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Relationships between Body Composition and Exercise Capacity in Obese Women

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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. **Methods:** The present study was concerned with 51 women obese patients (BMI ≥ 30 Kg/m2). Body composition analysis was carried out by Bioelectric Impedance Analyser (BIA) which identified total body fat mass (FM) and the lean mass (LM) in Kg and as a percentage. Cardiorespiratory capacities (VO_2 max), heart rate max (HRmax) and metabolic equivalent of task (MET) were assessed using an ergocycle. The correlations between body composition and cardiorespiratory capacities were calculated. **Results:** Average age of the obese women of the present study was 41.1 ± 12 years with average BMI of 36.9 ± 5.4 Kg.m-2. Average body weight was 93.43 ± 14.9 kg with an average Fat Mass (FM) of 41.3 ± 10 kg were observed. Average Heart Rate max (HRmax) of 152 ± 17 bmp with an average VO_2 max was 16.5 ± 2.08 ml. Kg -1.min-1 Were observed for the present study. Negative and statistically significant correlations were observed between VO_2 max and BMI ($r = -0.49$, $p \leq 0.02$), between VO_2 max and FM % ($r = -0.61$, $p \leq 0.01$). Similarly, HRmax was inversely correlated ($r = -0.71$, $p \leq 0.001$ with age). **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_2 max. 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_2 max, HRmax, Perimenopausal

Relaciones entre la composición corporal y la capacidad de ejercicio en mujeres obesas

Resumen

Introducción: La obesidad es una enfermedad metabólica caracterizada por la acumulación anormal de grasa. La inactividad física puede contribuir an esta acumulación de grasa, lo que reduce la capacidad cardiorrespiratoria en mujeres obesas. El exceso de peso puede perjudicar tanto las funciones cardiometabólicas como las mecánicas. La fase perimenopáusica está marcada por cambios que afectan la composición corporal de las mujeres. Nuestro objetivo es identificar los efectos de la composición corporal en las capacidades cardiorrespiratorias de mujeres perimenopáusicas que viven con obesidad. **Métodos:** El presente estudio se centró en 51 pacientes mujeres obesas (IMC ≥ 30 Kg/m2). El análisis de la composición corporal se realizó mediante UN analizador de impedancia bioeléctrica (BIA) que identificó la masa grasa corporal total (FM) y la masa magra (ML) en kg y como porcentaje. Las capacidades cardiorrespiratorias (VO_2 máx), la frecuencia cardíaca máxima (FCmáx) y el equivalente metabólico de la tarea (MET) se evaluaron utilizando un ergociclo. Se calcularon las correlaciones entre la composición corporal y las capacidades cardiorrespiratorias. **Resultados:** La edad promedio de las mujeres obesas Del presente estudio fue de 41, 1 ± 12 años con un IMC promedio de 36, 9 ± 5, 4 Kg.m-2. El peso corporal promedio fue de 93, 43 ± 14, 9 kg con una masa grasa (FM) promedio de 41, 3 ± 10 kg. Se observó una frecuencia cardíaca máxima promedio (FCmáx) de 152 ± 17 bmp con un VO_2 máx promedio de 16,5 ± 2,08 ml. Se observaron kg -1.min-1 para el presente estudio. Se observaron correlaciones negativas y estadísticamente significativas entre el VO_2 máx y el IMC (r = - 0, 49, p ≤ 0, 02), entre el VO_2 máx y el % FM (r = - 0, 61, p ≤ 0, 01). De forma similar, la FCmáx se correlacionó inversamente (r = - 0, 71, p ≤ 0,001 con la edad). **Conclusión:** La acumulación de tejido graso en nuestra serie parece influir negativamente en la capacidad cardiorrespiratoria de las mujeres perimenopáusicas con obesidad. La masa grasa como porcentaje proporciona mejor información sobre la evolución del VO_2 máx. Además de la edad, esta categoría de obesos parece presentar una limitación en el esfuerzo que debe tenerse en cuenta al prescribir una actividad física adecuada.

Palabras Clave: Obesidad, Masa grasa, VO_2 máx, FCmáx, Perimenopáusica

Introduction

According to the World Health Organisation, almost 40% of adults aged over 18 were overweight in 2016 and 13% were declared obese (WHO, 2025a) Around 3.2 million deaths each year are attributable to insufficient physical activity (WHO, 2025b). Physical inactivity and obesity are a public health problem. They are considered to be risk factors for a number of cardiometabolic diseases, like cardiovascular disease and diabetes (Barnes, 2012). 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 population than in non-obese population (Dickie *et al.* 2016). However, controversial results have been reported on the relationship between body fat mass and physical fitness (Dickie *et al.* 2016); Aerobic physical fitness is assessed by maximum oxygen consumption capacity (VO_2 max). This reflects the maximum amount of oxygen used by the body during maximal exercise (Bassett & Howley (1997) .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_2 max (L/min). During exercise, overweight and obese people carries more Fat mass (FM) with less Lean Mass (LM) which can contribute to higher absolute values .On the other hand, it is not known whether a high body fat mass can affect its own oxygen consumption. The physiological changes that can affect body composition in women are well known. They also affect cardiorespiratory capacities (CRF) under stress (Weltman *et al.* 1994). 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 (Lovejoy *et al.* 2008). 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 (Chitransh *et al.* 2023). 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. The aim of the present study was to identify the effects of body composition on cardiorespiratory fitness in perimenopausal women living with obesity.

Materials and Methods

Study Population

The study included 51 women who were obese (BMI ≥ 30 kg/m2). 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 for VO_2 max

The cardiorespiratory exercise test was performed on an Ergocycle (E100 COSMED Italy). VO_2 max was measured by direct method with a Metabolic Analyzer (Fitmate Med COSMED, Italy). Heart rate was recorded with Polar Sports Tester (Polar Electro, Finland) .Standard protocol was followed for measuring Maximum Oxygen consumption capacity.

Statistical Analysis

SPSS version 10 was used for statistical analysis. Results were considered statistically significant for a $p < 0.05$.

Results

Table 1. Physical characteristics and body composition of the studied population (n=51)

	Mean (± SD)	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 of the studied population (n=51)

	Mean (± SD)	**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)	86.2 (12.8)	90.0 [80.0; 90.0]	70.0	110
Estimated VO_2 max (mL/kg/min)	16.2 (1.65)	15.8 [15.2; 17.3]	12.7	19.7
measured VO_2 max (mL/kg/mn)	16.5 (2.08)	16.3 [15.7; 17.8]	13.1	20.4
Predictive VO_2 max (mL/kg/mn)	32.7 (4.77)	31.4 [28.8; 35.8]	26.2	41.3

Discussion

Obesity is a disease with serious health consequences. In addition to cardiovascular disease, it exposes people to metabolic risks such as diabetes (Grant & Sandelson, 2021). The treatment of obesity is based on lifestyle changes (Mallik *et al.* 2023). These changes are based on two main principles: a balanced diet and regular physical activity (Mallik *et al.* 2023). In order to undertake physical activity, an assessment of cardiorespiratory functional capacity in people living with obesity is indicated (Sweatt *et al.* 2024). The present study 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. Authors were able to demonstrate that the BMI of people living with obesity has certain limitations (Table 1 and Table 2).asasa

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_2 max 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_2 max (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_2 max (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

The contribution of the present study laid on highlighting the negative effects of body fat on physical capacity (Table 2). The present finding was very similar to the findings of Khona *et. al* (2017). In the present study, notable correlations were observed between VO_2 max levels and anthropometric variables (Table 3). VO_2 max 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). Fat Free Mass (FFM) played a major role in the present study.

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 somatovegetative state and psychological symptoms. However, in the case of cardiorespiratory fitness (CRF), no association between symptoms has been reported (Hyvärinen *et al.* 2024).

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. Study showed that women who develop ovarian failure following hormone therapy have a significantly greater increase in body mass than those who remain premenopausal (Hyvärinen *et al.* 2024). The results of the present study revealed 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 (Table 3). These results highlight the changes that occur during this phase of life and their potential impact on overall health. Results of the present study consolidated the negative effects of the perimenopausal phase on body composition, which was a significant finding given the challenges to women to face during this Perimenopausal stage and, consequently, on exercise-related physical capacity in women living with obesity.

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 stabilized 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. It was observed that weight did not increase significantly during the post-menopausal period. Changes during this period of life seemed to influence body composition and make perimenopausal women even more fragile.

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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Conflicts of Interest

No conflict of interest to declare