulas were applied.

Results. Training affects body mass, the average values for the percentage of adipose tissue decreased by $0.19 \pm 0.43\%$, fat mass by 0.69 ± 1.56 kg and lean mass by 1.81 ± 1.51 kg ($p > 0.05$). For maintaining/improving their health, participants spent RON 1750 ± 1610 in direct costs, while indirect costs were RON 810 ± 906 . Regarding the intangible costs, 8/10 have no pain or discomfort and do not feel anxious or depressed, 10/10 had no problems moving, washing/dressing or performing daily activities. The values recorded with the help of the Aeroscan device show that at an average heart rate of 167 bpm the average caloric consumption is 245 kcal/h. Testing with the help of Polar and Aeroscan devices allowed the collection of data that facilitates the programming of the effort on intensity intervals.

Conclusions. The HIIT exercise program contributes to weight and fat mass loss and offers a great level of personalization that allows it to be adapted for maximum lipid oxidation. The health expenditure is high for overweight young people.

Keywords: HIIT, overweight, fat mass, body composition, health expenditure.

Introduction

In recent decades, both highly industrialized and developing countries have seen a significant increase in BMI due to disordered lifestyles, such as sedentary lifestyles and the ingestion of high-calorie foods (Egger & Dixon, 2014; Atella et al., 2024).

In the case of increased caloric intake during meals, regular physical activity combats weight gain and associated cardiometabolic disturbances, such as increased blood pressure and LDL-c, as well as decreased insulin sensitivity (Ramirez-Jimenez et al., 2020).

Before the Covid-19 pandemic, the level of physical activity practiced by young people was low anyway, but a further decrease was found during and after the pandemic and along with the increase in time spent in front of screens and changes in diet, an increase in the number of kg was found in both men and women - the average weight gain was 5.11 ± 3.52 kg (Nasui et al., 2022).

According to the WHO, physical activity is defined as any body movement produced by skeletal muscles that requires energy consumption. The term "physical activity" should not be confused with "exercise", a subcategory of physical activity, which is planned, structured, repetitive and aims to improve or maintain one or more components of physical fitness. Beyond exercise, any other physical activity that takes place in a typical week brings health benefits. We can analyze the concept of physical activity under three aspects: physical activity during the time spent working, physical activity related to the way a person moves to various places and recreational physical activity that a person performs in his free time. "Of the total population aged 5 years and over, only 11.6% said they do various recreational physical activities in their free time weekly. Most people who perform such activities are children aged 5-14 years (50.2%) and young people aged 15-24 years (20.5%), after this age, the share of people who practice sports in their free time decreases

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significantly, from 11.0% in the age group 25-34 years, to 0.3% in people aged 75 and over" (National Institute of Statistics, 2021).

Our research aims to emphasize the link between HIIT exercise, body composition, and health expenses in overweight young adults.

Theoretical framework

Physical exercise aims to decrease body weight at the expense of fat mass, limit lean mass loss and decrease basal metabolism as well as stabilize body weight in the long term (Cordun, 2011).

Body composition refers to the size and distribution of structural components, specific to the human body, which sums up the total body weight. The assessment of body composition most commonly uses the physiological model, with two compartments, in which the human body is systematized into fat mass and non-fat mass (Cordun, 2009).

The relative contribution of fats and carbohydrates in the release of energy varies with the intensity of the effort (Bota & Teodorescu, 2007). Stress intensity is defined as the amount of mechanical work performed in the unit of time. Interval training involves alternating the exercise with the break and repeating this cycle several times. In interval activity, the degree of fatigue is much lower than during continuous activity (Teodorescu, 2009).

As for the financial expenses of overweight people, they are increased compared to those of the unaffected population (Ahern et al., 2022). This is due to an accumulation of costs necessary for medical services and investigations, pharmacotherapy, hospitalization or decreased productivity and working capacity, early retirement, etc. Certain intangible costs quantified in the form of suffering itself and psychological implications are also identified. That is why we believe that it is necessary for a body contouring program not to involve extensive costs and to be accessible even in your own home without the use of sophisticated equipment. Consistency in the practice of this type of activity is pursued.

In this sense, the purpose of our research is to highlight the interdependence between HIIT exercise, body composition and the costs of maintaining health in overweight young people.

According to Cordun (2009), medical gymnastics exercises to combat excess weight induce a series of effects on the body:

- morphogenetic (plastic) effects influence the musculoskeletal system: bones, joints, muscles, tendons.
- functional or physiological effects: they play a role in maintaining joint mobility and stability, maintain the properties of the muscle fiber and increase blood flow at this level, causing important biochemical changes.
- educational effects: in addition to having a favorable impact on intellectual functions, it also causes an improvement in body attitude, coordination of gestures and development of motor possibilities.
- prophylactic effects.
- therapeutic effects.
- Psychic effects: improving self-esteem and mental state.

Of the variety of exercises, interval exercises involve repeated sets of high intensity alternating with short periods of recovery. According to intensity, MacInnis and Gibala (2016) differentiate:

HIIT (high intensity interval training) - exercises on high-intensity intervals, performed at almost maximum effort, with $HR \geq 80\%$ (even 85-90%);

SIT (sprint interval training) - interval sprint exercises, characterized by efforts carried out at HR intensities $\geq VO_2$ max, including supramaximal efforts.

MICT (moderate intensity continuous training) are physical activities of longer duration, carried out at moderate, equal and continuous intensity. The graphic representation of the three is illustrated in Figure 1. Graphic expression of different types of aerobic exercise (MacInnis & Gibala, 2016).

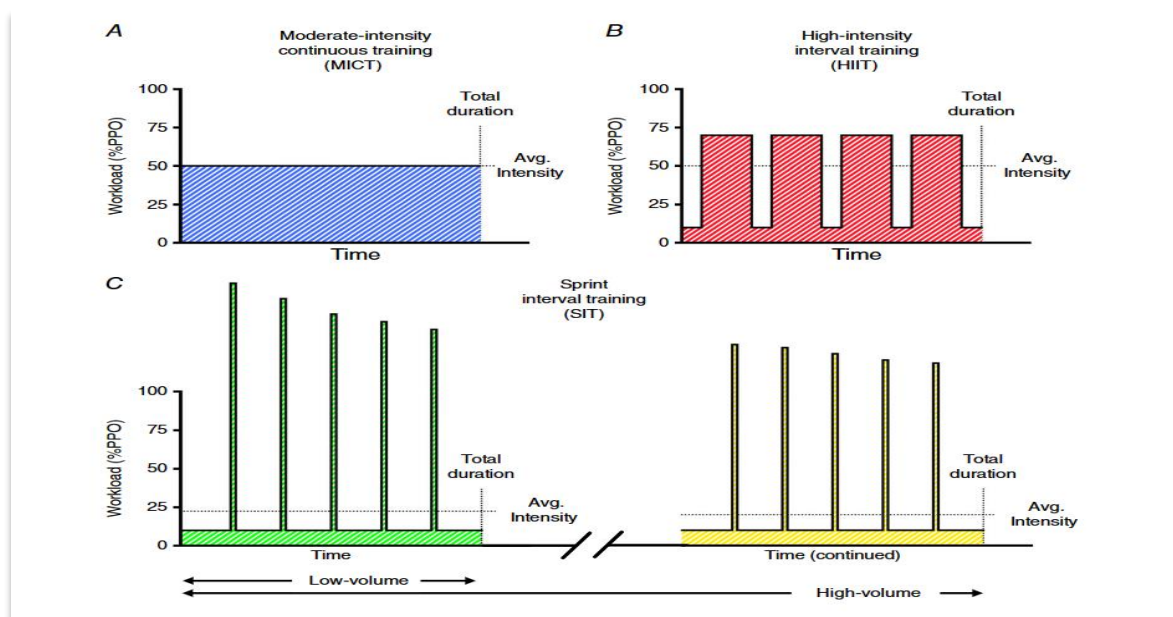


Figure 1. Graphic expression of different types of aerobic exercise (MacInnis & Gibala, 2016)

Worldwide, in recent years the effect of HIIT on body composition among overweight people has been studied, indicating favorable results compared to other types of exercise or compared to diet not accompanied by exercise (Heydari, Freund & Boutcher, 2012; Kong, Fan, Sun, Song, Shi & Nie, 2016; Su et al., 2019; Bouchard, 2015).

Comparing the effect on fat deposits induced by HIIT and moderate intensity continuous training (MICT), Viana et al. (2019) revealed that both types of activity determine reduction in fat mass percentage, but better results were obtained after HIIT than after MICT by 28.5%. For both normal weight and overweight people, HIIT is a time-effective strategy for decreasing fat deposits, including abdominal fat in the visceral region (Maillard, Pereira & Boisseau, 2017).

Torment et al. (2019) shows that for young adults suffering from overweight, performed even once a week, HIIT is sufficient to induce significant improvements in aerobic capacity, body composition and blood pressure, demonstrating the advantage offered by HIIT in terms of the minimum time needed to be allocated weekly.

Physical activity increases lipid oxidation, with much better results in HIIT-type activities if practiced for a period longer than 4 weeks, making favorable progress each week (Atakan et al., 2022; Schubert et al., 2017; Chin et al., 2019). In sedentary people, lipid oxidation increases after 12 weeks of interval training (Astorino et al., 2013; Yin et al., 2023).

The increased incidence of metabolic diseases is related to changes in body composition, in particular the increase in fat mass and loss of lean mass (Abildgaard et al., 2013).

Both from the perspective of the individual and from the perspective of the general population, an increased BMI is strongly correlated with a sum of high costs, necessary for specialized medical care (Edwards et al., 2023). Excess weight is associated with the increased use of medical services leading to increased medical costs, especially in patients with morbid obesity (Effertz et al., 2015).

People suffering from obesity generate the highest expenses throughout their lives, the main reason for increased expenses being pharmacotherapy, among which women have higher expenses than men (Atella et al., 2023). The financial impact of being overweight is predominantly among young people (Atella et al., 2024). Both at the micro- and macroeconomic levels, excess weight is considered a major public health problem, due to affecting a growing segment of the active population. It manifests itself as a burden for society, both through the direct and indirect costs it entails. At the same time, from a medical point of view, excess weight also involves certain intangible costs that are quantified in the form of suffering itself, of the psychological implications it entails (Figure 2. Components of cost analysis).

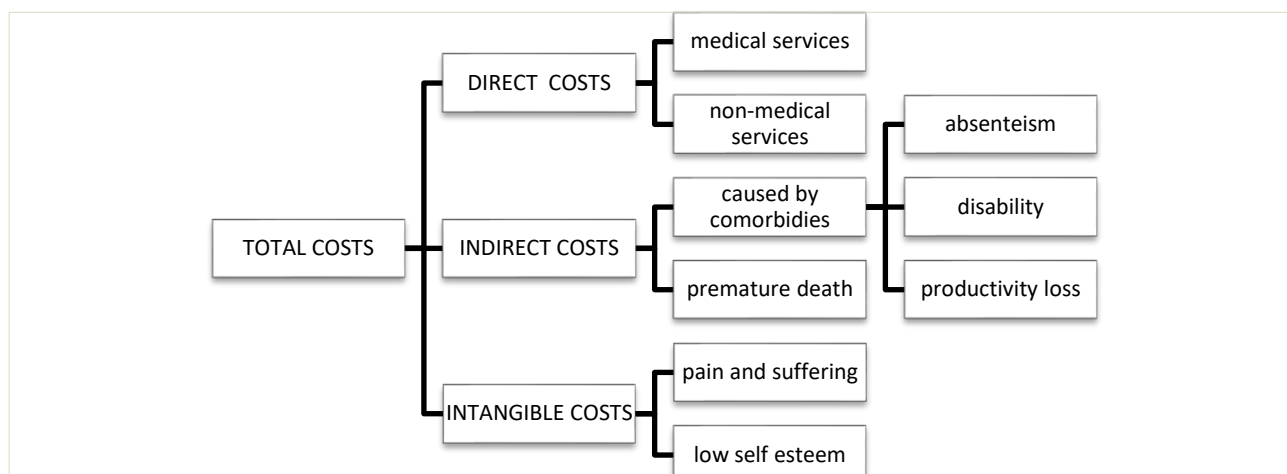


Figure 2. Components of cost analysis

Increasing number of overweight population is also accompanied by a hidden burden of intangible costs caused by low productivity.

To date, to our knowledge, there have been no studies linking the effectiveness of HIIT in influencing body composition to the impact of the costs that subjects must bear to maintain their health during the program.

We observe a significant difference between theory and practice both in the literature which, based on scientific studies, documents morpho functional evolution in all aspects, but especially in everyday life, in which we encounter, or should we identify the "results" of the aforementioned studies. More specifically, between what we know and should apply, from a practical point of view, to reduce the risks of illness caused by a sedentary lifestyle and especially by unhealthy eating habits (Rosenblat et al., 2020; Teixeira et al., 2023).

Study participants

Students of physical therapy faculties are considered role models for their future patients in terms of body image and physical condition (Elboim-Gabyzon et al., 2020; Black et al., 2012). On the other hand, recent research has shown that, due to the limitation of the possibilities of practicing physical activities, the pandemic caused by COVID-19 was a determining factor for the increase in BMI (Bakaloudi et al., 2022; Yang et al., 2020).

Given the profile of the participants, we considered referring to fat mass because, in certain situations, such as in performance athletes and bodybuilders, an increased BMI does not directly correlate with their health due to increased muscle mass that can falsely increase their BMI (Weir, 2022).

Thus, our study was carried out between September 2023 and May 2024 on a group of students at the Faculty of Physical Therapy within UNEFS, identified in a preliminary study (previously conducted) as overweight. An important argument for the use of this group of participants for our study is the fact that UNEFS students go through an evaluation of their effort capacity when enrolling for studies in the institution, which makes them suitable for the means proposed in our approach.

In order to preserve the homogeneity of the group, we have established the following inclusion criteria: age 19-28 years, BMI ≥ 25 kg/m², adipose tissue percentage $\geq 25\%$ in men and $\geq 32\%$ in women.

A total of 10 students met the conditions for inclusion. The somatic characteristics of the students who met the inclusion conditions are illustrated in Table 1. Participant characteristics (mean \pm standard deviation).

Table 1. Participant characteristics (mean \pm standard deviation)

<i>Parametric</i>	<i>Female</i>	<i>Male</i>
<i>Sex (N= F/M)</i>	2	7
<i>Age (Y)</i>	20 \pm 0	20 \pm 0.66
<i>Height (M)</i>	1,62 \pm 0.02	1,80 \pm 0.50
<i>Mass (Kg)</i>	81 \pm 3.00	106 \pm 12.39
<i>Fat Mass (%)</i>	40.34 \pm 4.32	38.78 \pm 3.24

During the intervention, the participants were not under the influence of drug treatment and the level of physical activity outside the exercise program submitted to the study was at the same parameters as before the initiation of the program.

Methods

In order to classify the information on the effectiveness of HIIT programs and data on the costs caused by excess weight, as a first phase of the research we started a bibliographic study, disseminating information found in the specialized literature, both nationally and internationally. At the same time, the information found allowed us to establish the means that can be used by the participants in the study, in accordance with the equipment they have and their possibilities of time allocated for the program.

Before initiating the intervention program and the initial measurements, the subjects were informed about the program they were going to carry out and pilot sessions were carried out to familiarize themselves with the tasks they had to perform.

Considering the profile of the participants in the study, being students of the Faculty of Physical Therapy, we benefited from their openness and perseverance to carry out the program, which allowed an efficient collaboration and the collection of genuine data.

In carrying out the research, we also benefited from the help, information and advice of the UNEFS teaching staff and the specialized staff of the research laboratory within the "Dr. Alexandru Partheniu" Interdisciplinary Research Center of the University.

In order to achieve the objectives of the study, we used:

Anthropometric measurements of selected subjects to determine indices to which excess weight is related (weight and height measurement, measurement of skin folds for the application of the caliper method);

Functional measurements aimed at determining heart rate (HR) and VO_2MAX ;

The method of tests to determine the intensity of the workout at which fat burning is maximum (POLAR, AEROSCAN).

All evaluation methods were carried out with the granting of informed consent and consent to the processing of personal data and were carried out within the Center for Interdisciplinary Research "Dr. Alexandru Partheniu" of the National University of Physical Education and Sport (UNEFS).

To calculate the reference indices of excess weight, using the same instruments and conditions, we performed a series of anthropometric measurements:

1. Body height (H - cm) – was measured between the vertex and the plane of the plants with the help of the U-Grow UHM-001 model thalometer.

2. Body weight (G - kg) – was measured with the Omron scale, model 201801-00273F.

3. The triceps skinfold (mm) was measured with a caliper on the posterior aspect of the arm, vertically, halfway between the acromial and radial points (acromion and olecranon); the subject's hand is positioned in supination.

4. The subscapularis skinfold (mm) – is oblique downwards and laterally to the inferior angle of the scapula and was measured with a caliper at 1 cm from it, at an angle of 45° to the horizontal.

Thus, we were motivated to use a complex method for measuring fat mass indirectly. In this regard, we have gone through several steps:

Using the caliper method, we measured two skin envelopes (triceps and subscapular);

With the help of the formula proposed by Nagamine & Suzuki we calculated body density;

Based on body density, with the help of Siri's formula, we calculated fat mass.

For each subject, the following were measured:

Body height (H - m), body weight (G - kg), triceps fold (mm), subscapular fold (mm);

With the help of anthropometric parameters, we calculated the body density according to Nagamine & Suzuki's formula:

Body density = $1.074 - 0.0005322 (\Sigma 2 \text{ skinfolds}) - 0.0009603 * \text{BMI}$, where

$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 \text{ (m)}$

Fat mass was calculated based on body density, using Siri's formula:

$$\% \text{ body fat} = \left(\frac{4.95}{\text{body density}} - 4.5 \right) \times 100$$

The maximum exertional heart rate (HR max) was calculated using Åstrand's universal formula:

$\text{max HR} = 220 - \text{age}$

The maximum oxygen consumption was calculated with the following formula:

$$VO_2MAX = \text{exercise HR} - \frac{\text{resting HR}}{\text{max HR}} - \text{resting HR}$$

For adults, if the BMI exceeds 25 kg/m^2 , the subject is considered overweight, and if the BMI exceeds 30 kg/m^2 , the subject is considered obese.

The correct diagnosis of obesity must be made based on the study of body composition, we cannot refer only to BMI, since "the human body is a complex dynamic system, made up of subsystems with very different structure, chemical composition and density, maintained in constant proportions and functionally integrated." (Cordun, 2009).

Body composition refers to the size and distribution of structural components, specific to the human body, which sum up the total body weight. The assessment of body composition most commonly uses the physiological model, with two compartments, in which the human body is systematized into fat mass and non-fat mass.

As for the optimal average values for body fat percentage, they differ according to gender, in general women need a higher fat mass (Ogden et al., 2013; De Lorenzo et al., 2016). Considering the study participants, in their age category, the normal values of body fat percentage are at a maximum of 25% for men and 32% for women.

The intensity of the effort that allows us to identify the priority energy chain is expressed by heart rate indicator (HR), oxygen consumption, perception of effort. The maximum exercise HR is variable and is established based on the theoretical maximum HR. Oxygen consumption is low at rest and increases progressively with the intensity of the effort. The maximum amount of oxygen taken from the lungs, transported and then diffused to the muscles during physical exertion is expressed with the help of VO_2MAX .

The Aeroscan test, by measuring respiratory volume, respiratory rate and oxygen absorption and CO_2 emission, allows the analysis of respiratory gases during exercise. Thus, it shows how the metabolism reacts to different intensities of effort and provides information for determining the exact range of intensity of effort in which fat burning is maximum.

In addition to the measurements presented, the testing with the help of the Aeroscan device allowed the evaluation of the aerobic energy pathway and the establishment of the exercise zones in which fat burning is maximum. At the same time, this testing confirmed the efficiency of the program also from a cost perspective, since until this stage of the program no means of any cost were used. The test protocol consisted of treadmill running on effort stages, starting at 6 km/h and constant loading at 1km/h, until reaching a maximum peak of aerobic possibilities (Figure 3. Testing with the Aeroscan device).



Figure 3. Testing with the Aeroscan device

In socio-human studies, the questionnaire-based survey is the most commonly used method as it is an effective means of collecting data in an experiment and highlighting aspects of social facts as well as the factors that determine them. Being a sociological research technique, the questionnaire survey method lends itself to the level of the subjects included in our study.

Our study benefited from the application of a standardized and validated questionnaire for our country: European Quality-of-Life-5D (EQ-5D-5L). This is a research tool developed by a multidisciplinary team of the EuroQol group, used in multiple studies that have a component of assessing quality of life in relation to health status, especially in the clinical and economic evaluation of healthcare (Greiner et al., 2003; Rabin & De Charro, 2001; Van Hout et al., 2012). EQ-5D-5L has also been used in Romania, in clinical trials (Olariu et al., 2022).

The questionnaire was self-administered by the participants. It assesses 5 dimensions of health status: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each size has 5 levels of operation: no problems, mild problems, moderate problems, serious problems, and incapacitated. The tool also includes a visual analog scale (EQ VAS) in which health is rated from 0 (worst health imaginable) to 100 (best imaginable health).

The inclusion of the cost component in our study was done by adding a question at the end of the EQ-5D-5L regarding the subjects' expenditure level for maintaining/improving their health.

In the time interval September 2023 and May 2024, the subjects went through a HIIT-type exercise training program, three times a week, with the following structure:

Execution time 30 seconds, 3 sets of each exercise;

The aim was to do a maximum number of repetitions in 30 seconds;

Rest time was adapted periodically to the exercise program, initially it was 60 seconds;

The exercise program had the following sequence:

Starting from the standing position, will step on a higher surface (stepper) with each leg alternating for 30 seconds.

Starting from the prone position, will execute push-ups for 30 seconds, with support on the palms and forefeet.

Starting from the standing position will execute squats for 30 seconds, the feet are set apart with the tips pointing outwards, the elbows in flexion with the fists close to the midline.

Starting from the supine position, will execute crunches for 30 seconds. The knees at 90 degrees angle, foot support on the entire sole, elbows flexed and palms at the level of the occipital area.

Starting from the high plank prone position, with support on the palms and forefeet, elbows in extension, the neck and spine in alignment, will execute mountain climbers by bringing the right knee across the body to the other side, toward the left elbow, return to the high plank position and repeat with the other knee. Repeat for 30 seconds.

Starting from the supine position with the knees flexed, feet flat on the floor, elbows extended and palmar face facing the ground, execute glute bridge: pushing from the heels bring the hips up to create a straight diagonal line from the knees to shoulders. Then slowly return to the starting position, without dropping the body to the floor. Total execution time is 30 seconds.

Starting from the standing position, the feet at shoulder-width apart, toes facing forward, elbows flexed and the hands lightly grasped to the midline. Will take a step forward and then execute squat down until the back knee almost touches the floor. The front knee will be at 90 degrees angle. Will return to starting position and repeat with the other leg. Total execution time is 30 seconds.

During the course, the exercise program was adapted to irregular time intervals, determined by the subjects' ability to adapt to the demands of the applied means. To determine the intensity level, we referred to Åstrand's universal formula described in 2.4. Thus, we developed 3 programs per level that we applied successively:

Work-to-break ratio 1 to 2 (30 seconds/60 seconds);

Work-to-break ratio 1 to 1 (30 seconds/30 seconds);

Work-to-break ratio 1 to 0.5 (30 seconds/15 seconds).

To process the collected data, we used descriptive statistics provided by REDCap and the Statistical Package for the Social Sciences (SPSS) program. As could be expected, the small sample in this study did not result in normally distributed data. For pragmatic reasons however, results were presented as means and the 95% confidence intervals. The cost data were collected using the questionnaire and were estimated based on the values entered by the participants in the questionnaire, then processed with REDCap.

To understand the strength of the relationship between two continuous or ordinal variables that have extreme values, a non-parametric measurement is used that involves calculating the Kendall-Tau coefficient:

$$\tau = \frac{C-D}{C+D} \text{ where:}$$

(C) represents the number of matching pairs;

(D) represents the number of discordant pairs.

The Kendall-Tau correlation coefficient results in values from 0 to 1, where: 0 is not a relationship, 1 is a perfect relationship.

The Paired Sample Correlated T-Test is a statistical test used to determine whether two paired datasets are significantly different from each other. The variables should be continuous, normally distributed, and have a similar dispersion between the two data sets. Also, the two datasets should be paired and there should be enough data (more than 5 values in each set). Interpretation of the test: $p < 0.05$ (or $p < 0.01$), then the difference between the means is statistically significant; $p > 0.05$ (or $p > 0.01$), then the difference between the means is random.

Results

The study participants have an average age of 20 ± 0.6 years, and in terms of height, the average height is 1.76 ± 0.08 m (1.80 ± 0.50 m men and 1.62 ± 0.02 m women) and an average weight of 101 ± 15 kg (106 ± 30 kg men and 81 ± 3 kg women) as shown in Figure 4. The values obtained for height (m) and weight (kg) for the subjects participating in the exercise program.

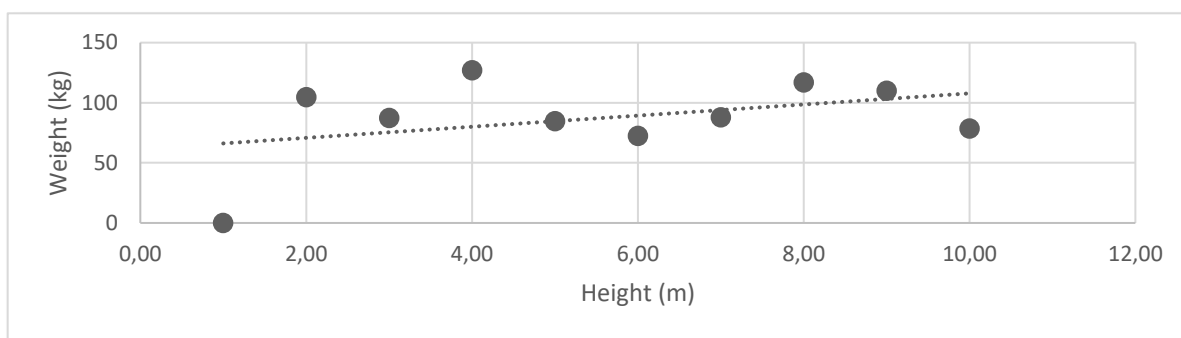


Figure 4. The values obtained for height (m) and weight (kg) for the subjects participating in the exercise program

Regarding body composition, the distribution of fat mass in relation to lean mass is illustrated in Figure 5. Body composition of the subjects participating in the training. On average, the fat mass is 39.76 ± 8.21 kg (41.49 ± 12.44 kg in men and 32.80 ± 4.71 kg in women). Lean mass is 61.34 ± 7.96 kg (64.63 ± 17.66 kg in men and 48.20 ± 1.71 kg in women). The percentage of adipose tissue is represented in Figure 6. Body fat (%) of the subjects participating in the training and had an average of $38.73\% \pm 3.65\%$ ($38.56 \pm 11.20\%$ in men and $39.43 \pm 4.22\%$ in women).

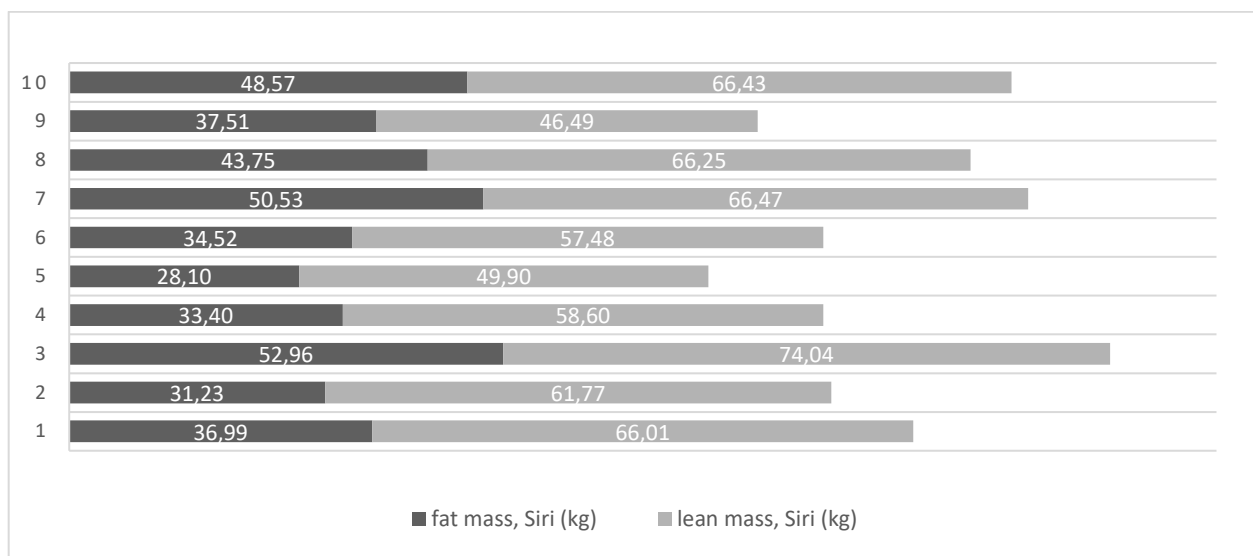


Figure 5. Body composition of the subjects participating in the training

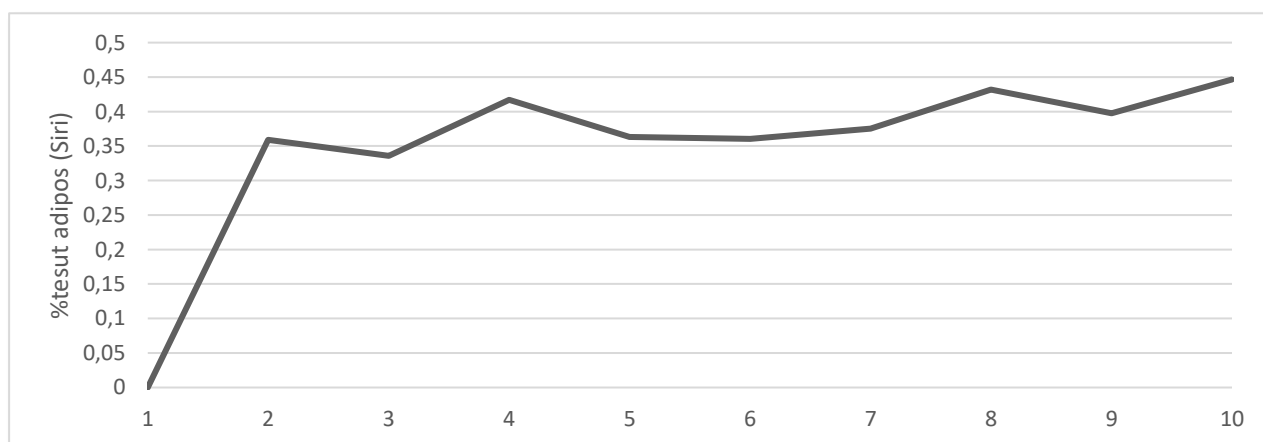


Figure 6. Body fat (%) of the subjects participating in the training

Testing with the help of Polar and Aeroscan devices allowed the collection of data that facilitates the programming of the effort on intensity intervals. The summary of the values recorded with the help of the Polar device are represented in Table 2. Heart rate values during exercise measured with Polar:

Table 2. Heart rate values during exercise measured with Polar

Participant	Absolute values		Percent	
	Mean HR	Max HR	Mean HR	Max HR
1	148	185	74%	93%
2	126	160	63%	80%
3	170	186	85%	93%
4	153	192	77%	96%
5	159	187	80%	94%
6	158	178	79%	89%
7	157	180	79%	90%
8	175	199	88%	100%
9	156	174	78%	87%

The values recorded with the help of the Aeroscan device show that at an average heart rate of 167 bpm the average caloric consumption is 245 kcal/h (Figure 7. Energy consumption with lipid oxidation).

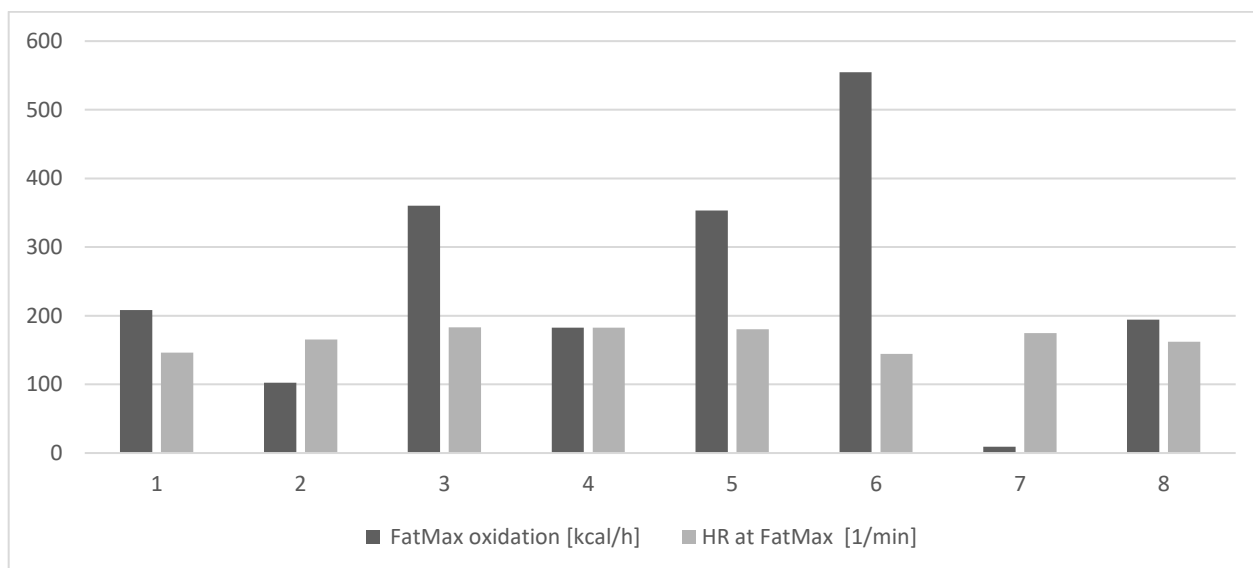


Figure 7. Energy consumption with lipid oxidation

Regarding the costs for maintaining health, the reported values are illustrated in Figure 8. Distribution of financial costs for maintaining health, on average the direct costs were 1750 ± 1610 RON (2038 ± 1591 RON for men and 600 ± 100 for women). The indirect costs were on average 810 ± 906 RON (963 ± 540 RON men and 200 RON women).

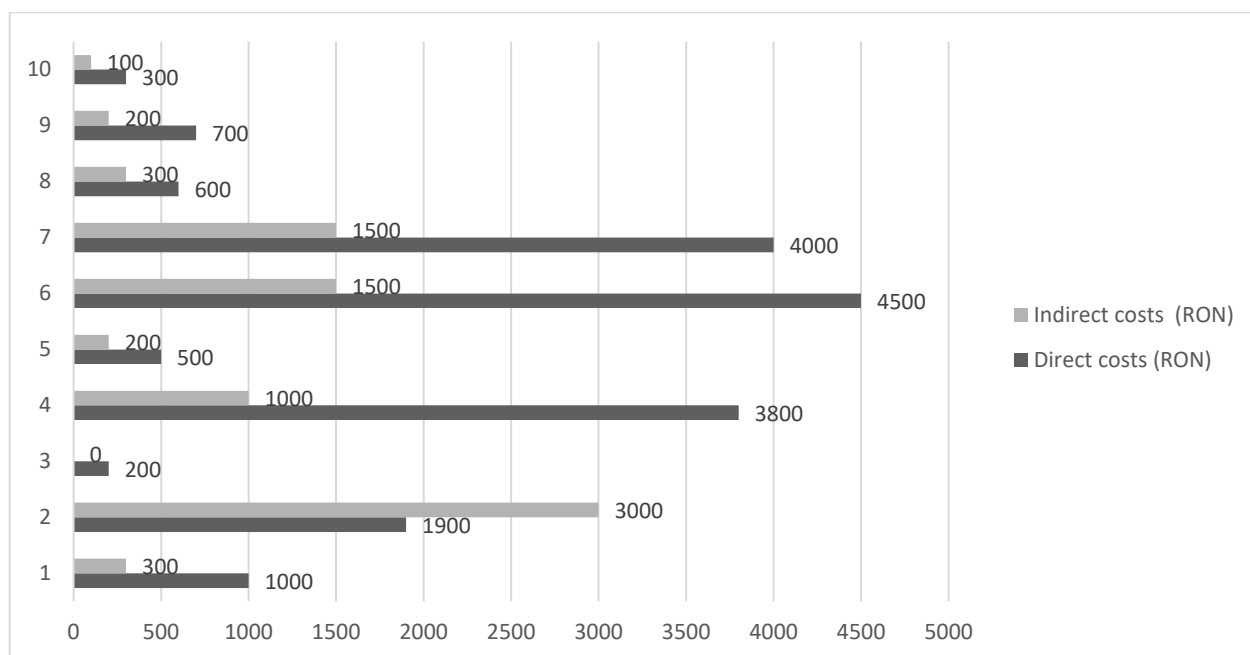


Figure 8. Distribution of financial costs for maintaining health

Following the analysis of the proposed training program, the subjects showed improvements in body mass (Fig. 9), in the sense that the mean values for the percentage of adipose tissue decreased by $0.19 \pm 0.43\%$, fat mass by 0.69 ± 1.56 kg and lean mass by 1.81 ± 1.51 kg, differences statistically confirmed with the correlated T test ($p = 0.21$), the values recorded being strongly correlated (Pearson = 0.99).

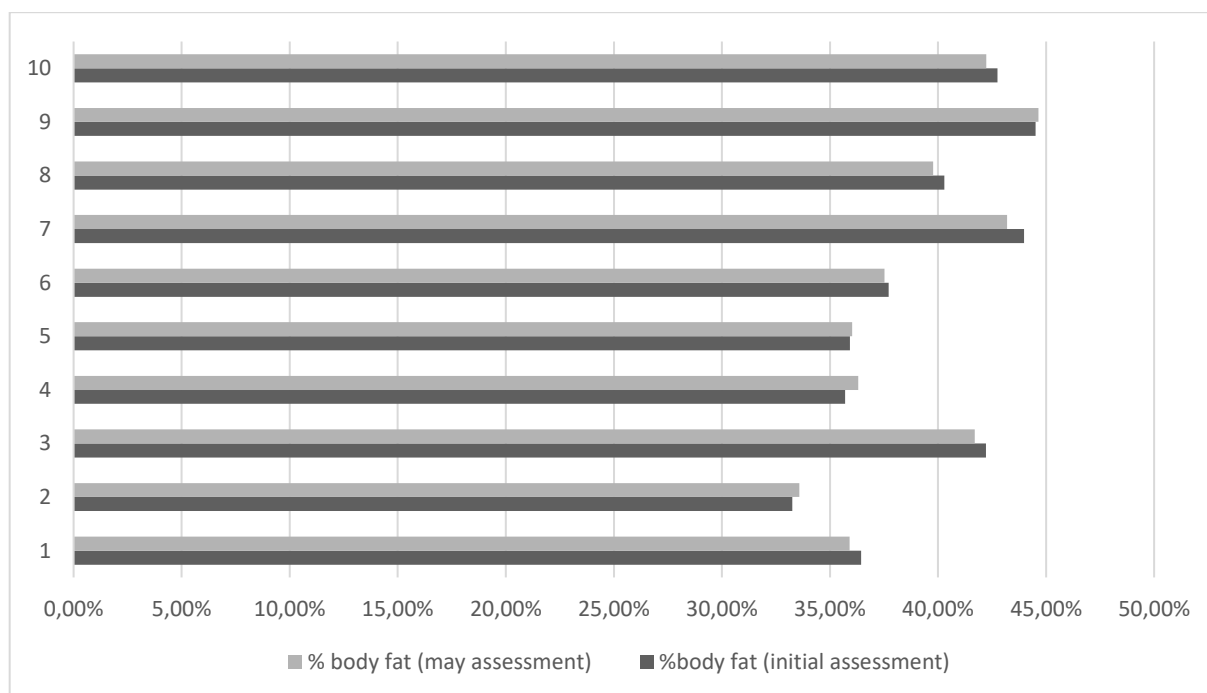


Figure 9. Adipose tissue (%) of the subjects participating in the training

The dissemination of the answers regarding the costs that the participants have to maintain/improve their health allowed us to quantify the financial effort, this time.

From the data processing, we found that Direct monthly expenses are in a week positive correlation with indirect monthly expenses, also medical expenses represent an important financial effort for the participants. (fig. 10). Since the analyzed variables are continuous but have extreme values, the correlation was calculated using the Kendall-Tau coefficient which is 0.63, with a statistical significance $z = 0.5$.

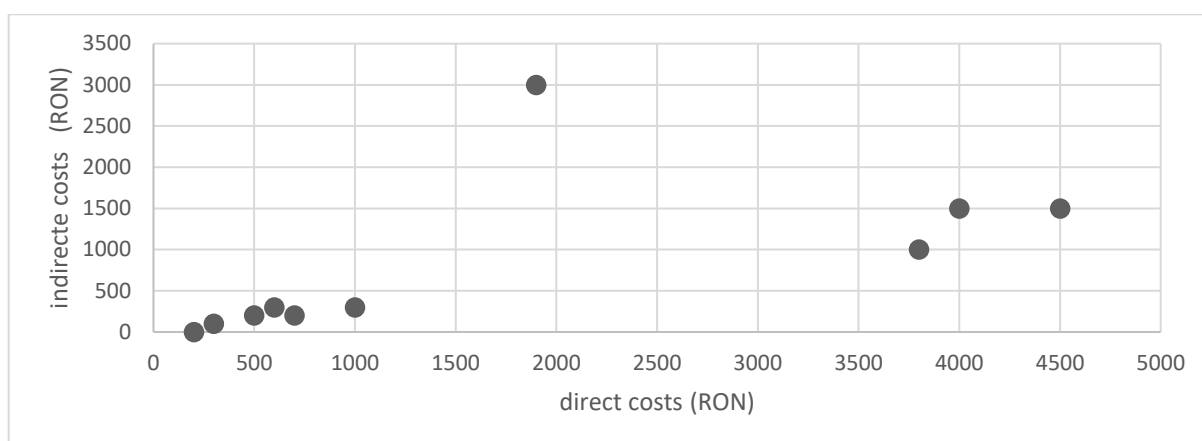


Figure 10. Correlation of direct and indirect costs for maintaining health

The intangible costs of maintaining health were assessed using the EQ-5D-5L questionnaire. The summary of the answers to the questionnaire is presented in Table 4. Intangible costs of maintaining health by coding for mobility, care, pain, depression with values from 1 to 5, where 1 represents the best grade and 5 the worst grade and values from 0 to 100, where 100 represents the best grade and 0 the worst grade for the perception of health status. 8 out of 10 students declare that they do not have pain or discomfort and that they do not feel restless or depressed. All of them declared that they have no problems moving, washing/dressing or performing their usual activities.

Table 3. Intangible costs of maintaining health

Mobility	Self Care	Daily Activities	Pain/ Discomfort	Restlessness/ Depression	Perceived Health
1	1	1	1	1	90
1	1	1	1	1	100
1	1	1	1	1	75
1	1	1	1	1	80
1	1	1	2	2	80
1	1	1	1	1	70
1	1	1	1	1	60
1	1	1	1	1	85
1	1	1	1	1	65
1	1	1	2	2	60

The average score given for the Health Status status perceived by the subjects is 76.50 ± 13.13 , the highest score awarded was 100 and the lowest was 60 (fig. 11)

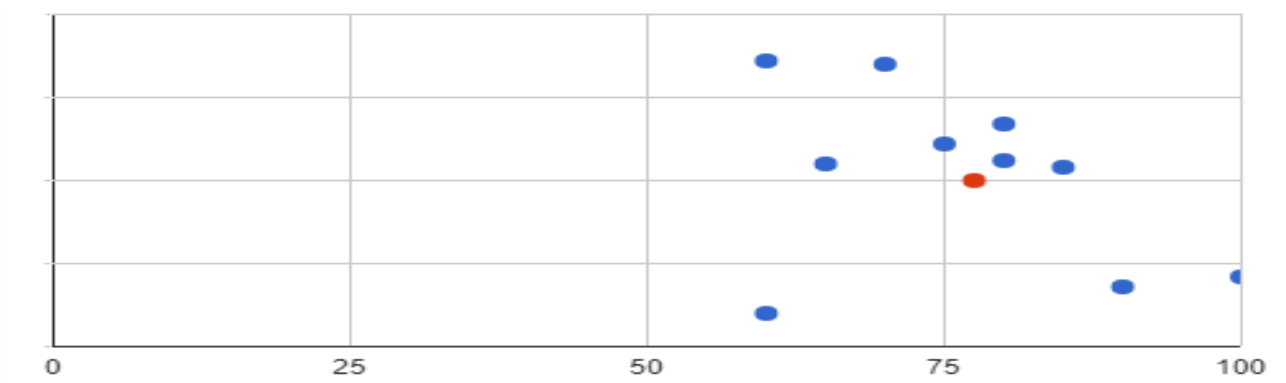


Figure 11. Perceived health status

Conclusions

Following the scientific approach carried out and the analysis of the data collected from the participants in the study, we can say that the research hypothesis has been confirmed. Also, the processing, interpretation and analysis of the evolution of the results obtained allowed the following conclusions to be drawn regarding the problem addressed:

The HIIT exercise program contributes to weight loss and fat mass.

Also, this type of training has a high degree of personalization and allows, based on the analysis of anthropometric indices correlated with the results of the tests with Aeroscan and Polar devices, to be adapted according to the effort area in which lipid oxidation is maximum.

The costs of maintaining health are high in overweight young people.

The program proved to be innovative because it does not require special equipment or location to be deployed, confirming the effectiveness both for improving body composition and for decreasing the costs necessary to carry out a body remodeling program.

The effectiveness of the program can be improved if its completion will be associated with diet and sleep hygiene.

We consider this study as an intermediate stage of our research, proposing in this regard to continue the administration of the HIIT program adapted to each individual. Also, the program will be extended and we will introduce new means respecting the principle of individualization. The data obtained are encouraging and consequently, we intend to publicize this program in the form in which it was covered by the subjects, in order to make it accessible to the general public.

Authors' Contributions

All authors have equally contributed to this study.

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