ISSN: 2469-5718

GUEDJATI MR, et al. Int J Sports Exerc Med 2025, 11:273
DOI: 10.23937/2469-5718/1510273
Volume 11 | Issue 1
Open Access

International Journal of
Sports and Exercise Medicine

ORIGINAL ARTICLE

Effects of Body Composition on the Cardiorespiratory Capacities of Perimenopausal Women Living with Obesity

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Abstract

Introduction: Obesity is a metabolic disease characterized by abnormal fat accumulation. Physical inactivity can contribute to this accumulation of fat, which reduces cardiorespiratory capacity in obese women. The excess weight can impair both cardiometabolic and mechanical functions. The perimenopausal phase is marked by changes that affect women's body composition. Our aim is to identify the effects of body composition on cardio-respiratory capacities of perimenopausal women living with obesity.

Material and Methods: Our study concerned patients with obesity (BMI ≥ 30 Kg/m^2). Body composition analysis was carried out by bioelectric impedancemetry. It allowed us to identify the total fat mass (FM) and the lean mass (LM) in Kg and as a percentage. Cardiorespiratory capacities, oxygen consumption rate (VO_2max), heart rate max (HRmax) and metabolic equivalent of task (MET) were assessed using an ergocycle, for a maximal exercise test. The correlations between body composition and cardiorespiratory capacities were sought.

Results: 51 women, average age 41.12 ± 12 years, BMI = 36.9 ± 5.4 Kg/m^2, weight = 93.43 ± 14.9 kg including Fat Mass (FM) 41.3 ± 10 kg. The Heart Rate max (HRmax) was 152 ± 17bmp, the VO_2max was 16.5 ± 2.08 ml/Kg/min. Negative and statistically significant correlations were found between VO_2max and BMI (r = - 0.49, p = 0.02), FM in % (r = - 0.61, p < 0.01). Likewise, HRmax is inversely correlated (r = - 0.71) with age and in a highly significant manner (p < 0.001).

Conclusion: The accumulation of fatty tissue in our series seems to negatively influence cardiorespiratory capacities in perimenopausal women with obesity. Fat mass as a percentage provides better information on the evolution of VO_2max. In addition to age, this category of obese seems to present a limitation in effort that must be taken when prescribing an appropriate physical activity.

Keywords

Obesity, Fat mass, VO_2max, HRmax, Perimenopausal

Introduction

According to the World Health Organisation (WHO), almost 40% of adults aged over 18 were overweight in 2016 and 13% were declared obese [1]. Around 3.2 million deaths each year are attributable to insufficient physical activity [2]. Physical inactivity and obesity are a public health problem. They are considered to be risk factors for a number of cardiometabolic diseases, such as cardiovascular disease and diabetes [3]. However, there is no consensus on whether obesity and physical inactivity are linked or whether they are independent risk factors. In several populations, a range of studies have sought to verify the relationship between obesity and physical capacities of exercise. The results of these studies have shown that cardiorespiratory fitness (CRF) appears to be lower in obese subjects than in non-obese subjects [4,5]. However, controversial results have been described concerning the relationship between body fat mass and physical fitness [4,6]. Levels of aerobic physical fitness are traditionally assessed by maximum oxygen consumption rate (VO_2max). This reflects the maximum amount of oxygen used by the body during maximal exercise [7]. In addition, maximum oxygen consumption can be used as a means of identifying physiological performance levels during exercise.

VO_2max is generally expressed in relation to weight and per unit time (mL/kg/min). This parameter faithfully reproduces the degree of tolerance to physical exercise [8]. This applies to obese individuals, defined as such in a clear way [9], VO_2max should be readjusted. It would be

Citation: GUEDJATI MR, TAIBI AD, MAAKOUF S (2025) Effects of Body Composition on the Cardiorespiratory Capacities of Perimenopausal Women Living with Obesity. Int J Sports Exerc Med 11:073 doi.org/10.23937/2469-5718/1510273

Accepted: July 04, 2025: **Published:** July 08, 2025

more accurate when related to lean body mass (in mL/kg/min), as this better reflects the physiological capacity of the tissue to consume oxygen [6]. In overweight and obese adults, this relationship may present some particularities. Overweight and obese people are characterised by a high percentage of body fat, which can affect oxygen consumption. The controversy lies in the use of the absolute value of VO_2max (L/min). Indeed, and during exercise, overweight and obese people should also have a greater fat mass (FM) than lean mass (LM), which can contribute tohigher absolute values [6]. On the other hand, it is not known whether a high body fat mass can affect its own oxygen consumption. Ideally, to allow inter- individual comparison, absolute VO_2max should be considered taking into account physiological muscle mass and therefore the muscles involved in physical exercise [10,11]. Skeletal muscle tissue is primarily responsible for the increase in oxygen consumption during exercise and physical activity. It also contributes to the increase in left ventricular, end-diastolic and systolic volumes, and cardiac output, hence VO_2max [12,13]. Nevertheless, for practical reasons, lean body mass or fat-free mass (FFM) is often used instead of skeletal muscle mass, as these compartments are made up mainly of muscle mass. The influence of gender on body functions has been identified as a key factor in the interpretation of biological data. The physiological changes that can affect body composition in women are well known. They also affect cardiorespiratory capacities (CRF) under stress [14]. The perimenopause is a period of transition. It is often marked by a drop in resting metabolism and levels of physical activity. These two factors, if not offset by lifestyle adjustments, contribute to weight gain. A number of studies have shown that perimenopausal women experience an accumulation of body fat, particularly around the abdomen, probably due to hormonal fluctuations associated with a drop in energy expenditure. This accumulation of visceral fat (VF) can lead to an increased risk of cardiometabolic diseases [15,16]. In addition to the increase in body fat, it has been observed that muscle mass tends to decrease during the perimenopause. This phenomenon contributes to a slower metabolism and increased fat accumulation. This reduction in muscle mass also affects bone density [17].

As far as we know, this population category of perimenopausal women deserves special attention. The hormonal transition characteristic of this phase of life is associated with a number of risk factors, of which obesity and the resulting cardiometabolic sequelae are prominent. Structured management approaches should be envisaged, including training sessions, provided that clarification is given regarding the impact of body composition on cardiorespiratory capacities.

Our aim is to identify the effects of body composition on cardiorespiratory fitness in perimenopausal women living with obesity.

Method and Materials

The study population

Our study included 51 women who were obese (BMI ≥ 30 kg/m^2). Perimenopausal age was considered to be between 30 and 55 years. Women with a serious illness or any contraindication to exercise were excluded.

Body composition analysis

It was performed using bioelectrical impedancemetry with 8 electrodes (BC 418 MA TANITA Japan). All patients fasted, had an empty bladder and were scantily clad. In addition to weight and BMI, the analysis provided fat mass (FM) expressed in kilograms and as a percentage, total body water expressed as a percentage, lean mass (LM) expressed in kilograms and visceral fat (VF) expressed as an absolute value.

The maximal effort test

The cardiorespiratory exercise test was performed on an ergocycle (E100 COSMED Italy). The parameters were collected by a monitor (Fitmate Med COSMED Italy). The patients fasted and wore suitable exercise clothing. We used a max bike ramp protocol of 10 watts/min. The empty warm-up phase lasted 2 minutes. We began the test in increments of 10 watts per minute until exhaustion. The test ended with a two-stage active and passive recovery phase. The effort parameters were monitored on the monitor's LCD. These parameters were printed out for analysis at the end of the test: maximum heart rate (HRmax), measured and theoretical, expressed in beats per minute (bpm), maximum oxygen consumption rate (VO_2max), measured, theoretical and predicted, expressed in (mL/kg/min), Maximum Aerobic Power (MAP) corresponding to the maximum load and expressed in watts, and metabolic equivalents of task (MET).

Statistical analysis

This is a descriptive study. The data was entered into Excel MICROSOFT 2024. The results were analysed on the website https://www.pvalue.io/fr/ [18]. They are expressed as the mean plus or minus the standard deviation. Pearson correlations (r) between body composition and functional capacities linked to exercise were sought. These results are considered statistically significant for a p value < 0.05.

Results

Our study included 51 women with a mean age of 41.5 ± 12.9 years. They were obese with an average weight of 36.6 ± kg/m^2. Visceral fat was 9.52 ± 3.84. Body fat averaged 41.3 ± 10 kg, for a percentage of 45 ± 6.65 %. (Table 1).

We found, a moderate level of physical activity with MET 4.77 ± 0.576. The estimated $\dot{V}O2max$ was 16.2 ± 1.65 (mL/kg/min) and measured was 16.5 ± 2.08 (mL/kg/min), this parameter represents almost half of the predicted value 32.7 ± 4.77 (mL/kg/min) (Table 2).

Table 1: General characteristics of the study population

	Mean (± standard deviation)	Median [Q25-75]	Min	Max
Age (years)	41.5 (12.9)	45.0 [33.0; 52.0]	18.0	59.0
Weight (kg)	93.4 (14.9)	89.7 [82.6; 102]	71.7	127
Height (cm)	159 (4.73)	160 [155; 164]	151	167
BMI (kg/m2)	36.9 (5.74)	35.8 [32.3; 41.0]	27.7	47.3
Visceral Fat (VF)	9.52 (3.84)	11.0 [7.00; 12.0]	1.00	15.0
Fat mass (%)	45.0 (6.65)	45.4 [42.4; 47.3]	33.9	65.8
Fat mass (kg)	41.3 (10.0)	38.7 [35.0; 46.8]	24.3	66.3
Lean mass (kg)	51.3 (4.51)	50.6 [48.1; 53.9]	43.3	60.9

Table 2: Cardiorespiratory fitness following a maximal exercise test.

	Mean (± standard deviation)	Median [Q25-75]	Min	Max
Resting heart rate (bpm)	78.5 (7.83)	80.0 [72.0; 83.0]	65.0	95.0
HRmax measured (bpm)	152 (17.2)	150 [137; 162]	127	189
Theoretical HRmax (bpm)	179 (8.99)	176 [172; 185]	167	195
Metabolic Equivalent of Task (MET)	4.77 (0.576)	4.80 [4.50; 5.10]	3.70	5.80
Load (watts)ǂ	86.2 (12.8)	90.0 [80.0; 90.0]	70.0	110
Estimated VO_2max (mL/kg/min)	16.2 (1.65)	15.8 [15.2; 17.3]	12.7	19.7
measured VO_2max (mL/kg/mn)	16.5 (2.08)	16.3 [15.7; 17.8]	13.1	20.4
Predictive VO_2max (mL/kg/mn)	32.7 (4.77)	31.4 [28.8; 35.8]	26.2	41.3

Table 3: Correlations between cardiorespiratory capacities and body composition

	Age (years)		Weight (kg)		Height (cm)		BMI (kg/m2)		Visceral Fat (VF)		Fat Mass (%)		Fat Mass (kg)		Lean mass (kg)	
	r*	p	r*	p	r*	p	r*	p	r*	p	r*	p	r*	p	r*	p
Resting heart rate (bpm)	-0.264	0.25	0.0361	0.88	0.369	0.099	-0.0406	0.86	-0.268	0.24	-0.0625	0.79	- 0.0191	0.93	0.141	0.54
HRmax measured (bpm)	-0.718	**< 0.001**	-0.0214	0.93	0.0124	0.96	-0.00978	0.97	-0.00787	0.97	0.00715	0.98	0.109	0.64	0.000693	1
Theoretical HRmax (bpm)	-0.990	**< 0.001**	0.155	0.5	-	0.44	-	0.79	-0.267	0.24	0.0826	0.72	-	0.49	-	0.36
Metabolic Equivalent of Task (MET)	-0.0988	0.67	-0.294	0.2	0.272	0.23	-0.345	0.13	-0.163	0.48	-0.489	**0.024**	-	0.28	-	0.71
Load (watts)‡	-0.415	0.062	0.248	0.28	0.254	0.27	0.251	0.27	-0.0202	0.93	0.125	0.59	0.425	0.055	0.458	**0.037**
Estimated VO_2max max(mL/kg/min)	-0.190	0.41	-0.543	**0.011**	0.0709	0.76	-0.646	**< 0.01**	-0.132	0.57	-0.529	**0.014**	-0.542	**0.011**	-0.413	0.063
measured VO_2max (mL/kg/mn)	-0.0665	0.77	-0.408	0.066	0.196	0.4	-0.478	**0.029**	-0.107	0.65	-0.613	**< 0.01**	-0.442	**0.045**	-0.0777	0.74
Predictive VO_2max (mL/kg/mn)	-1.000	**< 0.001**	0.139	0.55	-	0.52	-	0.82	-0.267	0.24	0.0795	0.73	-	0.51	-	0.43

* Pearson correlation

(p) is statistically significant for a value < 0.05

Age has a negative and statistically significant influence on HRmax ($p<0.001$). Similarly, maximal oxygen consumption rates (VO_2max) evolved inversely with BMI, r = (-0.47), p = 0.02 (Table 3). A strong correlation was found between maximum oxygen consumption rates (VO_2max) and total fat mass both expressed as a percentage (r = -0.61 p < 0.01) and in kilograms (r = -0.54 p = 0.01), Lean mass evolves positively with MAP expressed as a load r = 0.45 p = 0.03 (Table 3).

Discussion

Obesity is a disease with serious health consequences. In addition to cardiovascular disease, it exposes people to metabolic risks such as diabetes [19,20]. The treatment of obesity is based on lifestyle changes [21,22]. These changes are based on two main principles: a balanced diet and regular physical activity [22,23]. In order to undertake physical activity, an assessment of cardiorespiratory functional capacity in people living with obesity is indicated [24]. Our work was carried out on a population of women living with obesity, with the aim of identifying the effects of body composition on cardiorespiratory functional capacity during exercise. We were able to demonstrate that the BMI of people living with obesity has certain limitations. The BMI already has limits of interpretation [25] and the BMI of this category of individuals does not, on its own, identify the effects of obesity on physical capacity [26]. BMI, calculated using biometric parameters, is inversely proportional to VO_2max, weight expressed in kilograms and the square of the height expressed in metres [27]. The latter does not seem to have any link with the reduction in functional capacity linked to exercise, particularly in people living with obesity. The WHO defines obesity as an excess of fatty tissue that can damage health [28]. Excess fat tissue is assessed by the anthropometric measurement as BMI 28]. While height did not have a significant influence on functional exercise capacity in our series of studies, weight, on the other hand, appears to have a negative effect on maximum oxygen consumption rate. Khona et al found similar correlations [29]. The contribution of our work lies in highlighting the negative effects of body fat on physical capacity. Expressed in kilograms or as a percentage, our results are similar to those of Khona and Dimkpa [29,30]. Notable correlations were observed between VO_2max max levels and anthropometric variables, such as height ($p < 0.001$), BMI ($p = 0.004$), fat free mass ($p < 0.001$), fat mass ($p < 0.001$) and percentage fat mass ($p < 0.001$). However, Dimkpa did not find strong correlations between the level of physical activity and the percentage of body fat, in contrast to our results, where a negative correlation was found between visceral fat and the level of physical activity. It should also be emphasised that, based on weight, the measurement of VO_2max in people living with obesity presents certain limits of interpretation [31], even though weight significantly alters the work done by the heart, particularly in terms of maximum heart rate (HRmax) [32].

VO_2max is often expressed in relation to lean mass, of which muscle mass represents the whole. It is therefore more judicious to use fat free mass (FFM). This particular attention given to this parameter, lean mass, plays a major role in our work. It would seem that, in addition to the predisposition of the women in our sample to the cardiometabolic risks associated with obesity, there is the additional risk of sarcopenia in this category of women, the early diagnosis of which is essential [32]. The originality of our study lies in having explored the effects of body composition on physical capacity in women who are vulnerable in both metabolic and hormonal terms, and for whom body composition analysis is recommended [32]. Body composition analysis refers to objective methods for assessing the distribution of body fat, fat free mass (FFM) and muscle mass [33]. In addition, assessing body composition provides valuable information for evaluating nutritional status, functional capacity, and quality of life [34]. The reduction in muscle mass in women living with obesity is maintained by hormonal changes during the menopause. Higher body weight and specially body fat mass have been associated with serious menopause-related symptoms, particularly the somato vegetative state and psychological symptoms. However, in the case of cardiorespiratory fitness (CRF), no association between symptoms has been reported [35]. We believe that the vulnerability of this category of people lies in a vicious circle maintained by perimenopausal hormonal changes that favour loss of lean body mass and encourage a sedentary lifestyle and hence obesity. Goodwin et al have shown that women who develop ovarian failure following hormone therapy have a significantly greater increase in body mass than those who remain premenopausal [35]. This increase in body mass is associated with a redistribution of adipose tissue towards the trunk [36,37]. Skeletal muscle tissue is primarily responsible for the increase in oxygen consumption during exercise and physical activity. It also contributes to increases in left ventricular, end-diastolic and systolic volumes and cardiac output, and hence VO_2max [12,13]. The results of the study reveal a positive correlation between perimenopausal age and several physiological parameters, including body weight, body mass index (BMI), resting energy metabolism (RMR) and visceral fat (VF). However, skeletal muscle mass was found to correlate inversely with body fat. These results highlight the changes that occur during this phase of life and their potential impact on overall health [38]. Our results consolidate the negative effects of the perimenopausal phase on body composition, which is a significant finding given the challenges women face during this life stage and, consequently, on exercise-related physical capacity in women living with obesity.

It should be noted that additional factors such as genetics and gender may influence body composition and CRF status [39]. Gail et al have quantified the longitudinal evolution of trajectories linking body composition and weight before, during and after the menopausal transition phase [40]. With regard to body composition, significant changes were observed, with an increase in fat mass and a decrease in lean mass, before the onset of the menopause. Analysis of the data collected revealed a significant acceleration in changes in body composition during the menopausal transition period, marked by a two- to four-fold increase in fat mass and a proportional loss of lean mass. In this study, it was observed that, on average, body composition stabilised in the post-menopausal period, with a zero slope. The average patterns of change in body weight and BMI differed from those of body composition. In particular, weight and BMI increased steadily before and during the menopausal transition, with no acceleration related to the menopausal transition [40]. It was observed that, similarly to body composition, weight did not increase significantly during the post-menopausal period.

Even our work has certain limitations. The sample size is small. It was difficult to recruit a larger number of patients for whom stress tests would be performed. This kind of test is not something that is usually done, particularly in women who are obese and who are at a time in their lives when their metabolism is vulnerable, which is often the case during perimenopause. We had no information about the clinical, hormonal and psychological changes associated with this phase of the menopause in our study. The fact that we have studied this phenomenon in this population of women is a strong point of our work. Changes during this period of life seem to influence body composition and make perimenopausal women even more fragile. It is recommended that the sample size be increased and that more details be provided on the effects of hormonal changes in this category of women on body composition and cardiorespiratory fitness.

Conclusion

In women living with obesity, BMI and body composition have a negative impact on respiratory capacity during exercise in the perimenopausal hormonal transition period.

This category of women needs to be given special attention, as they appear to be more metabolically vulnerable.

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