RESEARCH ARTICLE

International Journal of
PHYSICAL EDUCATION, FITNESS AND SPORTS

DOI: 10.26524/ijpefs1826

Received 16th May 2018
Accepted 18th June 2018

www.ijpefs.com

Comparison of health benefits between a high intensity interval training and a moderate intensity continuous training when performed in a non-laboratory setting, in moderately obese women

Sophie Garnier [a, b], Sandra Joffroy [a, c], Cédric Hérédia [a, d], Denis R. Joanisse [e], Pascale Mauriège [e*]

[a] Faculté des Sciences du Sport et du Mouvement Humain, Université Paul Sabatier, 31062 Toulouse Cédex 9, France
[b] Groupe de Recherches en Activités Physiques Adaptées, Université du Québec à Montréal (UQAM), Faculté des Sciences Biologiques, Montréal, Qc, Canada H2X 1Y4
[c] Institut Toulousain d'Ostéopathie, 31670 Labège, France
[d] Espace Forme, 81100 Castres, France
[e] Département de Kinésiologie, Faculté de Médecine, Université Laval, Québec, Qc, Canada G1V 0A6
[*] Corresponding Author: Ph:(418) 656-2131 ext 7268; E mail: pascale.mauriege@kin.ulaval.ca

Abstract: The objective of this pilot study was to compare the effects of a high-intensity interval training (HIIT) and a moderate intensity continuous training (MICT) performed within a fitness center, on various health indices of 49 sedentary and moderately obese women (age 37 ± 7 years; BMI 32 ± 4 kg/m2) randomly assigned to supervised exercise on a cycle ergometer, 3 times/week, during 12 weeks, at 60% (MICT, n=24) or 85% (HIIT, n=25) of their heart rate reserve for weeks 5-12. Anthropometry, body composition, cardiorespiratory fitness, CRF (2 km-walking test estimated $\dot{V}O_2max$), quality of life, QoL (SF-36 Questionnaire), eating behaviors (Three Factor Eating Questionnaire, TFEQ) and perceived health (Short Health Perceived Questionnaire, SHPQ) were obtained before and after training from 10 HIIT vs. 13 MICT participants who completed the program. At baseline, both groups showed similar characteristics, except for a better sleep quality (SHPQ) in MICT than in HIIT participants ($p<0.005$). Increases in CRF (+3 to +5%) and decreases in body weight (-2%) and thus BMI (-2.5 to -4.5%), waist girth (-4%) and fat mass (-6 to -8%) were comparable ($0.0001<p<0.05$). The physical component score (SF-36), the cognitive restriction and hunger scores (TFEQ), and the perceived health items (SPHQ) were similarly improved, irrespective of the training mode ($0.01<p<0.05$). Twelve weeks of either HIIT or MICT led to similar body weight and fat mass losses as well as to comparable improvements in CRF, QoL, eating behaviors and perceived health, in healthy, sedentary and moderately obese women. However, the large dropout in the HIIT (58%; 14 of 24) and MICT (48%; 12 of 25) groups questions the implementation of such training programs within a non-laboratory setting. Further studies are clearly needed to better adapt the conditions of practice to subjects' characteristics and thus promote their long-term adherence to exercise.

Key Words: endurance training, fitness, body composition, quality of life, adherence

Sophie Garnier, *PhD Interventional Epidemiology in Physical Activity, Université Paul Sabatier (Toulouse, France). My research interests include aerobic activity, muscle quality, physical and mental health, and quality of life in young and old women. My research topic focuses on heath and exercise in the laboratory "Physical Activity and Health" led by Professor Pascale Mauriège from 2000 to 2002. With her team, I have developed a project entitled "Impact of an active walking program on the health of postmenopausal women" in collaboration with the French Federation of Physical Education and Voluntary Gymnastics. When Professor*

Mauriège moved to Canada, I still continued to work with her on this topic and more recently, I have been interested in the impact of physical activity on social inequities in health. Since 2014, I am collaborating on the thematics of sarcopenia, obesity and the promotion of active aging with Professor Mylène Aubertin-Leheudre (GRAPA, UQÀM, Montréal, Canada). Also, I am a formations' manager in fitness at Université Paul Sabatier.

***Sandra Joffroy,** PhD Biological and Medical Sciences, Université Paul Sabatier (Toulouse, France). From 2000 to 2002, I have participated to a project "Impact of an active walking program on the health of postmenopausal women" in the laboratory of Physical Activity and Health led by Professor Pascale Mauriège, in collaboration with the French Federation of Physical Education and Voluntary Gymnastics. As an elite swimming athlete, I pursued applied research of high-level training in sports swimming in connection with health. From 2005 to 2007, my research focused more on fundamental principles integrating the acquisition of new analytical techniques in the laboratory of Development Biology for the study of neurogenesis and psychomotility in current and fossil hominoids using ontogenetic, functional and neurological data (collaboration with researchers of MNHN and IPH, Paris). In 2009, I led a post-medical research protocol "Crossing the Atlantic in paddleboard, UCAR CAPODYSSEE, 2009. Briefly, since 2007, my research themes focused on physical activity and health, training - performance and biological evolution.*

***Cédric Hérédia,** MSc Physical Education, DEUST "Métiers de la Forme", Université Paul Sabatier (Toulouse, France). As a specialist in fitness and sport management, I have managed a fitness center in Castres (south west of France, near Toulouse) and also acted as a coordinator of the implementation of various training programs, since 2002.*

Also, I have been teaching the last decade physical activity at different levels of formation at the department STAPS of Université Paul Sabatier, during the last decade. More recently, I have been working on projects related to sports and health with Professor Pascale Mauriège and her colleagues (Sophie Garnier and Sandra Joffroy) since 2016.

***Denis R. Joanisse**, PhD, is a Full Professor in the Department of Kinesiology at Université Laval in Québec City, Canada. Prof. Joanisse's research focuses on skeletal muscle physiology and biochemistry in obesity, diabetes and athletic performance, mostly in humans but also in animal models. Specific interests are insulin resistance, skeletal muscle-adipose tissue cross-talk, and the effects of preconditioning and hypoxia on muscle function.*

***Pascale Mauriège** is Professor in the Department of Kinesiology at Université Laval in Québec City, Canada, since 2002. Her research focuses on adipose tissue physiology and biochemistry in obesity, metabolic syndrome and type 2 diabetes, mostly in humans but also in animal models. Her specific interests are adipose tissue lipid storage (enzymatic assays) and mobilization (in vitro lipolysis), its secretory characteristics (and more particularly inflammation), and the related cardiometabolic health (focused on lipid-lipoprotein profile and insulin resistance), as well as the effects of various training programs alone or combined with nutritional interventions on adipose tissue functions. More recently, she get interested in the field of adipose tissue-skeletal muscle cross-talk that she is developing with her colleague, Dr Denis R. Joanisse.*

1 Introduction

Epidemiological evidence supports the notion that both physical inactivity and obesity are associated with numerous risk factors for all cause-mortality and premature death, and more particularly, coronary heart disease in women [1, 2]. As the global prevalence of obesity continues to increase dramatically [3], it is thus of importance to find the most promising tools to fight against this pathology and its related co-morbidities. The World Health Organization has recommended at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity throughout the week to maintain CRF and to control for body weight and fatness in adults [4]. However, although MICT is known to promote benefits in terms of body weight and fat mass losses and CRF improvements, the impact of HIIT is still a matter of debate, mainly because of the protocols used and the cohorts examined [5]. While HIIT was shown to promote greater reductions than MICT in body fatness of young adults [6] as well as in subcutaneous leg and trunk fat of young women [7], this was not always observed. For example, body weight and fat mass were similarly reduced in obese individuals with metabolic syndrome, irrespective of the training protocol [8], while they decreased only in moderately obese women subjected to a MICT program [9]. Regarding physical fitness, participation in different forms of HIIT by healthy young adults and older patients, lasting from 2 to 15 weeks, resulted in significant increases in V;˙O_2 max ranging from 6 to 41 %, as reviewed in [5]. In this regard, similar [6, 7, 9] or higher [8] improvements in CRF were noted in non-obese or obese subjects with or without metabolic complications, after HIIT vs. a MICT program. Once again, these inconsistent V;˙O_2 max responses could be due to heterogeneity of the training protocols and/or the study populations. More recently, despite similar increases in CRF, HIIT was unable to reduce body fatness and android fat accumulation, when compared to MICT, in overweight adults [10]. Finally, although less studied in apparently healthy individuals than in cardiac or diabetic patients [11], health-related QoL is generally improved after training. However, only one study showed greater improvements in some components of QoL (SF-36) in obese adults subjected to HITT rather than to MICT [12]. Conflicting data also revealed significant improvements in appetite regulation after an HITT but not a MICT program in overweight men [13], but a similar decrease in energy intake in overweight adults irrespective of the training mode [10]. Changes in eating behaviors should be thus investigated to verify whether HIIT could provide a better dietary control than MICT.

Although the effects of HIIT seem to be promising compared to those of MICT [14], more studies are needed in order to find the most suitable exercise program for a given population. The first objective of this pilot study performed within a non-laboratory setting (exercise sessions undertaken in a fitness center) was thus to compare, in healthy, sedentary and moderately obese women, the benefits of 3 times/week, over 12 weeks of HIIT (25 min consisting of 10 intervals of 1 min each at 85 % of their heart rat reserve (HRR), for weeks 5-12) vs. MICT (35 min at 60 % HRR, for the same period as the one cited above) on body weight and fat mass losses as well as on CRF improvements. The second aim was to verify the effects of both interventions on the putative changes in QoL, eating behaviors and perceived health of our participants.

2. Methods

2.1 Participants

Prior to their enrollment in the study, all women provided a written informed consent and completed a health history questionnaire. Women had a physical examination by their personal physician and a medical certificate authorizing participation in a physical activity program. The study was approved by institutional review boards and was carried out following the principles of the Declaration of Helsinki. Healthy sedentary women, aged 37 ± 7 years, overweight to moderately obese (BMI of 32 ± 4 kg/m2) (mean ± SD) were recruited from the suburbs of Toulouse (France) to participate in a 12-week training program, through announcements in local newspapers. Recruitment was undertaken by the training centers involved in the study. From a total of 61 contacts, 49 met the following inclusion criteria: no known cardiomyopathy, endocrine disorders or orthopaedic limitations, sedentary (exercising less than 30 minutes per week), non-smokers, moderate to no consumption of alcohol and caffeine, and body weight stability (less than 2 kg weight change) in the year before the onset of the study. All participants were randomized into a 12-week MICT or HIIT program consisting of training on a cycle ergometer during 3 non-consecutive days per week. Of the 49 women who began the 12-week training program, 23 completed the intervention. Of the 26 subjects who dropped out or did not comply with the program, 14 were from the HIIT group and 12 from the MICT one.

2.2 Training programs

During each training session, heart rate (HR) was continuously measured with a heart rate monitor (Polar model FS1 type, Kempele, Finland) to ensure compliance with the required exercise intensity. Exercise intensity was calculated as a % of HRR estimated as maximal HR (220 - age expressed in years) minus the resting HR [15]. Warm-up and cool-down periods were incorporated into all training sessions as reported in [16]. Participants assigned to the HIIT program began with 6 intervals of 1 min each at an intensity that elicited 75 to 85 % HRR, separated by 1-min of low intensity recovery, while those assigned to the MICT program began with 15 min of continuous physical activity at 50 to 60 % HRR. The difficulty of both training programs increased progressively during the study period. For weeks 5-12 (*i.e.,* the majority of the intervention period), HIIT participants performed 10 intervals on a work: recovery schedule of 1 min: 1 min (Table 1). Time commitment per session which included a 5-min warm-up/cool-down, ranged from 17 to 25 min (HIIT) vs. 20 to 35 min (MICT). Total training time totalled 51 to 75 min/week for HITT and 60 to 105 min/week for MICT programs. Training sessions were performed either on the morning or the afternoon, as fed vs. fasted training does not alter the response of our primary outcomes (i.e., body composition and CRF) in the context of HIIT [17].

Table 1. Training programs

Weeks	MICT		HIIT		
	Intensity of exercise	Total duration of the session*	Number of repetitions 1 min/1 min	Exercise intensity	Total duration of the session*
1	50-60% HRR	20 min	6	75-85% HRR	17 min
2	50-60% HRR	25 min	6	80-85% HRR	17 min
3	55-60% HRR	30 min	8	80-85% HRR	21 min
4	60% HRR	30 min	8	85% HRR	21 min
5 to 12	60% HRR	35 min	10	85% HRR	25 min

HRR: heart rate reserve; MICT: moderate intensity continuous training, HIIT: high intensity interval training. * including warm-up (3-min) and cool-down (2-min).

2.3 Measures

Anthropometry, body composition, CRF (2 km-walking test), QoL (Physical and Mental Component Scores assessed through the SF-36 questionnaire), eating behaviors (restriction, disinhibition and hunger scores evaluated by the TFEQ), and perceived health (SHPQ) were determined on the morning, 5-7 days before the intervention and after the 12-week training program, 2-4 days following the last training session in order to avoid the acute effects of exercise.

2.3.1 Anthropometry, body composition and CRF

Body weight was measured to the nearest 0.01 kg using an electronic scale. Height was determined to the nearest 0.5 cm using a tape measure fixed to the wall, while participants in light clothing without shoes and in standing position looked straight ahead with their shoulders and buttocks against the wall, with feet joined and arms hanging loosely on both sides. BMI was calculated as the ratio of weight (kg) to height^2 (m^2). Waist girth considered as a crude index of abdominal fat accumulation was measured to the nearest 0.1 cm at the narrowest circumference of the trunk, using a graduated flexible tape when subjects were in standing position. Fat mass and lean mass were measured by a standard bioelectrical impedance technique (Bodystat 1500, Isle of Man, UK). Anthropometric and body composition measurements were performed in triplicate, and then averaged [18, 19]. CRF was assessed by the 2 km-walking test previously validated for moderately fit and obese but otherwise healthy 20-65 year-old men and women [20]. The equation used to predict V;˙O_2max in women was the following: V;˙O_2max (mLO_2/kg/min) = 116.2 - 2.98 x time - 0.11 x HR - 0.14 x age - 0.39 x BMI, where time is the elapsed time for a walk in minutes, HR is the value at the end of the walk (beats/min), age is expressed in years and BMI in kg/m2. Walking time was recorded at the nearest second and HR was monitored throughout the walk (Polar model FS1 type, Kempele, Finland). This procedure has already been validated [18, 19].

2.3.2 QoL, eating behaviors and perceived health

QoL was measured using the French version of the SF-36 Health Survey questionnaire which is composed of 36 items that assess the following eight QoL dimensions or scales: physical functioning, role-physical, body pain, general health, vitality, social functioning, role-emotional and mental health [21]. For each of the eight domains, scores were transformed linearly to a scale ranging from 0 (maximal impairment) to 100 (no impairment). Physical functioning, role-physical and body pain reflect the Physical Component Score (PCS), whereas general health, vitality, social functioning, role-emotional and mental health comprise the Mental Component Score (MCS). Calculation of PCS and MCS was performed using the equations initially developed [22]. A French version of the TFEQ, a 51-item questionnaire [23] was completed by participants. The purpose of this questionnaire is to assess three factors related to cognition and behaviors associated with eating: cognitive dietary restraint which represents the intent to restrict food intake to control weight (21 items; scores ranging from 0 to 21, where higher levels are associated with conscious, cognitive control of eating); disinhibition, generally high in women, which refers to an overconsumption of food in response to cognitive or emotional cues caused by a variety of situations associated with loss of control of food intake (16 items; scores ranging from 0 to 16, where high levels are associated with a tendency to lose control of intake during emotional times or with external cues); and susceptibility to hunger, which refers to food intake in response to feelings and perceptions of hunger (14 items; score ranging from 0 to 14, where high levels are associated with an increased awareness and sensitivity to sensations of hunger). This questionnaire has been validated in large cohorts, which included middle-aged non-obese and obese men and women [24], and its three scales have been reported to show good test-retest reliability [23, 25]. The SPHQ specifically designed to explore lifestyle, physical activity and psychosocial orientation [19] was also administered to participants. Six items were investigated: 1) perceived physical fitness, 2) perceived ideal weight, 3) perceived healthy balanced diet, 4) perceived sleep quality, 5) perceived stress level, and 6) perceived general health. A 10-point Likert scale from 1 (not at all) to 10 (very good) was used to assess each item.

2.4 Statistical analyses

Statistical analyses were performed using JMP® 9.0.2 software (2010 SAS Institute Inc., Cary, NC, USA). Values shown in Tables and Figures are means ± standard deviation (SD). Between-group differences at baseline, for all subjects randomized into the MICT or HIIT group, were analyzed with a Kruskal-Wallis test. Differences in baseline characteristics between subjects who completed the study vs. those who did not were analyzed using a 2-way ANOVA (exercise group x completion interaction effects). Tukey-Kramer HSD post-hoc tests were used to locate between-group differences. Changes following the intervention for subjects who completed the study were analyzed by repeated measure ANOVA (exercise group x time interaction effects). Data were considered statistically different when $p<0.05$.

3. Results

Characteristics of the two randomized exercise groups at baseline.

Women from the MICT group (n=25) were characterized by comparable body weight and thus BMI, as well as by similar waist girth, fat mass and lean mass when compared to participants from the HIIT group (n=24). Also, estimated $\dot{V}O_2max$ was not significantly different between groups. The SF-36 PCS and MCS as well as eating behaviors (TFEQ) did not differ between groups. Finally, with the exception of sleep quality being higher in the MICT than in the HIIT group ($p<0.005$), the remaining five perceived health items assessed through the SHPQ were comparable for the two groups (Table 2).

Table 2. Characteristics of the randomized exercise groups at baseline

	MICT (n=25)	**HIIT (n=24)**	**p value**
Body weight (kg)	84.2 ± 10.9	87.4± 15.9	0.63
Height (m)	1.66 ± 8.8	1.63 ± 6.3	0.19
Body mass index (kg/m^2)	30.9 ± 3.8	32.8 ± 5.1	0.23
Fat mass (kg)	34.3 ± 7.9	38.6 ± 9.9	0.15
Lean mass (kg)	50.1 ± 4.5	48.4 ± 6.3	0.19
Waist girth (cm)	89.2 ± 7.5	92.2 ± 12.4	0.55
$\dot{V}O_2max$ (mLO$_2$/kg/min)	32.9 ± 2.1	32.0 ± 3.3	0.36
PCS (SF-36)	52.1 ±5.7	51.9 ± 6.3	0.98
MCS (SF-36)	51.4 ± 7.4	49.8 ± 10.7	0.93
Restriction (TFEQ)	8.3 ± 4.2	8.8 ± 4.2	0.58
Dishinibition (TFEQ)	8.4 ± 3.3	9.3 ± 2.8	0.37
Hunger (TFEQ)	4.8 ± 3.5	6.6 ± 3.5	0.09
Physical fitness (SPHQ)	5 ± 1.8	5.5 ± 1.7	0.28
Ideal weight (SPHQ)	8.6 ± 1.3	8.9 ± 1.0	0.48
Healthy diet	5.1 ± 1.8	5.4 ± 2.2	0.61

(SPHQ)			
Sleep quality (SPHQ)	7.3 ± 2.1	5.3 ± 2.2	0.004
Stress level (SPHQ)	5.4 ± 2.0	5.3 ± 2.7	0.72
General health (SPHQ)	6.1 ± 1.6	7.0 ±1.9	0.07

MICT: Moderate Intensity Continuous Training; HIIT: High Intensity Interval Training; PCS: Physical Component Score; MCS: Mental Component Score. SF: Short Form; TFEQ: Three Factor Eating Questionnaire; SHPQ: Short Health Perceived Questionnaire.

Between-group differences in characteristics of completers vs. non-completers at baseline

No significant differences were found between women who completed vs. those who dropped out of or did not comply with the MICT program. In contrast, women who completed the HIIT program (n=10) had lower height and lean mass ($p<0.05$), as well as better MCS (SF-36), perceived sleep quality and general health (SPHQ) than those who dropped out or were non-compliant with this program (n=14) ($0.005<p<0.05$) (Table 3).

MICT vs. HIIT responses

Body weight, BMI, fat mass and waist girth decreased similarly in both groups after training ($0.0001<p<0.05$). In addition, estimated V;˙O$_2$max was improved, irrespective of the intervention ($p<0.01$) (Figure1). These changes were not significantly different between programs, as shown by the lack of exercise group by time effect interactions (p values ranging from 0.314 to 0.977).

As assessed using the SF-36 questionnaire, the PCS increased ($p<0.01$) whereas the MCS did not change in response to the two training programs. Concerning eating behaviors (TFEQ), the restriction score increased while the susceptibility to hunger one decreased in both groups after the 12-week intervention ($p<0.05$); no changes were, however, observed in the disinhibition score (Figure 2). These changes were comparable between programs, as reflected by the non-significant exercise group by time effect interactions (p values ranging from 0.178 to 0.914).

Perceived physical fitness, healthy balanced diet, sleep quality, stress level and general health increased, while perceived ideal weight assessed through the SHPQ decreased in both groups ($0.0001<p<0.05$) (Figure 3). Once again, these responses did not differ between the two programs, as indicated by the lack of significant exercise group by time effect interactions (p values ranging from 0.114 to 0.750).

4. Discussion

The present study shows that both HITT and MICT programs led to similar benefits in terms of anthropometry, body composition, and physical fitness, in healthy, sedentary and moderately obese women. The two training programs similarly reduced body weight (-2%) and thus BMI (-2.5 to -4.5%), as well as waist circumference (-4%) and fat mass (-6 to -8%). Our data are concordant with the comparable body mass and subcutaneous fat losses reported after both training programs [8], but not consistent with data showing higher reductions in body fatness and abdominal fat accumulation after HIIT [6,7] or with unchanged body weight and composition noted after this training program [9]. Also discordant with our results, is the higher reduction reported in body fat percentage in a boxing group (HIIT), than in a brisk walking one (MICT) [12]. Moreover, in contrast to HIIT, MICT was reported to reduce body fat and abdominal fat accumulation in overweight adults [10] while moderate-to-vigorous continuous training led to body weight and fat mass losses in obese young women [26]. These discrepancies could be partly due to the heterogeneity of HIIT interventions (i.e., length, intensity and stimulus type), the cohorts examined (i.e., number of subjects, age, sex, degree of obesity, presence or absence of metabolic complications; analysis of men and women together) and the methods used to match HIIT and MICT prescriptions across studies, as recently reviewed [27]. This meta-analysis including 13 out of 1334 initially screened studies, concluded modest and similar reductions in body fat mass and waist circumference in overweight or obese participants aged 18-45 years subjected to a 10-week MICT or HITT program, an observation in good accordance with our data.

Both training programs similarly increased estimated V;˙O$_2$max (+5 and +3% in HIIT and MICT, respectively), values close to those reported (+6 to +8%) in one study [9], although being not concordant with the greater increase in CRF in response to HIIT (+20 to +35%) than MICT (+16 to +26%) observed by others [6-8]. Once again, these discrepancies could be explained by differences in HIIT programs in terms of intensity, duration, combinations of intervals and recovery periods, and the physical activity selected (running, cycling, walking or a combination of 2 of these modalities).

Table 3. **Between-group differences in characteristics of completers vs. non-completers at baseline**

	Completers		Non-completers		ANOVA Model p value	Group effect p value	Completion status effect p value	Group x Completion interaction p value
	MICT (n=13)	HIIT (n=10)	MICT (n=12)	HIIT (n=14)				
Body weight (kg)	84.3 ± 9.0	82.1 ± 16.3	84.1 ±13.0	91.2 ± 15.0	0.352	0.529	0.259	0.237
Height (m)	1.68 ± 0.10	1.59 ± 0.05	1.64 ± 0.06	1.66 ± 0.05[a]	0.014	0.068	0.439	0.005
Body mass index(kg/m^2)	30.6 ± 3.5	32.7± 6.1	31.1 ± 4.3	32.9 ± 4.5	0.521	0.154	0.786	0.915
Fat mass (kg)	34.5 ± 6.8	37.5 ± 12.5	34.1 ± 9.3	39.5 ± 7.9	0.393	0.118	0.764	0.654
Lean mass (kg)	50.4 ± 4.0	44.6 ± 5.0	49.7 ± 5.1	51.0 ± 5.9[a]	0.019	0.131	0.055	0.019
Waist girth (cm)	91.1 ± 7.7	91.0 ± 14.0	87.1 ± 7.0	93.2 ± 11.7	0.518	0.321	0.768	0.301
V; $\dot{}O_2max$ (mLO_2/kg/min)	33.2 ± 1.6	32.1 ± 2.5	32.7 ± 2.7	32.0 ± 3.9	0.684	0.277	0.710	0.784
PCS (SF-36)	50.6 ± 6.7	53.0 ± 3.4	53.7 ± 4.0	51.1 ± 7.8	0.516	0.937	0.722	0.151
MCS (SF-36)	51.8 ± 8.1	55.9 ± 5.7	50.9 ± 6.8	45.5 ± 11.4[a]	0.037	0.791	0.026	0.057
Restriction (TFEQ)	8.2 ± 4.7	9.4 ± 4.3	8.5 ± 3.9	8.3 ± 4.2	0.905	0.677	0.757	0.556
Dishinibition (TFEQ)	8.4 ± 3.7	9.2 ± 3.1	8.5 ± 2.9	9.4 ± 2.7	0.790	0.336	0.849	0.950
Hunger (TFEQ)	4.5 ± 3.5	5.9 ± 3.3	5.2 ± 3.7	7.1 ± 3.7	0.283	0.111	0.366	0.822
Physical fitness (SPHQ)	5.1 ± 1.6	5.9 ±1.9	4.9 ± 2.0	5.2 ± 1.6	0.597	0.278	0.411	0.609
Ideal weight (SPHQ)	8.6 ± 1.1	9.0 ± 0.9	8.7 ±1.5	8.9 ± 1.0	0.812	0.339	0.976	0.855
Healthy diet (SPHQ)	5.4 ± 1.8	5.2 ± 2.2	4.8 ± 1.9	5.5 ± 2.2	0.804	0.632	0.777	0.430
Sleep quality (SPHQ)	7.3 ± 2.4	6.4 ± 2.5	7.3 ± 1.8	4.6 ± 1.7[a]	0.004	0.005	0.124	0.148
Stress level (SPHQ)	5.6 ± 2.0	6.5 ± 2.9	5.2 ± 2.1	4.4 ± 2.2	0.186	0.912	0.063	0.226
General health (SPHQ)	6.3 ± 1.7	8.1 ± 1.0	5.9 ± 1.5	6.2 ± 2.0[a]	0.015	0.032	0.02	0.120

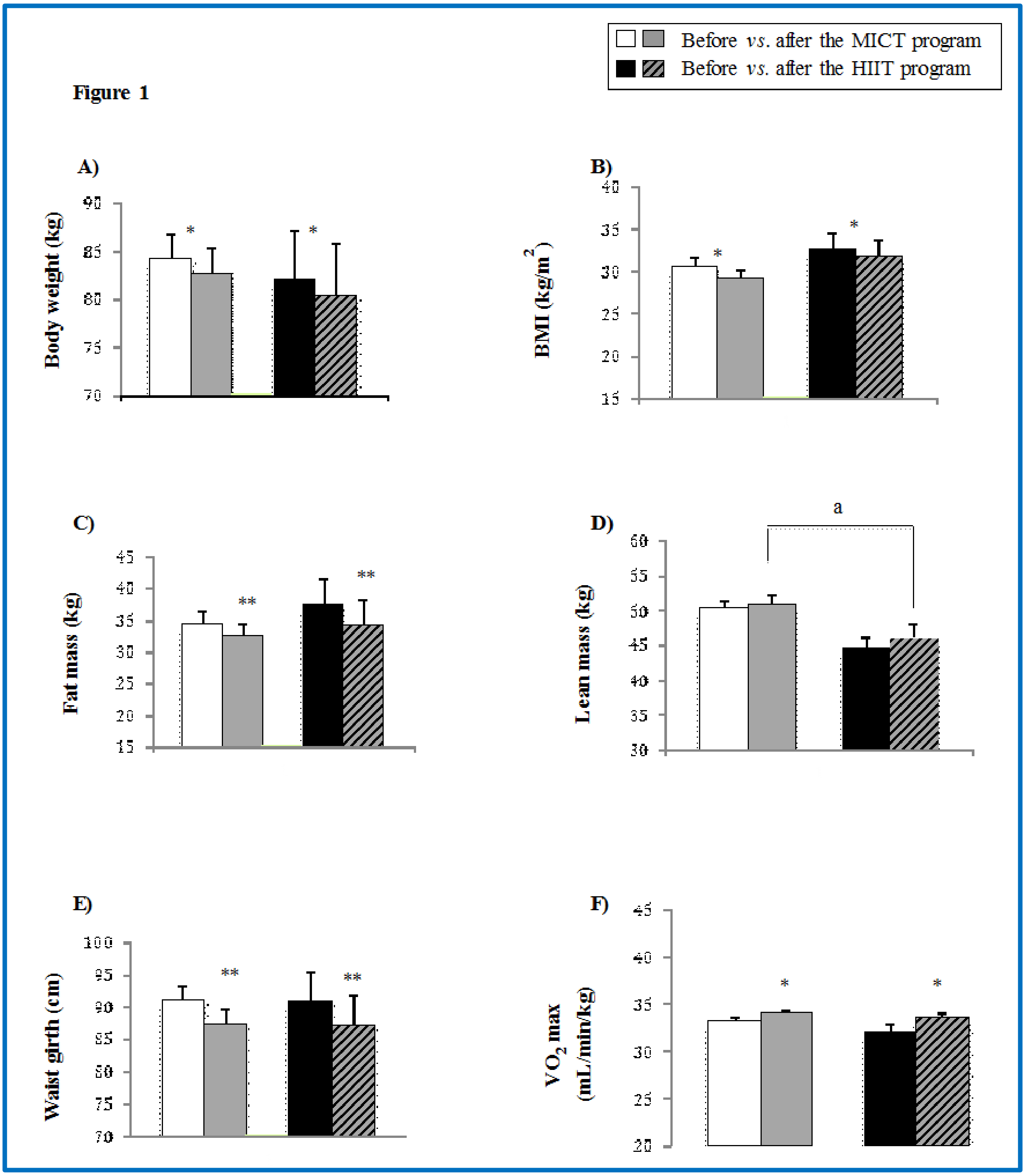

Figure 1. Body weight **(A)**, body mass index **(B)**, fat mass **(C)**, lean mass **(D)**, waist girth **(E)** and cardiorespiratory fitness **(F)** before and after the 12-week training programs. Differences between before and after training, in each group at *p<0.05 and **p<0.01. Between group differences at ᵃp<0.05. HIIT: High-Intensity Interval Training; MICT: Moderate-Intensity Continuous Training.

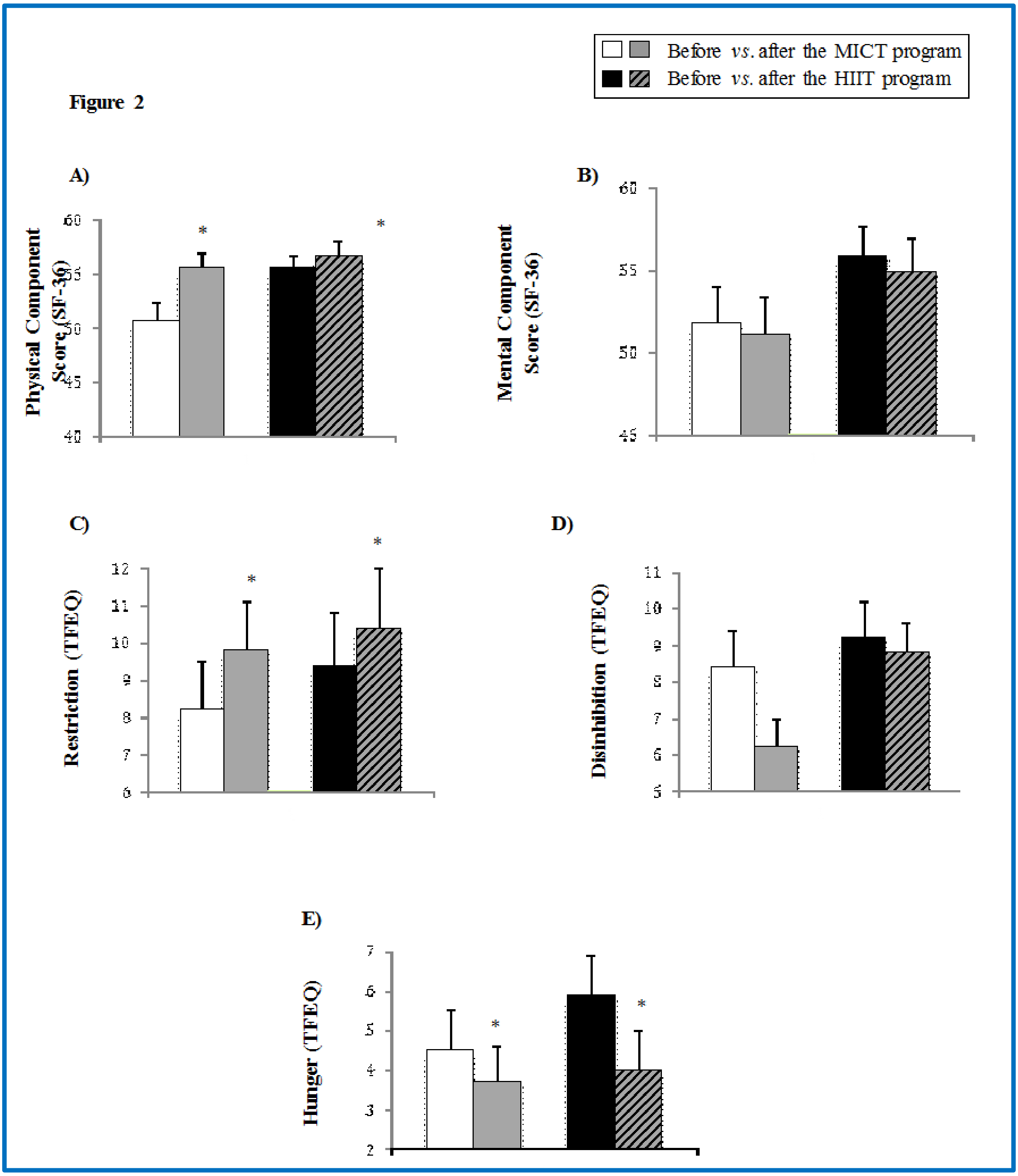

Figure 2. SF-36 Physical Component Score **(A)** and Mental Component Score **(B)**, as well as TFEQ-restriction **(C)**, disinhibition **(D)** and hunger scores **(E)**, before and after the 12-week training programs. Differences between before and after training, in each group at *p<0.05 and **p<0.01. HIIT: High-Intensity Interval Training; MICT: Moderate-Intensity Continuous Training; SF-36: Short Form-36 Health Survey questionnaire; TFEQ: Three Factor Eating Questionnaire.

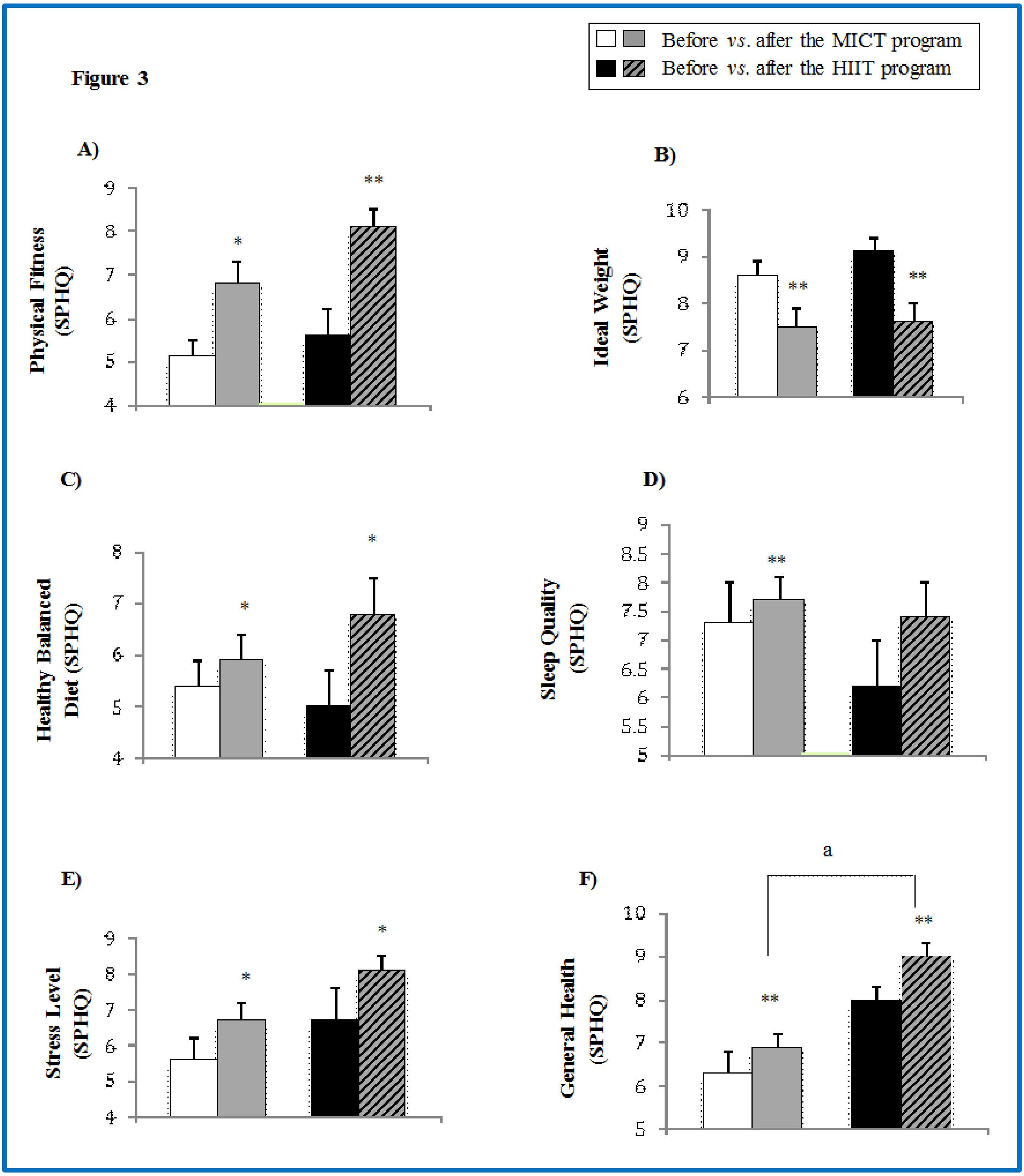

Figure 3. SHPQ-Perceived Physical Fitness **(A)**, Ideal Weight **(B)**, Healthy Balanced Diet **(C)**, Sleep Quality **(D)**, Stress Level **(E)** and General Health **(F)** before and after the 12-week training programs. Differences between before and after training, in each group at *p<0.05 and **p<0.01. Between group differences at a p<0.05. HIIT: High-Intensity Interval Training; MICT: Moderate-Intensity Continuous Training; SHPQ: Short Perceived Health Questionnaire.

Another explanation related to the large distribution of V;˙O2max responses observed through the literature could be due to subjects' trainability, some showing either little or no improvement in CRF even after 20 weeks of a structured training program [28]. In this context, a meta-analysis which examined a subset of 9 studies including 72 subjects for which the mean increase in V;˙O2max was approximately 0.8-0.9 L/min (ours ranging from 0.9 to 1.5 L/min), provided evidence of a marked response in all subjects [29]. Taken together, these results re-emphasized the need of considering the concept of trainability. Although the exercise intensity has already been questioned [30], low vs. high levels of interval training programs led to similar V;˙O2max improvements (+22%) in young, healthy and sedentary women exercising on a cycle ergometer 3 days/week, for 12 weeks [31]. In addition, modest changes in V;˙O2max were reported in overweight inactive adults after 12 weeks of aerobic interval training (IT) or maximal volitional IT consisting of walking or jogging, thus emphasizing that exercise intensity is not likely related to benefits in CRF [32].

Both interventions also resulted in similar improvements in the PCS (SF-36). Although the effects of MICT vs. HIIT on QoL have been little examined, neither the PCS nor the MCS was significantly modified in obese inactive men and women, irrespective of the exercise mode [32]. In contrast, only one study reported improved physical functioning and vitality domains of health-related QoL (SF-36) in the HIIT group, while the MICT group experienced a worsening of vitality in obese adults [12]. Differences between these data and ours could be mainly attributed to HIIT protocols which may vary in exercise intensity and in timing of the work: recovery cycles, type and intensity of recovery, and the number of intervals [32], making comparison between studies difficult. Our study also examined the impact of both training programs on perceived health assessed through the SHPQ [19] and showed an increase of each component, but no training group response differences. No other study has examined the impact of different training protocols on perceived health using this specific questionnaire. It has already been suggested that some emotional benefits of exercise might occur because of psychological gains from the experience of trying to get fit or believing that one is fit, rather than from an increase in CRF [33]. According to this author, perception of fitness is more closely associated with improved physical functioning than is physical capacity itself, as participation in exercise, more than V;˙O2max is known to ameliorate well-being. The fact that all participants showed improvements for the 6 items of the SHPQ in our study could thus be explained by an increased awareness of their health. Also, both of our training programs led to similar improvements in the restriction and susceptibility to hunger scores (TFEQ). However, the mechanisms of appetite regulation following training are unclear as perception of appetite (reflected by perceived hunger, fullness, satiation, desire to eat or prospective food consumption) and the circulating levels of a number of appetite-related peptides or metabolites were not significantly different between training programs [13]. Further studies are needed to address this issue.

Finally, the high dropout rate noted in the HIIT (58%; 14 of 24) and the MICT groups (48%; 12 of 25) could be due to the fact that training sessions were held within a fitness center where regular members followed their personal exercise programs, alongside our study participants who may have been intimidated by these regular adherents. Also, we believe that a high dropout rate often occurred within the initial period of an exercise program as Heisz et al. [34] have already reported that in more naturalistic settings the first six weeks of training represents a particularly vulnerable period for exercise adoption and maintenance. In this regard, affective response to exercise is an important feature to be considered [35], and feelings of pleasure and enjoyment can predict adherence to exercise [36]. As feelings of pleasure [37] and enjoyment [38] were not taken into account in our study, further experiments examining these psychological dimensions when designing such training programs are clearly warranted.

Some limitations of our study merit discussion. Our participants were healthy and probably represented a group of volunteers relatively more health conscious and motivated in losing weight and improving QoL compared to others. Although consequences of possible or even likely sampling bias on results obtained are difficult to estimate, it seems realistic to suggest that our data can neither be extended to the overall population nor to postmenopausal women, men or individuals of non-French origin. The lack of a non-exercising control group could be singled out as weakness, although studies in overweight and obese subjects have previously shown that HITT [39] and MICT [10] may reduce adiposity outcomes when compared to control or placebo conditions. In this regard, experimental designs directly comparing moderate-intensity interval training group to high-intensity interval training seem more suitable to determine which intervention may be most beneficial in terms of body composition, CRF, and QoL, but also in long-term adherence and cost-saving advantages [30]. Also, the fact that dietary and physical activity habits, key confounding variables, were not monitored may limit our conclusions on the impact of the training program. Completion of dietary diaries to verify participants compliance from a nutritional standpoint [40] and assessment of daily energy expenditure [41] should thus be included in future studies. Nevertheless, this pilot study also had several strengths, including the randomization of the exercise groups, considering one of the two training programs (*i.e.,* MICT) as a control condition, the fact that participants were studied in free-living conditions, and that both objective and subjective variables were measured.

5. Conclusions

In healthy, sedentary and moderately obese women, both HIIT and MICT programs performed within a fitness center led to similar body weight and fat mass losses as well as to comparable improvements in CRF, QoL, eating behaviors and perceived health. However, the large dropout noted in both the HIIT and MICT groups questions the implementation of such training programs within a non-laboratory setting. Further studies are required to develop exercise practice guidelines more adapted to subjects' characteristics in order to promote their long-term adherence to exercise.

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Acknowledgements:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing Interests:

The authors declare that they have no competing interests.