HIIT vs FATMAX
IN WOMAN WITH SEVERE OBESITY
A CASE STUDY

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ABSTRACT

Introduction: Obesity is a global epidemic that contributes to develop several health complications as cardiovascular disease, hypertension, type II diabetes, etc. In this line, bariatric surgery appears appears as a possible solution, but it implies a great surgical risk to patients. However, non-invasive methods as physical activity or diet, have shown to reduce the body composition and a healthy and health status without.
Aerobic exercise is beneficial in severe obesity, but the discussion about what kind of methodology is better to increase maximal fat oxidation (MFO)during exercise has lasted for a long time. The aim of this study was to compare the effects of high intensity interval training (HIIT) versus training at individual maximal fat oxidation intensity (Fatmax) on body composition, cardiometabolic risk factors and cardiorespiratory fitness in women with severe obesity.

Material and Methods: Two women with severe obesity (51.5±4.95 years, 36.85±1.63 $kg \cdot m^{-}2$) were distributed in two groups, HIIT (n=1) and Fatmax (n=1). Participants performed a training program that consisted of 12 weeks of isocaloric training prescription combined with nutritional intervention. The intensity of the HIIT group (HG) increased from 80% to 90% of VO_{2max}; the Fatmax group (FMG) trained at the intensity of individual MFO was produced. Before and after three months of intervention, we assessed anthropometrical and blood pressure measurements after overnight fast, and cardiorespiratory fitness level and MFO during exercise with a protocol in cycle ergometer. Blood sample analyses were provided to analyse cardiometabolic risk factors.
Key Words: Overweight, Severe Obesity , HIIT, Fatmax, Maximal fat oxidation, Isocaloric Prescription, hypocaloric diet.

INTRODUCTION

The accumulation of excess body fat, obesity, is a significant and rapidly increasing global health issue. More than 39% of adults were considered overweight (BMI > 25 kg/m^2) and 13% considered obese (BMI > 30 kg/m^2) in 2014, and the prevalence of overweight and obesity has doubled globally since 1980 (Finucane, 2011). This illness cases health problems because the people who suffer it have got a high risk of suffer diseases like hypertension, cardiovascular risk, type II diabetes, etc. (Shetty & Schmidhuber, 2006). The bariatric surgery appears as a possible solution for people with BMI above 40 kg/m^2 and associated with comorbidities such as diabetes (type II), hypertension or cardiovascular risk (Brolin, 2002; Rubio, 2004), but, other methods to reduce the body weight and achieve a healthy condition such as follow medical treatment, including medicine intake, diet, but also become active people (Narayanaswami, & Dwoskin, 2017) can help them.

The regular practice of physical activity may get health benefits like improve cardiometabolic risk factors and quality of life (Tsigos, 2008). The improve of physical fitness (ability to carry out daily tasks with vigour, without fatigue and with ample energy to enjoy the free time and to meet unforeseen emergencies) has been show important to improve as it is associated with a reduction in cardiovascular risk and premature mortality in obese individual (Lee, 1999; Fogelholm, 2010).

Recent studies focused in the adaptive effects of the high-intensity interval training (HIIT) bouts (Talanian, 2007; Perry, 2008), have reported better results that moderate-intensity continuous training (MICT) about the muscle metabolism improvements, weight loss and cardiovascular status which results in important improvements of muscle metabolism. Several studies have suggested high-intensity interval training (HIIT) yield more favourable results in weight loss, metabolic and cardiovascular status (Rakobowchuk, 2008; Tjonna, 2008; Tjonna, 2009; Wisloff, 2007).

Moreover, HIIT requires less time for session and it is perceived to be more enjoyable, serving as a stronger driver of exercise participation and adherence (Gaesser, 2011).

However, there is more scientific evidence about MICT than about HIIT (Chudyk, 2011), which is easier to apply at low intensity in very sedentary patients in whom strenuous exercise is poorly tolerated and even potentially harmful (Perri, 2002), and furthermore, this type of exercise recommended to improve body composition, cardiorespiratory fitness, insulin resistance, and lipid profile (Donnelly, 2009).

In order to optimize the results with low-intensity exercise, it would be necessary to improve efficiency focusing on the concept of maximal lipid oxidation during muscular activity (Brun, 2012).

During steady-state exercise performed at low intensity, there is an intensity of exercise than elicits the maximum oxidation of lipids which has been termed FATmax (maximal lipid oxidation at exercise) (Achten, 2002). FATmax has been used as a target for individualized training. When low-intensity endurance exercise is performed (associated to diet) with well-coached protocols at the FATmax (Brun, 2011) or at 40% VO_{2max} assumed to target this zone (Lazzer, 2011), as a generalization if we can’t obtain the intensity associated with FATMAX, it is efficient for weight loss. This is what studies do, such as Lazzer (2011), where after 2 months with an obese adolescent they lost 7.5 kg of fat mass.

Compared to high-intensity exercise, obese adolescent had lost twice more fat (Lazzer, 2011). In the Brun's metaanalysis on FATMAX training showed greater losses of fat mass when training in Fat_{max} was used as an objective (weight decreased by –2.9 kg [95% confidence interval (CI): –4.1; –1.7]. Fat mass decreased by 1.73% (95% CI 1.82-1.64).

Following the same line another meta-analysis of 16 Fat_{max} training studies showed that 3 or 4 weekly sessions of 45 minutes cycling at the Fat_{max} results in a weight loss off -2,9 kg which is at least as efficient as the various protocols studied in the literature (Thorogood, 2011).

Therefore, the objective of this study is to compare the effects of Fat_{max} and the HIIT impact on weight loss, fat mass and quality of life in people with morbid obesity. Our hypothesis will be that training methodology through the Fat_{max} will obtain greater improvements than the training through the HIIT.

METHODS

Patients

Two woman with severe obesity (>35 kg/m^2) were recruited as inpatients from the *General Hospital*, where they followed a lifestyle education program. This program included phychological and nutritional follow-up. The criteria for inclusions in this program were 1) have a higher BMI than 35 kg/m^2, 2) claim that they are inactive subjects and do less 1h a week of physical exercise a week and 3) age between 35 and 55 years old. An other hand, exclusion criteria were 1) have respiratory diseases, 2) heart diseases, 3)reduced mobility, and 4) hypothyroidism. The protocol was in accordance with local legal requirement and the Helsinki Declaration for research on humans beings, and approved by the Ethical Committee of University Miguel Hernández. Their general characteristics are presented in Table 1.

Table 1. *Participant Characteristics*

Group	**HIIT**	**FATmax**
Age	55	48
Stature (cm)	158	163
Body mass (kg)	89.1	100.9
BMI (kg/m^2)	35.7	38

All values are mean ± SD. Range in brackets
BMI, body mass index.

Experimental Design

The patients were assigned to two training groups [Fat_{max} group (GFM: n = 1); HIIT group (GHIIT: n = 1)]. All subjects completed an adaptation period of 3 days/week during 1 week. Then, both groups started the program of 12 weeks duration with 3 sessions per week. The intensity varies according to the training group. The GFM performed continuous power intensity with a maximal fat oxidation (MFO). The intensity of the GHIIT varied from 80% to 90% vo2peak with active recoveries at 30% peak power out (PPO). Two readjustments of training loads were made. The first one was after the first 4 weeks a readjustment of the training loads of all the patients was made and the second after 8 weeks.

Evaluation

Anthropometric measurements

Weight and height were measured following standardized recommendations using an electronic scale (bc-420ma, TANITA, Tokio, Japan) and a stadiometer. The two measurements, weight and height, was used to calculate the body mass index (BMI) as the weight in kilograms divided by the square of the height in meters (kg·m^{-2}). Waist circumference (WC) was determined taken with flexible tape at the waist (at the midpoint between the las rib and the iliac crest) (Marfell-Jones, 2012) three times and doing the average of those measures. The body fat and the fat free body was measurement by a bioimpedance. Percentage EWL was calculated according to the formula: EWL = [body weight (BW) before − BW after]/excess BW before, where excess BW = total BW − ideal BW. Ideal BW was calculated following the guidelines of the American Society for Bariatric Surgery Standards Committee (Oria, H. E.,2005).

Cardiorespiratory fitness

Subjects performed two maximal incremental test to exhaustion on a cycle-ergometer (Tecnogym US corp., Seattel, EEUU) to determinate VO_{2peak} with gas analyser Master Screen CPX (Jagger, Friedberg, Germany) and HR_{peak}, with Polar Heart Rate sense H7 fi-90440 Kempelet, Finland, during each of the following tests: 1) a maximal incremental ramp test with a short time duration (8-12min) (S_{test}) in the first session, and 2) a maximal incremental test with a longer time duration (20-25min) (L_{test}).

Maximal incremental ramp test with a short time duration (S_{test}). The S_{test} was performed in the morning and fasting. First the patients made a 30-min rest period, later the subjects started with a 5-min warm-up at 40W. after warm-up, the power output (PO) was linearly increased by 20W every minute until exhaustion, which was determined by the inability to maintain a minimum pedalling frequency (60 revolutions per min.) (Lanzi, 2015).

Maximal incremental test with a longer time duration (L_{test}). The L_{test} was performed in the morning after a minimum of two days following the Stress test. This test was performed in fasted state in order to determine to determine the substrate oxidation. After a standardized 10-min warm-up at 20% peak power output (PPO) reached during Stress test, the PO was increasing by 10% PPO every 5 min until reaching 70% PPO, or until RER reached 1.0. At this point, PO was increasing by 15W every minute until exhaustion as previously defined (Lanzi, 2015).

Training Programme

Both group carried out the ergometer cycle training program, 3 sessions per week for 12 weeks, and their heart rate was checked at the same time the session was done. At the end of the session the perception of effort was recorded with the Borg scale.

The volume of the training session was determined by the isocalories that should be consumed weekly according to the weight. The isocalories consumed weekly during the entry and its progression were the same for each group. The increase in isocalories consumed weekly increased every week except from the 4th week to the 6th week, from the 9th to the 10th week and from the 11th to the 12th week where they were maintained (table2). In week 4 and 8 the tests were carried out to check if it had been improved because of the training and thus readjust.

In the HIIT group, the intensity evolved every month from 80% to 90% $VO2_{peak}$ (corresponding in watts) and, therefore, the heart rate also evolved from 80% to 90%. The first month they made 2 blocks with 1 minute of recovery between blocks. The stages were from 30 seconds to 80% with active recovery from 30 seconds to 30% of peak VO_2. In the second and third month the stages were a single block of 30 seconds of work with 30 seconds of active recovery.

With the Fat_{max} group he made only one block of Fat_{max} intensity (individualized for each subject), corresponding in watts, 3 times a week. The intensity did not follow any progression, but it was readjusted in weeks 4 and 8.

Table 2. *Exercise protocol data and the week time commitment*

VARIABLE		HIIT GROUP	FAT_{max} GROUP
Protocol	1^{st} Month	2 x (NSx30s/30s); 1 min recovery	SV (1xD)
	2^{nd} Month	NSx30/30s	SV min (1xD)
	3^{rd} Month	NSx30/30s	SV min (1xD)
Frequency		3 sessions per week	3 sessions per week
Workload (W)		Interval: 80-90% VO_{2peak} (correspondent in W) Recovery: 20±10% VO_{2Peak} (correspondent in W)	%VO_{2peak} Fat_{max} (correspondent in W)
HR (bpm)		Interval: 80-90% HR_{peak} Recovery: 40±5% HR_{peak}	%HR Fat_{max}
Isocaloric prescription (Kcal/kg/min weekly)	1^{st} week	4.5	4.5
	2^{nd} week	7.1	7.1
	3^{rd} week	9.7	9.7
	4^{th}-6^{th} week	9.7	9.7
	7^{th} week	11.1	11.1
	8^{th} week	12.5	12.5
	9^{th}-10^{th} week	12.5	12.5
	11th-12th week	13.9	13.9

Abbreviations: HIIT, High intensity interval training; Fat_{max}, maximum fat oxidation; NS, number step; SV, session volume; D, duration; s, seconds; min, minutes; VO_{2peak}, peak oxygen consumption; W, watts; HR, Heart rate; bpm, beat per minute

Nutritional Intervention

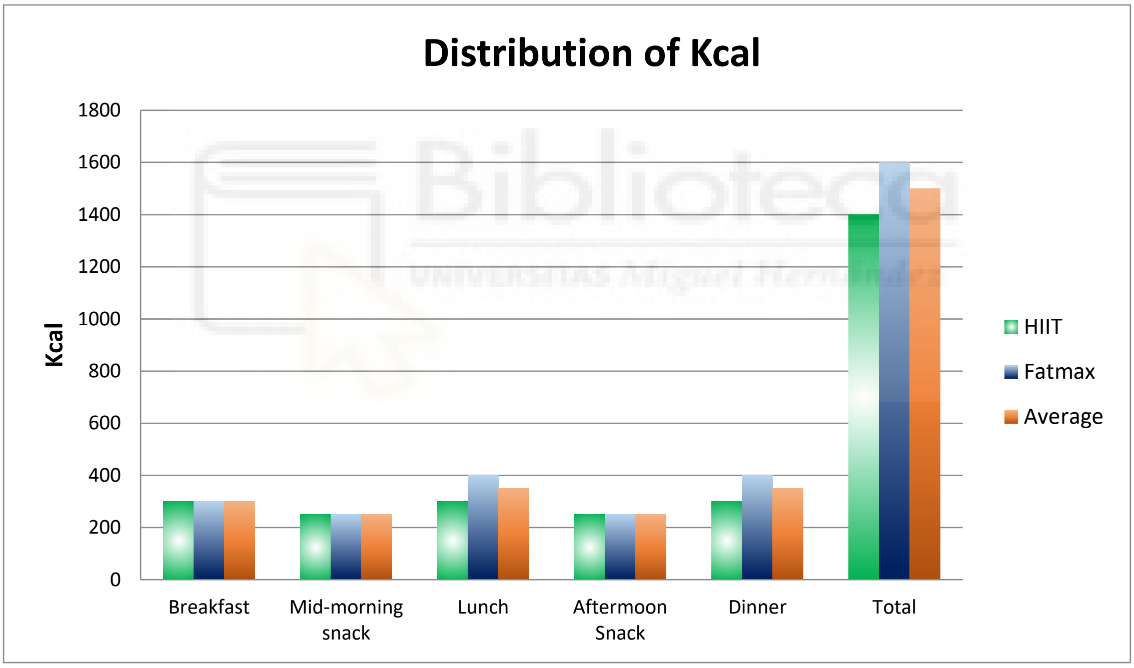
The study performed with bariatric surgery patients carried out a nutritional intervention with both groups, GHIIT and GFM.

Caloric expenditure was estimated and divided into 3 components: resting metabolic rate, physical activity expenditure and thermic effect of feeding. Resting metabolism was obtained through a basal test that consisted of a 30-minute record. The data on physical activity were extracted from an accelerometer that the patients took for 7 days and based on the activity of the accelerometer, the energy expenditure was quantified following the indications of Harris Benedict (Frankenfield, D., 2005). The thermal effect of food was estimated as the 7% of the sum of physical activity expenditure plus resting metabolic rate (Kalina R.M., 2015).

Several aspects were considered in the nutritional intervention: meal distribution during the day (table 3), moment of the application of calorie restriction for weight loss and diet composition in macronutrients and micronutrients.

The weekly caloric restriction was 30-40%, close to the basal metabolism and was carried out with a Mediterranean diet methodology adapted to the daily amounts of micro and macronutrients according to the Recommended Dietary Allowances (RDA) for Spanish women over 40 years. We also had control over hydration before, during and after the training session.

Diets were analysed and designed using Dietsource software (Novartis, Barcelona, Spain). Diets were adapted to each particular patient according to their analytics.



Statistical analysis

All data from the investigated period are presented as means ± standard divided into three tables. The analysis of results was made through a delta of change. All analyses were carried out in Microsoft Office Excel 2016 (Microsoft, Redmond, WA, United States).

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