ORIGINAL ARTICLE

Obesity Indices, Cardiorespiratory Fitness and Mental Health in Obese and Non-Obese Women: A Cross-Sectional Study

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Abstract

Background: Obesity is a contributing factor to depression and anxiety in women and is linked to decreased cardiorespiratory fitness. Middle-aged women with high levels of anxiety and depression have been found to have higher obesity indices. The relationship between obesity and depression/anxiety is bidirectional, with each potentially causing or exacerbating the other. There is evidence to suggest that the association is more likely in individuals with abdominal obesity. It is known that this type of obesity is strongly linked to metabolic and cardiovascular changes.

Objective: To determine whether the presence of obesity affects anthropometric parameters, cardiorespiratory fitness, and symptoms of anxiety and depression in women.

Methods: A total of 103 women aged between 18-59 years participated in the study. An evaluation of anxiety and depression symptoms was conducted using the Beck Inventory, while cardiorespiratory fitness was assessed using the shuttle run test. Anthropometric measurements and body composition were evaluated using body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), and body fat percentage (%BF). The groups were compared using the t-Student and Mann-Whitney tests, frequencies were compared using the Chi-square test, and correlation was assessed using Spearman and Pearson methods.

Results: The overweight group had higher waist circumference (WC) (Δ = 14.4 cm, p =< 0.001), waist-to-hip ratio (WHR) (Δ = 0.1, p =< 0.001), percentage of body fat (%BF) (Δ = 11. 7, p =< 0.001), and scores for anxiety (Δ = 4.4, p = 0.056) and depression symptoms (Δ = 4.7, p = 0.016), while VO_{2max} (Δ = 0.8 ml/kg/min, p = 0.040) was lower. BMI, WC, and WHR were directly related to workload (p = 0.020) and negatively related to VO_{2max}.

Conclusion: Obesity in women may be related to physical and mental health damage, workload, and a reduction in the ability to perform aerobic exercise. Changes in lifestyle habits, such as adequate nutrition, increased physical activity, and stress reduction, can be effective in improving the quality of life related to the work environment. This can also lead to a reduction in medical certificates and sick leave.

Keywords

Obesity, Physical and mental health, Cardiorespiratory fitness, Workload, Women

Background

Obesity is defined as having excess body fat and is a significant health concern due to its association with cardiovascular diseases, diabetes, and certain types of cancer, as well as an increased risk of mortality [1]. In Brazil, the number of obese individuals has increased by 72% in the past 13 years, and it is projected that by 2025, 2.3 billion adults worldwide will be overweight

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[2]. Research suggests that there is a higher prevalence of overweight/obesity in women compared to men [3-5].

The relationship between obesity and symptoms of anxiety and depression has been extensively studied. Although this relationship is not yet fully understood, studies have shown that obese individuals tend to experience more depression [6]. This relationship may be attributed to psychological symptoms resulting from negative self-perception of body image related to stigmatization of overweight, inducing eating disorders that lead to negative emotions, mood swings, and depression [7,8], or biological factors resulting from the damage that obesity causes to hormonal functions, especially in women [9].

Research suggests that individuals with anxiety and depression, particularly women, exhibit higher predictive values for measures of obesity, such as waist circumference (WC), body fat percentage (%BF), and abdominal volume [6,10]. Abdominal obesity is directly related to cardiorespiratory fitness (CRF), meaning that individuals with reduced CRF have a higher abdominal volume index and are therefore more likely to develop cardiovascular disease (CVD) [11,12]. Furthermore, improved CRF levels are linked to a decreased risk of CVD mortality in both obese and eutrophic women [13]. Long working hours [14-16] and factors such as monthly income, work status, education level, and duration of sleep are associated with body mass gain [14]. Workload may be a possible explanation for obesity as it reduces the time available for physical activities and sleep.

The study compared women of normal weight with those who were pre-obese and obese. The participants were employees of a university, a population that has been under-evaluated despite their long workload both inside and outside the home. Many of the participants have a double working day, including domestic services, which makes it difficult for them to engage in physical exercise. Maintaining a seated posture for extended periods can lead to a reduction in daily caloric expenditure, increasing the risk of obesity and symptoms of anxiety and depression, and decreasing cardiorespiratory fitness. It is important to note that there is evidence of a relationship between obesity and symptoms of depression [9].

Although there are studies in the literature that evaluate the relationship between body composition and symptoms of depression, there is still a lack of research on employees in the university environment. It is important to assess this population because they work in public service positions with many people in the same place, among other factors previously mentioned. To assess the obesity outcomes among female university workers, it is necessary to use cardiovascular risk factors such as cardiorespiratory fitness assessment,

which is a protective factor against cardiovascular diseases. Additionally, it is important to verify the presence of symptoms of anxiety and depression. It is worth mentioning that working conditions in university environments can vary, including time spent sitting, standing, or in movement during work hours. The aim of this study was to investigate whether obesity affects anthropometric parameters, cardiorespiratory fitness, and symptoms of anxiety and depression in women.

Methods

Sample

This cross-sectional study was conducted with female employees of a higher education institution. At the time of the research, the institution had 1726 employees, of which 935 were women. Out of the 423 women approached, only 103 agreed to participate in the study. Of these, 68 (66%) were from the administrative sector, 30 (29%) were from general services, and 5 (5%) were teachers. The sample was recruited for convenience. The study included only female participants between the ages of 18 and 59 who had been employed by the institution since at least 2019. Those who did not complete all stages of the research, had any recent infectious or autoimmune disease, severe heart disease, and/or chronic lung disease were excluded. The sample power calculation was performed post hoc based on the statistical test to be used (comparison of two groups and correlation in continuous variables), considering an average effect size of 0.5, a significance level of 5%, 53 eutrophic women and 50 women with overweight/obesity. A power of 81% was achieved.

Study design

The project received approval from the Ethics and Research Committee on human beings of the Evangelical University of Goiás - UniEVANGÉLICA under number 4,441,878/2021. All participants who agreed to collaborate signed the Informed Consent Form.

Data were collected between January and June 2021 at the Laboratory of Evaluation and Intervention in Physiotherapy and at the multi-sport gym at Universidade Evangélica de Goiás - UniEVANGÉLICA. The data collection was interrupted twice due to the lockdowns imposed during the pandemic. The study began by collecting sociodemographic data, followed by administering the Beck questionnaires for anxiety and depression. Anthropometric measurements, including waist circumference (WC), hip circumference (HC), and body fat percentage (%BF), were then taken. Finally, the maximum oxygen consumption (VO_{2max}) was estimated through the CRF test.

Outcome variables

The study classified women's weight using BMI as the dependent variable and used anthropometric

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measurements (WC, WHR), body fat (%BF), cardiorespiratory fitness (VO$_{2max}$), symptoms of anxiety and depression, and daily and weekly workload as independent variables.

Assessment protocols

Sociodemographic data: The study collected sociodemographic data on age, education level, marital status, monthly income, physical exercise, and weekly and daily workload.

Anthropometric measurements and body composition: BMI was calculated by dividing weight in kilograms by height in meters squared, classifying women as eutrophic with values less than 25 kg/m^2 and overweight/obese with values greater than or equal to 25 kg/m^2 [17]. Waist circumference (WC) and hip circumference (HC) were measured using an inextensible tape measure (Sanny brand, model TR-4010 2m, São Paulo, Brazil). To measure waist circumference (WC), place the tape around the abdomen at the midpoint between the last rib and the iliac crest. For hip circumference (HC), position the tape at the level of the greater trochanter of the femur, around the hip. This method allows for the calculation of waist-to-hip ratio (WHR) by dividing WC by HC. The reference values for WC and WHR are ≥ 88 cm and < 0.76 cm, respectively [18].

The body fat percentage (%BF) was assessed using the seven-site skinfold protocol developed for adult females [19]. The skinfolds assessed were triceps (TR), middle axillary (AM), pectoral (PT), medial thigh (CX), subscapular (SE), suprailiac (SI), and abdominal (AB). The folds were pinched using an adipometer (Sanny brand, model AD1011-LD, São Paulo, Brazil) and measured at least twice consecutively by the same evaluator. The following equations were used and interpreted according to Jackson, et al. [19]. Where: Σ7SF = sum of 7 skinfolds (SE + TR + PT + AM + SI + AB + CX).

Equation 1: Body density = 1.097 - 0.00046971(Σ7SF) + 0.00000056(Σ7SF)^2 – 0.00012828* (age)

Equation 2: Fat Percentage (%BF)= (495/SF) – 450.

Beck inventory: The self-administered Beck questionnaire, validated for the Brazilian population, was utilized. It consists of 21 multiple-choice questions [20] and employs a four-point Likert scale (ranging from 0 to 3) for symptom classification, where 0 indicates no symptoms and 3 indicates severe symptoms. After completing the questionnaire, the points were categorized as follows: No depression/anxiety (0 to 13 points), mild depression/anxiety (14 to 19), moderate depression/anxiety (20 to 28), and severe depression/anxiety (29 to 63 points) [21].

Cardiorespiratory fitness: The CRF was evaluated using the 20-meter shuttle run test, which has been validated for Brazilians [22]. This test is capable of identifying maximum aerobic power on a flat surface, specifically on a 20-meter track, as described by Léger, et al. [23]. A metronome was used to reproduce sequences of beeps with increasing intensities, starting at 8.5 km/h. The test consists of 20 stages, with the number of laps increasing with each stage. The test was stopped when participants failed to complete two subsequent stages. The velocity of the final completed stage was used to estimate VO$_{2max}$ using the formula [22,23]:

Equation 3: VO$_{2max}$ = - 24.4 + 6 x (Vel.) ml/kg/min.

Data analysis: The normality of the data was assessed using the Kolmogorov-Smirnov test and expressed as mean, standard deviation, frequency, and percentage. To compare two groups (eutrophic and overweight), the student's t-test was used for independent samples with a normal distribution, and the Mann-Whitney test was used for independent samples with an asymmetric distribution. The Chi-square test was also conducted to compare frequencies. Additionally, correlation analysis was conducted using both Spearman (for asymmetrical distribution) and Pearson (for symmetrical distribution) coefficients for continuous variables. The effect size was calculated and classified according to Cohen [24]. The p-value threshold was set at < 0.05, and the Statistical Package for the Social Sciences (SPSS, IBM, version 23.0, Armonk, NY) was used for the analysis.

Results

Table 1 presents the sociodemographic characteristics of the evaluated women. Participants had completed higher education, with 60.2% holding master's and doctoral degrees. Additionally, 72.8% did not engage in physical exercise. Overall, 48.5% of the participants were classified as overweight.

The group of overweight women had higher values for WC (Δ = +14.4 cm, p < 0.001), WHR (Δ = +0.1, P < 0.001), and %BF (Δ = +11.7%, P < 0.001). VO$_{2max}$ presented lower values (Δ= -0.8 mL/kg/min, P = 0.040) and the depression symptoms scores (Δ = +4.5, P = 0.016) were higher in the overweight group (Table 2).

The Chi-square test indicated that among the overweight group there were 56% (P < 0.001) with CC, 90% (P = 0.006) with RCW and 98% with %BF higher. As for symptoms of depression and anxiety, 66% (P = 0.06) were between mild and severe and 56% (P = 0.034) had minimum symptoms, respectively. Regarding the weekly workload, 52% (P = 0.064) worked ≤ 40 h/week.

Obesity indices (BMI, WC and WHR) correlated negatively with VO$_{2max}$ and directly with working hours (Table 3).

Discussion

The study found that overweight women had higher values for waist circumference (WC), waist-to-hip ratio (WHR), and body fat percentage (%BF). Additionally, anxiety and depression scores were higher in overweight

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Table 1: Sample characterization (n = 103).

	Total (n = 103)	Eutrophic (n = 53)	Overweight (n = 50)	P-value*
Sociodemographic variables	Mean (SD)	Mean (SD)	Mean (SD)	
Age (years)	36.4 ± 10.2	34.2 ± 10.5	37.5 ± 9.4	0.150
Body mass (kg)	67.2 ± 12.7	59.7 ± 6.7	67.5 ± 6.0	< 0.001
Stature (m)	1.6 ± 0.1	1.63 ± 0.06	1.60 ± 0.06	0.026
	n (%)	n (%)	n (%)	
Physical exercise				
Yes	28 (27.2)	17 (32.1)	11 (22.0)	0.251
No	75 (72.8)	36 (67.9)	39 (78.0)	
Education level				
Elementary Level	21 (20.3)	06 (11.3)	15 (30.0)	
Incomplete higher education	20 (19.4)	14 (26.5)	06 (12.0)	0.094
Complete higher education	34 (33.0)	16 (30.2)	18 (36.0)	
Post-graduation	28 (27.2)	17 (32.1)	11 (22.0)	
Marital status				
Married	62 (60.2)	33 (62.3)	29 (58.0)	
Divorced	03 (2.9)	01 (1.9)	04 (4.0)	0.588
Single	37 (35.9)	19 (35.8)	18 (36.0)	
Widowed	01 (1.0)	0 (0)	01 (2.0)	
Climacteric				
Yes	11 (10.7)	04 (7.5)	07 (14.0)	0.289
No	92 (89.3)	49 (92.5)	43 (86.0)	

SD: Standard Deviation *Data to P < 0.05.

Table 2: Comparison of obesity indices, cardiorespiratory fitness, symptoms of anxiety and depression, and workload between eutrophic and overweight women (n = 103).

	Total (n = 103)	Eutrophic (n = 53)	Overweight (n = 50)		
Parameters	Mean (SD)	Mean (SD)	Mean (SD)	ES	P-value*
Body mass index (kg/m²)	25.8 ± 4.7	22.5 ± 2.1	29.3 ± 4.2	0.71	< 0.001
Waist circumference (cm)	82.6 ± 12.4	75.6 ± 7.5	90.0 ± 12.3	0.58	< 0.001
Waist-hip ratio	0.81 ± 0.09	0.77 ± 0.06	0.85 ± 0.11	0.41	< 0.001
Body fat percentage (%)	46.7 ± 12.5	41.0 ± 10.5	52.7 ± 11.5	1.06	< 0.001
VO_{2max} (ml/kg/min)	25.2 ± 2.1	25.6 ± 2.3	24.8 ± 1.7	0.19	0.040
Score BIA	15.5 ± 10.8	13.3 ± 9.9	17.7 ± 11.6	0.20	0.056
Score BID	12.9 ± 9.6	10.7 ± 7.7	15.2 ± 10.7	0.23	0.016
Weekly workload (h/wk)	40.9 ± 4.6	40.1 ± 5.2	41.8 ± 3.7	0.19	0.061
Daily workload (h/d)	8.2 ± 0.9	8.0 ± 1.0	8.4 ± 0.7	0.63	0.061

SD: Standard Deviation; ES: Effect Size; VO_{2max}: maximum oxygen consumption; BIA: Beck Inventory of Anxiety; BID: Beck Inventory Depression. The t-Student for independent samples and Mann-Whitney for independent samples. *Data for P < 0.05.

women, who also had lower values for VO_{2max} compared to eutrophic women. The obesity indices (BMI, WC, and WHR) were found to be correlated with VO_{2max} and workload.

The study found a prevalence of 48.5% of overweight women, which is consistent with the literature (47.4%) [4]. Overweight women also showed higher values for WC, WHR, and %BF. These alterations are directly related to body fat. It is worth noting that in women,

an increase in body fat may be due to high androgen production linked to chronic stress, which induces dysregulation of the hypothalamic-pituitary-adrenal axis [25]. Additionally, mental disorders are associated with obesity, as approximately 43% of individuals with depression are obese [8].

In a study was found that women with a higher prevalence of obesity and %BF reported not having enough time to exercise [4]. This can be attributed

Table 3: Correlation of obesity indices with cardiorespiratory fitness, anxiety and depression scores, and weekly and daily workload (n = 103).

	BMI	WC	WHR	%BF
Parameters	r (P-value)	r (P-value)	r (P-value)	r (P-value)
VO_{2max} (mL/kg/min)	-0.21 (**0.035**)	-0.28 (**0.005**)	-0.38 (**< 0.001**)	-0.18 (0.071)
Score BIA	0.11 (0.269)	0.12 (0.225)	0.11 (0.270)	0.13 (0.187)
Score BID	0.16 (0.109)	0.15 (0.132)	0.13 (0.182)	0.14 (0.156)
Daily workload (h/d)	0.22 (**0.028**)	0.23 (**0.020**)	0.22 (**0.026**)	0.10 (0.510)
Weekly workload (h/wk)	0.22 (**0.028**)	0.23 (**0.020**)	0.22 (**0.026**)	0.10 (0.510)

BMI: Body Mass Index; WC: Waist Circumference; WHR: Waist-Hip Ratio; BF: Body Fat; VO_{2max}: maximum oxygen consumption; BIA: Beck Inventory of Anxiety; BID: Beck Inventory Depression. Correlation using Spearman (asymmetric distribution) and Pearson (Gaussian distribution). Data for P < 0.05.

to a reduction in physical activity, resulting in low displacement of body segments, metabolic expenditure, and increased body mass [26]. Additionally, the study showed that overweight women have a higher score of symptoms of depression.

Obesity and depression have been found to have a bidirectional relationship in women. Therefore, it is important to address both obesity and depression in women to improve their overall health and well-being. It is established that obesity can interfere with hormonal dysregulation by impairing the function of estrogen and progesterone, which disrupts the menstrual cycle and reduces the protective effect of hormones on mitochondrial function. This mitochondrial dysfunction can lead to worsening obesity and depression. Obesity can lead to worsening mitochondrial dysfunction and depression, which in turn can exacerbate obesity [9].

Although overweight women had the highest scores of depression symptoms, no correlation was found between obesity and depression. However, there is evidence of a correlation between BMI, WC, and symptoms of depression, suggesting that these women are at a greater risk of developing depression. Moreover, while the group of women with high WC showed the highest risk of severe depression, there was no relationship found between BMI and symptoms of depression [27].

Depression severity and presence have been linked to various factors, including BMI, WC, HC, WHR, %BF, and %BF of visceral fat [6]. Additionally, the results indicate that an increase in the abdominal volume index contributes to the development of anxiety and depression in women. The literature suggests that high anthropometric measures are associated with the development of cardiovascular diseases, particularly in women with higher anxiety and depression scores [10].

The study also found that overweight women have a lower VO_{2max}, which indicates reduced exercise tolerance. Additionally, there was an inverse relationship between body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) with maximal oxygen uptake (VO_{2max}). This may be since the majority of the sample does not engage in physical activity (PA) (72.8%). Good cardiorespiratory fitness (CRF) is a known protective factor against obesity and cardiovascular diseases. Low VO_{2max} values have been associated with high BMI levels and an increased risk of developing abdominal obesity in women [12,13,28,29]. According to Oktay, et al. [30], PA is the most effective strategy for maintaining good CRF as it reduces the adverse effects of excess adiposity and other CVD risk factors.

The study found a direct correlation between BMI and weekly and daily workload. Specifically, the majority of women who worked more than 40 hours per week were overweight. Previous research has shown a strong association between working hours and overweight/obesity [14,16]. Therefore, women who work for 40 or more hours per week are more likely to be obese. Additionally, the literature suggests that body mass is correlated with various factors such as age, education, income, physical activity, daily sleep duration, and daily caloric intake [14]. Another study found that women who work more than 9 hours a day have a higher BMI and %BF [15].

However, this study has some limitations. Firstly, there was a lack of participation from women, despite the expected sample size needed for generalization of results. Secondly, due to COVID-19, a lockdown was imposed during the time of data collection. Thirdly, a self-report questionnaire was used to assess symptoms of anxiety and depression, which may be subject to recall bias, despite being a validated questionnaire used in several other studies. Lastly, as this is a cross-sectional study, a cause-effect relationship could not be established. Finally, we did not investigate the relationship between monthly income and education level with obesity, as this relationship has been extensively studied.

This work's strengths are highlighted, particularly the use of other parameters related to obesity. Despite being the most widely used parameter in studies, BMI does not distinguish the amount of adipose tissue. The study utilized the 7-site skinfold test to determine body fat percentage, a cost-effective and validated method considered the gold standard in the literature. Results

showed that female university employees were found to be obese, which may be related to their workload. Additionally, symptoms of anxiety and depression were observed. Thus, it is suggested that universities include physical exercise programs in their occupational health initiatives. These programs should focus on short, high-intensity workouts to increase caloric expenditure throughout the day, which can lead to an increase in basal metabolism.

Conclusions

In conclusion overweight women had higher BMI, WC, WHR, and %BF, and impaired cardiorespiratory fitness compared to eutrophic women. Overweight women also exhibit higher scores for symptoms of anxiety and depression, and long working hours are associated with high BMI. The observed obesity may be related to physical and mental health damage. Considering the demands for quick resolutions, dynamism, and high productivity in society, it is important to address work environments. An effective alternative would be to invest in programs that promote lifestyle changes such as adopting a healthy diet, increasing physical activity, and reducing stress within the workplace. This approach could lead to a reduction in medical certificates and sick leave while improving the overall quality of life in the work environment.

Authors' Contributions

ARB and PHAS VS: Wrting original draft, Conceptualization, Methodology, and Data Collection, VS Wrting Original draft, Formal analysis, and End writing_review, ASMC Writing_review and editing. All Authors have approved the final version of the manuscript.

Funding

No support.

Conflict of Interest

The author declares no conflict of interest.

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