

# Cardiorespiratory Fitness and Insulin Sensitivity Response to high-Intensity Interval Training in Overweight Post-menopausal Women

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## Research Article

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## Abstract

**Background:** It is known that physical exercise is an important non-pharmacological tool in the prevention and treatment of unwanted weight gain and diseases affecting post-menopausal women. High-intensity training is more efficient in improving glycemic control than low-intensity exercise and, interval protocol is better than continuous exercise to increase aerobic capacity. The objective of this study was to analyze the response of insulin resistance in postmenopausal women after 10 weeks of high-intensity interval training (HIIT).

**Methods:** 24 postmenopausal women ( $57 \pm 7.8$  yrs) were submitted to a 10-wk HIIT protocol, performed at 70-90% of maximum heart rate in treadmill. Blood pressure and heart rate were evaluated in every session. Level of physical activity and socio-demographic characterization were measured at baseline by the International Physical Activity Questionnaire (IPAQ-long-form version 8). Physical fitness (flexibility, handgrip, cardio respiratory fitness ( $VO_{2max}$ )) and, fasting plasma glucose, insulin, triglycerides, total cholesterol were analyzed. Anthropometry of body weight, height and adiposity were taken. The chi-square ( $\chi^2$ ), ANOVA for variables with symmetrical distribution and model range for repeated measures with asymmetric distribution were applied for comparison between moments (M0-M1). The significance level adopted was 5%.

**Results:** The sample was composed by low-income women, elementary level of schooling, perception of good health and good level of physical activity, showing overweight and dyslipidemia. Baseline insulin resistance was 25%. After 10-week intervention there was a significant increase in aerobic fitness, moderate increase in flexibility and null in handgrip strength. The HIIT protocol reduced 50% of hyperglycemics (and hyperinsulinemics) but only 16.7% of the altered HOMA-IR.

**Conclusions:** The present protocol of HIIT was effective in improving cardio respiratory fitness and only moderately effective in improving insulin sensitivity, probably due to the maintenance of overweight and visceral adiposity.

**Keywords:** Menopause; Blood Glucose; Physical Fitness; Aerobic Exercise

## Introduction

The climacteric is a distinctive feature of female aging that establishes the physiological state of progressive hypoestrogenism culminating in the final cessation of menstrual cycles. Menopause or cessation of ovarian function is the most striking stage of menopause, and creates significant physical, psychological and social changes [1].

Women spend around one third of their lives in postmenopause [2] and approximately 70% of Brazilian confirm the presence of symptoms related to menopause [3]. Weight gain in this stage of life is characterized by excessive accumulation of fat especially in the muscles and liver and, therefore, increases the risk of postmenopausal development of insulin resistance, type 2 diabetes and other chronic diseases [4]. Cardiovascular disease is the leading cause of death in postmenopausal women [5].

The identification of diseases and their risk factors affecting women in the aging process allow the introduction of prevention programs aiming to prevent or delay its onset, with consequent decrease in mortality rate and thus increase the quality of life [6-8]. Interventions with aerobic and/or resistance exercises shown to be effective in combating unwanted weight gain and improve cardiovascular and metabolic risk [9] in postmenopausal women [10].

The high intensity training improves fitness level [11], insulin sensitivity, glyceic control [12] and reduces the risk of coronary heart disease when compared to low intensity exercise [13]. However, more intense training programs are associated with poor adherence [14]. In addition, the impact of exercise intensity in type 2 diabetic patients is not yet clear [15]. Therefore, interval protocol is better than continuous exercise to increase aerobic capacity in healthy people [16,17] and in patients with cardiovascular disease [18]. Currently, the interval training is a well-known exercise protocol that merges high-intensity exercise with periods of rest or recovery [19] and helps to strengthen and improve cardiorespiratory fitness [20]. High-intensity interval training protocol showed significant improvement in glyceic control and cardiovascular risk factors in subjects with metabolic syndrome and type 2 diabetes, which [21,22].

We hypothesized that high intensity interval training might reduce insulin resistance in post-menopause women along with physical fitness and body composition improvements. Hence, the aim of this study was to analyze the response of insulin resistance in

postmenopausal women after 10 weeks of high-intensity interval training on a treadmill.

## Methods

### Study Design and Subjects

From the outcomes of reducing plasma glucose and insulin by high-intensity training (23) and taking the test power of 95% reliability and 5% error, the calculated minimum sampling for the present study was 22 patients. Therefore, a convenience sample of 24 post-menopausal women was selected among those enrolled in a Lifestyle Modification Program (Move for Health) conducted by this Institution since 1991. The inclusion criteria was the absence of menstruation for at least 12 months and not referring any type of endocrine-metabolic, gynecological and / or bone-joint diseases that prevented the practice of physical exercise. All included patients were informed about the proposal and procedures to be performed and signed the informed consent form for the Ethics Committee of the Botucatu Medical School – UNESP (SP, Brazil). At the end of the experiment were included only data from those that had achieved the minimum rate of 70% per high-intensity interval training and attended both, the baseline and final assessments.

### Measurements

Physical activity level (PAL), socio-demographic characteristics (gender, age, marital status, family income and education) and health status were obtained by applying the International Physical Activity Questionnaire (IPAQ version 8 - long form) [36]. Marital status was classified as married (married and stable union) and unmarried (single, widowed, divorced, and separated). The schooling level was classified as fundamental complete and incomplete, secondary education and higher. Family income ranked from up to five minimum wages (< 5SM) or greater/equal to five times the minimum wage ( $\geq 5SM$ ). Health perception was rated as good (excellent, very good or good) or bad (fair and poor).

Body weight and height measurements were taken [24] with subsequent calculation of body mass index ( $BMI = kg/m^2$ ) classified as normal weight when up to  $24.9 kg / m^2$ , overweight 25 up to  $29.9 kg/m^2$  and obese with values greater than  $30 kg/m^2$  [25]. The waist circumference (WC) was measured with millimeter tape inextensible and inelastic on the midpoint between the last intercostal space and iliac crest. The value of 88 cm was adopted as cutoff for abdominal obesity [24].

Body muscle and fat composition was performed in the supine position by bioelectrical impedance (BIA)

(Biodinâmics®, model 450, USA) with the calculation of muscle mass by the equation proposed by Janssen et al. [26] calculated as body mass index (IMM) as proposed by Baumgartner et al. [27]. Sarcopenia classification adopted for women was: Normal - IMM > 5.45 kg/m<sup>2</sup>, Sarcopenia - IMM ≤ 5.45 kg/m<sup>2</sup> [28]. The percentage of female fat used as normal was 20-35% [29].

The evaluation of the PA was held with the subject seated, following the recommendations of the VI Brazilian Guidelines on Hypertension [30]. Hypertension was defined as blood pressure greater than 130/85 mmHg [31].

The antecubital-vein blood sampling was drawn after an overnight fast (8-12 hours), using standard venipuncture vacuum. Plasma glucose, triglycerides (TG), total cholesterol (TC), HDL cholesterol (HDL-C), LDL cholesterol (LDL-C) and uric acid, were quantified by Dry Chemical method (System Vitros Johnson & Johnson). Insulin and high-sensitivity C-reactive protein (CRP) were measured by chemiluminescent method. The classification of normal values followed the NCEP-ATPIII [32]. All blood samples were measured in the Clinical Research Unit (UPECLIN) Clinical Hospital of the Faculty of Medicine of Botucatu - UNESP.

DM2 was defined by blood glucose value ≥ 126 mg/dL [33] or current use of oral hypoglycemic agents or insulin. State of glucose intolerance was defined as blood glucose ≥ 100 mg/dL [34]. Insulin resistance was determined by means of the homeostasis (homeostasis model assessment - insulin resistance) (HOMA-IR), which is the product of fasting insulin (μUI / mL) and fasting plasma glucose (mmol/L) divided by 22.5 [35]. It was adopted 3.5 as the upper limit of normal range.

The trunk flexibility (FLEX) was assessed by using the sit and reach test. Muscle strength of the upper limbs was determined using the handgrip test with hydraulic dynamometer. For both skills have adopted the classifications of "25 percentile" (p25), "percentile 25-75" (p25-75) and 75 percentile (p75) by sex, based on program participants to change in lifestyle (Move for Health).

Cardiorespiratory fitness was determined as maximal oxygen uptake (VO<sub>2max</sub>), using a treadmill (QMCTM90 model) according to the Balke protocol [37], with constant monitoring of heart rate and blood pressure. The treadmill inclination was used to determine the VO<sub>2max</sub> through formula. After obtaining the VO<sub>2max</sub>, cardiorespiratory fitness was classified in "25 percentile" (p25), "percentile 25-75" (p25-75) and 75 percentile (p75) by sex, also based on program participants to sample change in lifestyle (Move for

Health). The maximum heart rate (HR max) obtained during the baseline cardiorespiratory test was individually used to prescribe the intensity for the HIIT.

### Intervention Protocol

The patients were subjected to 60 minutes of supervised exercise twice weekly for 10 weeks. The exercise-protocol was composed by initial (5 minutes) and final (10 minutes) stretching; the latter was intended as an aid to relaxation for complete heart rate baseline recovering.

High-intensity interval training on treadmill included 10 minutes of warm-up at 70% of maximum heart rate (HR max), followed by 4 series of 4 minutes each on 90% HR max with 3-min intervals between series for active recovery at 70 % of FC max. The protocol ended with 5 minutes backing to calm. The total protocol lasted 43 minutes of treadmill-interval training. During the 10-wk experiment they all received dietary counseling but no specific prescribed diets.

### Statistical Analysis

Results were expressed as mean and standard deviation for continuous variables and frequency and percentage for categorical variables. The proportion comparisons were done by chi-square test ( $\chi^2$ ), the ANOVA repeated measure for symmetric quantitative variables and the range model repeated measures for the asymmetric quantitative. SAS for Windows, version 9.1 was used with a significance level of 5% or corresponding p-value.

### Results

The sample was composed in majority by under 60 years of age (70.8%), married (62.5%) with complete elementary school (33.3%), family earning income up to five minimum salaries (91.7%) and reporting good general health (79.2%). Anthropometrically, most were obese (54.2%) and overweight (33.3%), with higher than normal waist circumference (79.2%). Clinically mostly were normotensive either as systolic (66.7%) or diastolic (83.3%). Biochemically, the sample was characterized with being dyslipemics, with 54.2% hypercholesterolemia either total (54.2%), LDL-C (83.3%) or lower HDL-C (41.7%). Normal values were prevalent for triglycerides, uric acid (83.3%) and CRP (83.3%). Abnormal insulin achieved 16.7% whereas altered glucose and HOMA-IR achieved 25% of the women.

At baseline of the study they were within the recommended physical activity (91.7%), with fitness normal handgrip (62.5% between Q1 and Q4), 37.5%

showing low flexibility (Q1) and half of them (Q2-Q3) presenting  $VO_{2max}$   $30.7 \pm 1.7$  mlO<sub>2</sub>/kg/min.

Thus, overall we selected a sample of low-income women with intermediate schoolarity referring self-perception of good health, although overweight and with good weekly physical activity and grip strength fitness but poor trunk flexibility. Changes in insulin sensitivity were less frequent than those of hyperlipemia.

After 10 weeks of interval training on a treadmill, the average values changed statistically, only for cardiorespiratory fitness markers. The cardiorespiratory test increased 23.8% in time on treadmill, with 21.7% higher inclination of the treadmill ramp leading to a calculated increase of 12.3% in the  $VO_{2max}$  (Table 1).

	Mean ± SD	Frequency (%)	p value
<b>Age (years)</b>	57 ± 7.8		
<60 years	53.1 ± 4.2	17 (70.8)	0.009
≥60 years	66.6 ± 5.8	7 (29.2)	
<b>Total Physical Activity (min/week)</b>	841.3 ± 643.6		
<150 min/week	52.5 ± 74.2	2 (8.3)	<0.0001
≥150 min/week	913 ± 623.5	22 (91.7)	
<b>Domestic Physical Activity (min/week)</b>	493.5 ± 454.1		
<b>Occupational Physical Activity (min/week)</b>	125.4 ± 420.2		
<b>Leisure Physical Activity (min/week)</b>	138.2 ± 129.3		
<b>Transportation Physical Activity (min/week)</b>	84.2 ± 110.5		
<b>Flexibility (cm)</b>	23.0 ± 9.3		
Q1	13.9 ± 2	9 (37.5)a	
Q2-Q3	23 ± 3.9	8 (33.3)a	
Q4	35 ± 3	7 (29.2)a	
<b>Handgrip (kg)</b>	29.8 ± 5.3		
Q1	22.0	3 (12.5)a	
Q2-Q3	28.1 ± 2.1	15 (62.5)b	
Q4	36.2 ± 3.5	6 (25)a	
<b>VO<sup>2</sup>max (ml/kg/min)</b>	31.6 ± 4.2		
Q1	23.7 ± 1.1	3 (12.5)a	
Q2-Q3	30.9 ± 1.7	16 (66.7)b	
Q4	37.1 ± 0.8	5 (20.8)a	

Q1: 25th percentile; Q2-Q3: 25-75 percentile; Q4: 75th percentile;  $VO_{2max}$ : Maximal oxygen uptake; chi-square test ( $\chi^2$ ) trend for proportion of comparison; proportions followed by different letters differ statistically;  $p < 0.05$ .

Table 1: Demographic characteristics, fitness and physical activity baseline menopausal women participants of interval protocol.

Among the categorical variables the 37.5% flexibility-unfit women (Q1) found at baseline were reassigned either to Q2-Q3 (33.3%) or Q4(11.1%). Regarding the glucose-insulin status the interval protocol resulted in improvement in 50% of the former hyperglycemics and also of the hyperinsulinemics and 16.7% of those with altered HOMA-IR. Nevertheless none of these categorized changes showed statistical significance. Moreover, there was no positive or negative

reclassification neither for handgrip strength or body-or abdominal-obesity (Table 2- 6).

Thus, the physical intervention protocol was shown to be effective in improving aerobic fitness and flexibility, in addition to discrete effects on insulin sensitivity. Nevertheless it was ineffective in reducing abdominal adiposity and overweight as well dyslipemia.

	Mean ± SD	Frequency (%)	p value
<b>Body mass (kg)</b>	76.5 ± 12.7		
<b>Height (cm)</b>	157.8 ± 4.6		
<b>BMI (kg/m<sup>2</sup>)</b>	30.6 ± 4.3		
Eutrofic	24.2 ± 1.2	3 (12.5)a	
Overweigh	28.1 ± 1.2	8 (33.3)ab	
Obese	33.7 ± 3.2	13 (54.2)b	
<b>Waist circumference (cm)</b>	96.4 ± 10.8		
Normal	81.8 ± 3.9	5 (20.8)	0.0001
Altered	100.2 ± 8.4	19 (79.2)	

Chi-square test ( $\chi^2$ ) trend for proportion of comparison; proportions followed by different letters differ statistically;  $p < 0.05$ .

Table 2: Baseline characteristics of body composition in postmenopausal women participants of interval protocol.

	Mean ± SD	Frequency (%)	p value
<b>Cardiac Frequency (beat/min)</b>	71.0 ± 7.7		
<b>Systolic blood pressure (mmHg)</b>	123.3 ± 16.1		
Normal	113.7 ± 7.1	16 (66.7)	0.0433
Altered	142.5 ± 10.3	8 (33.3)	
<b>Diastolic blood pressure (mmHg)</b>	75.8 ± 10.6		
Normal	72.5 ± 7.9	20 (83.3)	<0.0001
Altered	92.5 ± 5	4 (16.7)	

Chi-square test ( $\chi^2$ ) trend for proportion of comparison;  $p < 0.05$ .

Table 3: Baseline hemodynamic characteristics of menopausal women participants of interval protocol.

	Mean ± SD	Frequency (%)	p value
<b>Fasting glucose (mg/dL)</b>	91.8 ± 17.9		
Normal	84.6 ± 8.5	18 (75)	0.0014
Altered	115.8 ± 22.2	6 (25)	
<b>Fasting insulin (mUI/mL)</b>	10.9 ± 8.4		
Normal	8.2 ± 4.8	20 (83.3)	<0.0001
Altered	31.2 ± 1.3	4 (16.7)	
<b>HOMA-IR</b>	2.6 ± 2.5		
Normal	1.6 ± 0.6	18 (75)	0.0014
Altered	8.2 ± 3.1	6 (25)	
<b>Triglycerides (mg/dL)</b>	120.5 ± 43.1		
Normal	103.3 ± 23.2	20 (83.3)	<0.0001
Altered	199.2 ± 26.2	4 (16.7)	
<b>Total cholesterol (mg/dL)</b>	205.0 ± 32.6		
Normal	176.1 ± 14.8	11 (45.8)	0.7728
Altered	230 ± 21	13 (54.2)	
<b>LDL-c (mg/dL)</b>	134.2 ± 30.4		
Normal	89.7 ± 3.8	4 (16.7)	<0.0001
Altered	140.8 ± 26.7	20 (83.3)	
<b>HDL-c (mg/dL)</b>	51.2 ± 12.5		
Normal	60.5 ± 7.3	14 (58.3)	0.3865
Altered	39 ± 6.2	10 (41.7)	

<b>Uric Acid (mg/dL)</b>	5.1 ± 1.4		
Normal	4.7 ± 0.6	20 (83.3)	<0.0001
Altered	7.7 ± 1.8	4 (16.7)	
<b>hsCRP (mg/dL)</b>	0.6 ± 0.3		
Normal	0.5 ± 0.1	20 (83.3)	<0.0001
Altered	1.2 ± 0.3	4 (16.7)	

LDL-C: low density lipoprotein; HDL-C: high density lipoprotein; HOMA-IR: homeostasis model assessment - insulin resistance; hsCRP: C-reactive protein ultrasensitive; chi-square test ( $\chi^2$ ) trend for proportion of comparison; p<0.05.

Table 4: Baseline biochemical characteristics of menopausal women participants of interval protocol.

	<b>M0 Mean ± SD</b>	<b>M1 Mean ± SD</b>	<b>p value</b>
Body mass (kg)	76.3 ± 0.8	76.7 ± 0.8	0.727
Free Fat mass (kg)	46.2 ± 0.7	46.7 ± 0.7	0.644
Body fat (%)	38.6 ± 0.7	38.3 ± 0.8	0.767
Muscle mass (kg)	20.1 ± 0.4	20.8 ± 0.5	0.299
Muscle mass index(kg/m <sup>2</sup> )	8.1 ± 0.1	8.3 ± 0.1	0.267
Muscle mass (%)	26.5 ± 0.5	27.2 ± 0.5	0.289
Systolic blood pressure (mmHg)	123.1 ± 3.2	122.7 ± 3.3	0.932
Diastolic blood pressure (mmHg)	75.8 ± 2.0	75.3 ± 2.1	0.861
Cardiac Frequency (beat/min)	71.0 ± 1.7	66.2 ± 1.8	0.073
Maximal Cardiac Frequency (beat/min)	150.1 ± 3.8	150.6 ± 4.0	0.919
Test time (sec)	604.2 ± 27.6	747.7 ± 28.9	<b>0.002</b>
Treadmill grade (%)	10.6 ± 0.4	12.9 ± 0.5	<b>0.002</b>
VO <sub>2max</sub> (ml/kg/min)	31.6 ± 4.2	35.5 ± 3.8	<b>&lt;0.001</b>
Glucose (mg/dL)	91.9 ± 5.4	99.1 ± 5.5	0.367
Insulin (mUI/mL)	0.1 ± 0.0	0.1 ± 0.0	0.353
HOMA-IR	0.5 ± 0.1	0.4 ± 0.1	0.363
Triglycerides (mg/dL)	120.5 ± 9.5	123.2 ± 9.9	0.843
Total Cholesterol (mg/dL)	205.4 ± 6.8	196.9 ± 7.1	0.400
LDL-c (mg/dL)	133.9 ± 6.1	130.7 ± 6.2	0.707
HDL-c (mg/dL)	51.5 ± 2.0	49.0 ± 2.1	0.415
Uric acid (mg/dL)	5.1 ± 1.4	4.7 ± 1	0.312
hsCRP (mg/dL)	0.6 ± 0.3	0.7 ± 0.5	0.239

VO<sub>2max</sub>: Maximal oxygen uptake; LDL-C: low density lipoprotein; HDL-C: high density lipoprotein; HOMA-IR: homeostasis model assessment - insulin resistance; hsCRP: C-reactive protein; Model range in repeated measurements for insulin and HOMA IR; ANOVA for repeated measures; p < 0.05.

Table 5: Effect of interval protocol on biochemical variables. body composition. hemodynamic and physical fitness with adjustment for age. BMI and CA.

	<b>M0</b>	<b>M1</b>	<b>c2</b>	<b>p</b>
<b>Flexibility</b>				
Q4	7 (29.2)	6 (27.3)	0	1.0
Q2-Q3	8 (33.3)	12 (54.5)	13.271	0.2493
Q1	9 (37.5)	4 (18.2)	12.674	0.2603
<b>Handgrip strength</b>				
Q4	7 (29.2)	3 (13.6)	0.8424	0.3587
Q2-Q3	15 (62.5)	16 (72.8)	0.1801	0.6713
Q1	2 (8.3)	3 (13.6)	0.0106	0.9179
<b>Glucose</b>				
Normal	17 (73.9)	17 (77.3)	0	1.0
Altered	6 (26.1)	5 (22.7)		

<b>Insulin</b>				
Normal	22 (91.7)	18 (100.0)	0.2734	0.601
Altered	2 (8.3)	0 (0.0)		
<b>HOMA-IR</b>				
Normal	19 (82.6)	13 (76.5)	0.0064	0.9363
Altered	4 (17.4)	4 (23.5)		

Q1: 25 percentile; Q2-Q3: 25-75 percentile; Q4: 75 percentile; Chi-square test ( $\chi^2$ ) trend for proportion of comparison;  $p < 0.05$ .

Table 6: Effect of 10 weeks of interval exercise on physical fitness and glycemic profile of postmenopausal women.

## Discussion

The outstanding finding in this study was the 12.3% improvement in cardiorespiratory fitness of menopausal women, after 10 weeks of treadmill high-intensity interval training. Usually, the high-intensity interval training shows slight improvement in  $VO_{2max}$  compared to continuous training in healthy active adults [38]. However, the same type of training (85-95% of HR max), almost doubles the cardiovascular fitness in chronic disease compared to the continuous training of moderate intensity [39]. In a study with middle-aged and elderly individuals submitted to an interval training (40-70% peak  $VO_2$ ), four days a week for twelve weeks, the improvement of approximately 10% was observed in the peak  $VO_2$  [40]. The results suggest therefore, that regardless of the sample, the interval exercise can improve cardiorespiratory fitness.

Despite the 12.3% increase in  $VO_{2max}$  in this study, SBP, DBP and glucose levels did not change with training which corroborates the results observed by Karstoft *et al.* [23]. Most of our sample had blood pressure levels and normal baseline glucose, which could explain the apparent lack of effect on these parameters. Differently from us, walk training with intervals of 1 hour / session, four days a week for 4 months, led to a decrease of 5%-30% in hypertension, 10-40% in hyperglycemia and 10-30% in high BMI, without significant reduction in blood lipids. These results were attributed to the significant increase in  $VO_2$  peak [41].

Similarly, to other [23] our intervention had not changed the lipid profile of postmenopausal women, following what was found also in obese women undergoing 16 weeks of high intensity training, without changes in HDL-C and triglycerides [42]. Aerobic exercise either moderate or high intensity improves HDL-C, but the same does not occur with the total cholesterol, LDL-C and triglycerides [43]. To achieve beneficial effects on total cholesterol, LDL-C and triglycerides it seems necessary weight loss or change in body composition [44].

Interval training reduces more body weight, fat mass and adiposity abdominal visceral compared to walk [29]. Differently from our data, Irving *et al.* [42] showed greater loss of fat mass after high intensity training. Probably our ten weeks of exercise had been insufficient to observe such changes, while the mentioned studies applied four month-lasting intervention. Furthermore, no prescribed diet was taken for optimizing the weight loss. Moreover, there was no improvement physical fitness of FPM, suggesting either lower volume training and/or the lacking of concurrent resistance training. The high-intensity interval training (2 days/week) combined with training resistance (2 days/week) was effective in healthy adults by reducing total body fat and visceral fat, and improving FPM, flexibility and cardiorespiratory fitness [45].

The presence of impaired fasting glucose was 25%, similar to the 24.5% observed by Mota *et al.* [46] and higher than the 17.8% [47] and 18.7% frequencies, found 10 years latter [48]. Significant changes in glycemic markers such as fasting glucose and HOMA-IR were not detected in this study.

The fasting blood glucose is essentially dependent on endogenous glucose production [49] and is still controversial whether the endogenous glucose production changes or not in response to training [50-52]. Karstoft *et al.* [29] showed significant reduction in fasting insulin in the interval training group, but found no significant difference in HbA1c, fasting blood glucose and oral glucose tolerance test.

Our previous studies with overweight women, a 2mo.walking exercise did not alter significantly plasma concentrations of glucose and insulin as well their area under the curve in response to overload exogenous carbohydrates [53]. However, by using longer protocol (24wk-walking), the reduction of impaired fasting glucose was 60.5% at 24 weeks and 31.4% at 12 weeks [46]. With the present protocol (HIIT), the found normalization of glycemia was 50% in 10 weeks.

The present study has some limitations as, for example, the sample size. Our sample was a small group in spontaneous demand and not a population sample. It is possible that some variables had reached statistical significance if there were a larger number of subjects studied. We also did not have a control group to determine whether our intervention was efficient in comparison. In addition, the interval protocol occurred only two days a week without diet prescription. Weight loss could have been optimized if accompanied diet and a greater volume of training, possibly result in beneficial results of body composition.

The aerobic interval training maintained the ability to reduce resistance insulin, previously observed in walk, this time with reducing the duration of the 24 protocol for only 10 weeks. Future improvement of this protocol can be done by the associated dietary intervention aimed at reducing adiposity, not obtained these physical protocols.

## Conclusion

The high-intensity interval training does not improve the response of insulin resistance in postmenopausal women. However, it is an effective protocol to improve cardiorespiratory fitness and can contribute significantly in tailoring the exercise recommendation for postmenopausal women in individual basis. More studies are needed with people who have more cardiovascular risk factors so as to elucidate the impact of HIIT on body composition and also glycemic control.

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