

Functional Aerobic Capacity and Quality of Life in Patients with Heart Failure by Body Mass Index Category and Different Body Mass Index

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Objective: Improved survival has been described in obese patients with heart failure (HF). However, whether this survival advantage is accompanied by better functional status has not been investigated in depth. Therefore, this study aimed to determine differences in clinical characteristics, functional aerobic capacity, and health-related quality of life among HF patients with different BMIs.

Methods: Cross-sectional descriptive study, 4 groups of patients with HF were compared according to BMI (underweight, normal weight, overweight, and obese). Sociodemographic and clinical variables were assessed using the Duke Activity Status Index, the Minnesota Living with Heart Failure Questionnaire (MLHFQ), and the Patient Health Questionnaire-9 (PHQ-9). Functional aerobic capacity was also assessed. The ethics committee approved the study, and all patients provided written informed consent.

Results: A total of 170 patients with HF were admitted; most were men. Arterial hypertension was more frequent in the obese group 33(84.6%) $P = .032$. Obese patients had higher waist circumference (103.9 ± 10.66 cm) and body fat ($34.44 \pm 7.33\%$; $P < .05$). High-density lipoprotein cholesterol was higher in the normal-weight group (50.72 ± 10.14 mg/dL; $P < .05$). The underweight group walked the shortest distance (231.5 ± 42.8 m), and the overweight group walked the longest (260.89 ± 45.1 m; $P < .05$). The obese group had higher MLHFQ scores ($P < .05$).

Conclusion: The study population was predominantly male. Obese patients had a higher prevalence of arterial hypertension, greater waist circumference, higher body fat percentage, and higher MLHFQ scores. The overweight group walked the greatest distance.

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Key words: Obesity, Underweight, Exercise tests, Heart failure, Quality of life

Among chronic non-communicable diseases (NCDs), cardiovascular diseases account for the highest number of deaths worldwide, followed by respiratory diseases, cancer, and diabetes. These conditions share common risk factors, including smoking, alcohol consumption, unhealthy diets, and physical inactivity (1). Similarly, in Colombia, cardiovascular diseases represent the leading cause of mortality (2), with coronary heart disease and arterial hypertension strongly associated with the development of heart failure (HF).

Several conditions related to NCDs, and consequently to cardiovascular disease, are associated with overweight and obesity, which have been identified as contributors to premature mortality (3). Extreme obesity may be associated with higher hospitalization-related mortality in patients with cardiovascular disease (4). For this reason, further investigation of this risk factor has been recommended, particularly when adjusted for other variables such as diabetes, elevated triglyceride levels, low-density lipoprotein (LDL) cholesterol, and blood pressure. This approach may support the hypothesis that a specific combination of cardiometabolic factors contributes to the development and progression of cardiovascular disease (5).

In the context of HF, the so-called “obesity paradox” refers to the counterintuitive observation that overweight and obese patients may demonstrate better survival and better clinical outcomes in the presence of established cardiovascular disease compared with their

normal-weight or underweight counterparts. Although excess body weight may represent an additional risk factor for adverse events, it may also exert a protective effect against adverse outcomes in certain clinical scenarios. This effect has been attributed in part to increased fat mass, often accompanied by greater lean mass, which may be associated with better cardiorespiratory fitness and improved global outcomes in overweight or obese patients (6,7). Moreover, improved survival has been reported in overweight and obese patients compared with underweight and normal-weight patients with HF (8).

Nevertheless, patients with HF experience a progressive decline in functional aerobic capacity—characterized by reduced exercise tolerance, dyspnea, and fatigue—followed by deterioration in health-related quality of life (HRQoL) and increasing limitations in activities of daily living (9). These impairments

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are attributable to cardiac dysfunction and related abnormalities, including altered peripheral blood flow, endothelial dysfunction, systemic inflammation, skeletal muscle alterations, ventilatory inefficiency, neurohormonal dysregulation, and psychosocial factors. Patients with these limitations are commonly referred to cardiac rehabilitation (CR) programs to improve their clinical and functional status (10,11).

To date, most research on the obesity paradox in HF has focused primarily on mortality. Functional aerobic capacity, depressive symptoms, and HRQoL across BMI categories remain insufficiently explored, particularly among patients enrolled in CR programs.

This study aimed to determine differences across BMI categories in selected clinical variables, functional aerobic capacity, and HRQoL among patients with HF.

Materials and Methods

Study design and Participants

This was a descriptive cross-sectional study conducted from April 2022 through August 2022. Patients with HF were classified into 4 BMI categories: underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), normal weight ($18.5 - 24.9 \text{ kg/m}^2$), overweight ($25.0 - 29.9 \text{ kg/m}^2$), and obese ($\text{BMI} \geq 30.0 \text{ kg/m}^2$).

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and Resolution 008430 of 1993 of the Colombian Ministry of Health and Social Protection. It was approved by the Ethics Committee of the Institución Universitaria Escuela Nacional del Deporte (Cali, Colombia) (#17115). Patients who agreed to participate provided written informed consent prior to any study procedures.

Using convenience sampling, all patients with HF admitted to the CR program of a fourth-level clinic in Cali, Colombia, were included. Inclusion criteria were a confirmed diagnosis of HF with stage C stratification and New York Heart Association (NYHA) functional class II or III (12). Patients in NYHA functional classes I and IV were excluded, as were those with limitations in performing active or resisted movements due to recent fracture, hemodynamic instability, coronary events after HF diagnosis, infectious disease, or neuromuscular limitations.

Variables

Sociodemographic characteristics included age, sex, marital status, type of health insurance, occupation, level of education, and socioeconomic stratum. In Colombia, strata 1, 2, and 3 correspond to low-income population groups whose members are beneficiaries of public utility subsidies, whereas strata 4, 5, and 6 represent higher-income population groups.

Clinical variables were collected via structured interviews and verified using medical records. These included cardiovascular risk factors, HF symptoms, physical activity level, and anthropometric measurements such as BMI, waist circumference, body fat percentage, body water percentage, and lean mass percentage. Additional laboratory parameters recorded were left ventricular ejection fraction, total cholesterol, HDL, LDL, triglycerides, hemoglobin, fasting plasma glucose, glycated hemoglobin (HbA1c), and blood urea nitrogen (BUN).

Functional capacity was assessed using the Duke Activity Status Index (DASI) (9). The total score ranges from 0 to 58.2, with higher scores indicating better functional capacity. Health-related quality of life was assessed using the Minnesota Living with Heart Failure Questionnaire (MLHFQ) (13), whose total score ranges from 0 to 105, with higher scores indicating poorer quality of life.

Depressive symptoms were evaluated using the Patient Health Questionnaire-9 (PHQ-9) (14), used to screen for and diagnose depression and to assess its severity. Scores indicate the following: <5 , no depression; 5-9, minimal or subthreshold depression; 10-14, moderate depression; ≥ 15 , major. All instruments were administered in their validated Colombian Spanish versions.

Functional aerobic capacity was evaluated using the sit-to-stand (STS) test (15) and the 6-minute walk test (6MWT) conducted according to American Thoracic Society guidelines (16).

For the 6MWT, a 30-meter corridor was set up with cones at each end to mark the distance. Before the test, each study patient was instructed to walk as far as possible, and the remaining time was announced at each minute. Two tests were performed, and the longest distance covered was recorded. Estimated oxygen uptake (VO_{2e}) was calculated using the formula $\text{VO}_{2e} = 3.5 \text{ mL/kg/min} + (\text{velocity} [\text{m/min}] \times 0.1)$ (17).

Variables recorded during the 6MWT included respiratory frequency (RF), heart rate (HR), peripheral oxygen saturation (SpO_2), and systolic and diastolic blood pressure, all measured pre- and post-test.

Procedures

Access to healthcare services in Colombia depends on contractual agreements between healthcare providers and institutions. Study participants attended the outpatient CR program at Clínica de Occidente in Cali, Colombia.

After cardiology evaluation, each study patient was referred to an initial meeting during which a physiotherapist explained the study objectives. Patients who agreed to participate provided written informed consent.

Anthropometric measurements included height assessed using a 4-segment stadiometer (precision 1 mm) and body weight, body fat, body water, and lean mass measured using a digital body composition monitor (precision 100 g). Waist circumference was measured using a non-elastic tape.

Clinical and laboratory variables were obtained from medical records. National protocols were followed for interpretation.

The DASI, MLHFQ, and PHQ-9 were administered via structured interviews conducted by a trained evaluator.

During the STS and 6MWT, SpO_2 , HR, and blood pressure were monitored using standardized equipment.

Statistical analysis

Data collected were entered into an Excel 2010 database and analyzed using SPSS version 24. Normality of quantitative variables was assessed using the Kolmogorov-Smirnov test. Quantitative variables are presented as means $\pm$ standard deviation.

Subsequently, comparisons were made between the BMI groups. For qualitative variables, the chi-square test was used. For quantitative variables, 1-way analysis of variance (ANOVA) was performed with post hoc tests. For variables meeting the

assumption of equal variances, the Tukey test was applied (with adjustment for unbalanced groups using Dunnett's T3 test). For variables not meeting the assumption, Dunnett's T3 test was used. Statistical significance was defined as $P < .05$.

Results

During the study period, 387 patients were admitted, of whom 210 met the inclusion criteria. Of these, 20 were excluded because of physical limitations that prevented them from performing the 6MWT. Ten had respiratory comorbidities such as chronic obstructive pulmonary disease and asthma, and 10 were decompensated and classified as NYHA IV at admission. Finally, data from 170 patients who met all the study entry criteria were analyzed (Figure 1).

Regarding the sociodemographic variables, men predominated across all BMI groups, with the highest proportion observed in the normal-weight group (28 [71.8%]). With respect to marital status, the predominant category was stable union, with the highest percentage observed in the obese group (24 patients [61.5%]). Concerning socioeconomic status, the middle stratum was the most prevalent across all groups, again with the highest proportion in the obese group (29 patients [74.4%]). No statistically significant differences were identified among BMI groups in any of the sociodemographic variables (Table 1).

Table 2 presents the clinical characteristics of the patients. Statistically significant differences were observed in arterial hypertension, which was more frequent in the obese group (33 [84.6%]; $P = .032$). Waist circumference and body fat percentage were significantly higher in the obese group (103.9 ± 10.66 cm and $34.44 \pm 7.33\%$, respectively; $P < .05$). The percentage of body water was higher in the normal-weight group ($53.01 \pm 4.40\%$; $P < .05$). High-density lipoprotein cholesterol levels were higher in the normal-weight group (50.72 ± 10.14 mg/dL), whereas triglyceride levels were lower in this group (105.9 ± 37.19 mg/dL; $P < .05$).

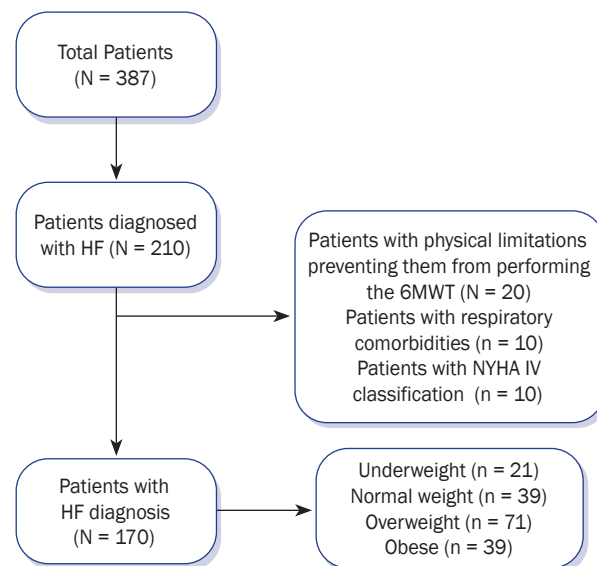
As measured during the 6MWT, the overweight group had higher resting SpO_2 ($96.4\% \pm 1.49\%$), higher resting systolic blood pressure (136.5 ± 17.09 mmHg), and higher diastolic blood pressure at the end of the test (76.61 ± 10.57 mmHg) ($P < .05$). The underweight group walked the shortest distance in the 6MWT (231.5 ± 42.8 m), whereas the overweight group walked the farthest (260.89 ± 45.1 m; $P < .05$) (Table 3).

For HRQoL, MLHFQ scores in the physical and emotional domains differed significantly across BMI groups. In the overweight group, the physical and emotional domain scores were the lowest (12.20 ± 9.87 and 28.80 ± 21.2 , respectively). In contrast, the obese group obtained the highest scores in both domains (18.21 ± 12.97 and 41.62 ± 28.97 , respectively), indicating statistically significant differences between groups ($P < .05$) (Table 4).

Discussion

Several studies have addressed the obesity paradox, primarily in relation to HF-related mortality (8,18,19); however, alterations in functional aerobic capacity, depression, and quality of life have not been extensively explored. In this regard, the present study demonstrated that in the population analyzed, patients classified as

Figure 1. Flowchart for admission to the study of patients with heart failure and different body mass indexes



6MWT indicates 6-minute walk test; HF, heart failure; NYHA, New York Heart Association.

overweight or obese by BMI had better functional aerobic capacity. In addition, patients classified as overweight exhibited better HRQoL among individuals with HF enrolled in a CR program.

With respect to sex, most of the participants with HF were men, across all BMI categories. These findings are consistent with those reported by other authors who have examined the relationship between BMI and clinical and quality-of-life variables in patients with HF (20).

Regarding age, no significant differences were observed among BMI groups; the mean age was 63.26 ± 13.23 years, indicating that patients were generally older at their time of entry into the CR program. This finding is comparable with findings reported in previous studies involving patients with HF participating in CR programs (21). Other sociodemographic variables, such as marital status and socioeconomic stratum, also showed no statistically significant differences between BMI groups and exhibited patterns similar to those described in the literature (22,23).

This study also found that patients with HF and obesity had a higher prevalence of arterial hypertension, which was corroborated by measurements of systolic and diastolic blood pressure at rest and following the 6MWT. Notably, the overweight group exhibited higher blood pressure values than the other groups. This finding may be explained by previous reports indicating that individuals with higher BMI (overweight or obese) are at increased risk of developing arterial hypertension due to systemic mechanisms, including alterations in the renin–angiotensin–aldosterone system (22,24). Furthermore, the greater waist circumference, body weight, and fat percentage observed in the obese group may indicate a higher cardiovascular risk profile (24), potentially

Table 1. Sociodemographic characteristics of the patients

Characteristic	Total participants n = 170	Underweight n = 21	Normal weight n = 39	Overweight n = 71	Obese n = 39	P value
Age*	63.26 ± 13.23	67.38 ± 16.89	64.85 ± 12.56	62.96 ± 13.19	60.0 ± 11.24	.172
Sex						.851
Male	113 (66.5%)	13 (61.9%)	28 (71.8%)	47 (66.2%)	25 (64.1%)	
Female	57 (33.5%)	8 (38.1%)	11 (28.2%)	24 (33.8%)	14 (35.9%)	
Marital status						.816
Stable union	99 (58.2%)	11 (52.4%)	21 (53.8%)	43 (60.6%)	24 (61.5%)	
No stable union	71 (41.8%)	10 (47.6%)	18 (46.2%)	28 (39.4%)	15 (38.5%)	
Health regimen						.869
Contributory	167 (98.2%)	21 (100%)	38 (97.4%)	70 (98.6%)	38 (97.4%)	
Subsidized	3 (1.8%)	-	1 (2.6%)	1 (1.4%)	1 (2.6%)	
Employment status						.464
Working	48 (28.2%)	3 (14.3%)	8 (20.5%)	23 (32.4%)	14 (35.9%)	
Not working (incapacity)	31 (18.2%)	3 (14.3%)	8 (20.5%)	15 (21.1%)	5 (12.8%)	
Retired	35 (20.6%)	6 (28.6%)	11 (28.2%)	10 (14.1%)	8 (20.5%)	
Not working (other)	56 (32.9%)	9 (42.9%)	12 (30.8%)	23 (32.4%)	12 (30.8%)	
Level of schooling						.830
None	4 (2.4%)	-	1 (2.6%)	2 (2.8%)	1 (2.6%)	
Primary school, incomplete	31 (18.3%)	3 (14.3%)	8 (20.5%)	16 (22.6%)	4 (10.3%)	
Primary school, complete	10 (5.9%)	3 (14.3%)	2 (5.1%)	3 (4.2%)	2 (5.1%)	
High school, incomplete	61 (35.9%)	5 (23.8%)	13 (33.3%)	24 (33.8%)	19 (48.7%)	
High school, complete	24 (14.1%)	3 (14.3%)	8 (20.5%)	9 (12.7%)	4 (10.3%)	
Technician	10 (5.9%)	1 (4.8%)	2 (5.1%)	3 (4.2%)	4 (10.3%)	
Technologist	21 (12.4%)	4 (19%)	3 (7.7%)	11 (15.5%)	3 (7.7%)	
University/postgraduate	9 (5.3%)	2 (9.5%)	2 (5.1%)	3 (4.2%)	2 (5.1%)	
Socioeconomic stratum						.151
Low	49 (28.8%)	7 (33.3%)	13 (33.3%)	22 (31%)	7 (17.9%)	
Medium	96 (56.5%)	10 (47.6%)	17 (43.6%)	40 (56.3%)	29 (74.4%)	
High	25 (14.7%)	4 (19%)	9 (23.1%)	9 (12.7%)	3 (7.7%)	

*Values are expressed as means ± standard deviation.

Stable union: legally or socially recognized partnership equivalent to cohabitation or marriage.

Health regimen: refers to the type of health insurance or public coverage (Contributory = paid; Subsidized = government-assisted).

Technician: completed technical college or vocational training.

Technologist: completed tertiary-level education or higher technical training.

related to lower adiponectin levels and elevated blood pressure (7,23). A similar pattern may be present in the overweight group, characterized by lower HDL levels and higher triglyceride concentrations.

In this study, overweight and obese patients demonstrated better performance on the 6MWT, which shows that cardiorespiratory fitness, as evidenced in functional aerobic capacity tests, is a better prognostic indicator than BMI in patients with HF who have greater muscle mass. This allows for greater muscle efficiency and the ability to walk longer distances (25), a pattern that appears to be present when patients do not have metabolic syndrome (25). Such an interpretation is supported by Horwich et al. (2018), who found that patients with HF with high BMI and relatively poorer cardiorespiratory fitness had a higher risk of mortality than those with better cardiorespiratory fitness (7). In addition, previous studies have shown that better aerobic capacity in patients with HF may reverse the phenomenon of the obesity paradox and even improve the prognosis of patients with lower BMIs (7,26).

Although further studies on the subject are required, intentional weight loss and increased physical fitness are recommended for patients with HF (27).

These findings support the recommendation of regular physical activity regardless of body weight, as even patients with HF and severe obesity may experience improvements in symptoms and quality of life with a weight reduction of approximately 5% to 10% (26,28).

Although there were no significant differences between groups on the DASI functional capacity questionnaire and the STS test, it should be noted that the underweight group had the lowest scores and the lowest VO₂e values. This is because underweight patients experience persistently low absorption of food in the intestinal villi, which can lead to a hypercatabolic effect, causing more significant systemic inflammation and contributing to the loss of muscle tropism necessary for functional performance (29). These results support the conclusion that the 6MWT correlates more strongly with functional aerobic capacity than other tests (30).

Table 2. Clinical characteristics of the patients

Characteristic	Total Participants n = 170	Underweight n = 21	Normal Weight n = 39	Overweight n = 71	Obese n = 39	P value
<i>Risk factors</i>						
Dyslipidemia	91 (53.5%)	8 (38.1%)	21 (53.8%)	40 (56.3%)	22 (56.4%)	.500
Hypertension	114 (67.1%)	13 (61.9%)	21 (53.8%)	47 (28.2%)	33 (84.6%)	.032
Diabetes	54 (31.8%)	7 (33.3%)	13 (33.3%)	20 (28.2%)	14 (35.9%)	.850
Obesity	111 (65.3%)	-	1 (2.6%)	71 (100%)	39 (100%)	<.001
Overweight	116 (68.2%)	-	6 (15.4%)	71 (100%)	39 (100%)	<.001
Hypothyroidism	31 (18.2%)	1 (4.8%)	8 (20.5%)	13 (18.3%)	9 (23.1%)	.347
Postmenopausal	46 (27.1%)	7 (33.3%)	9 (23.1%)	18 (25.4%)	12 (30.8%)	.775
Current smoker	5 (2.9%)	-	2 (5.1%)	-	3 (7.7%)	.089
Former smoker	54 (31.8%)	8 (38.1%)	13 (33.3%)	20 (28.2%)	13 (33.3%)	.825
Family history of cardiovascular disease	97 (57.1%)	13 (61.9%)	23 (59%)	35 (49.3%)	26 (66.7%)	.324
Sedentary lifestyle	154 (90.6%)	20 (95.2%)	37 (94.9%)	64 (90.1%)	33 (84.6%)	.388
<i>Symptoms</i>						
Angina	56 (32.9%)	5 (23.8%)	12 (30.8%)	24 (33.8%)	15 (38.5%)	.697
Syncope	4 (2.4%)	1 (4.8%)	-	1 (1.4%)	2 (5.1%)	.383
Dyspnea	98 (57.6%)	14 (66.7%)	22 (56.4%)	37 (52.1%)	25 (64.1%)	.519
Fatigue	113 (66.5%)	18 (85.7%)	25 (64.1%)	46 (64.8%)	24 (61.55)	.251
Palpitations	69 (40.6%)	5 (23.8%)	15 (38.5%)	27 (38.0%)	22 (56.4%)	.080
MMII edema	40 (23.5%)	8 (38.1%)	7 (17.9%)	14 (19.7%)	11 (28.2%)	.241
Claudication	11 (6.5%)	1 (4.8%)	2 (5.1%)	6 (8.5%)	2 (5.1%)	.851
Dizziness	71 (81.6%)	8 (38.1%)	20 (90.9%)	29 (74.4%)	14 (77.8%)	.776
<i>Physical activity</i>						
Sedentary	155 (91.2%)	20 (95.2%)	37 (94.9%)	64 (90.1%)	34 (87.2%)	.580
Active	15 (8.8%)	1 (4.8%)	2 (5.1%)	7 (9.9%)	5 (12.8%)	
BMI* (kg/m ²) ^{a, b, c, d, e, f}	25.88 ± 4.96	18.24 ± 0.28	23.12 ± 1.80	27.13 ± 2.89	30.46 ± 5.12	<.001
Weight* (kg) ^{a, b, c, d, e, f}	70.37 ± 14.89	50.9 ± 5.73	64.3 ± 9.12	73.3 ± 11.9	81.4 ± 15.33	<.001
Height* (m)	1.64 ± 0.09	1.66 ± 0.09	1.66 ± 0.08	1.64 ± 0.09	1.63 ± 0.11	.383
Waist circumference* (cm) ^{a, b, c, d, e, f}	94.53 ± 11.34	79.87 ± 7.33	89.5 ± 5.75	96.44 ± 9.20	103.9 ± 10.66	<.001
Fat* (%) ^{a, b, c, e, f}	28.20 ± 8.26	19.54 ± 4.73	23.9 ± 5.92	30.17 ± 7.24	34.44 ± 7.33	<.001
Water* (%) ^{a, e}	49.83 ± 6.33	53.01 ± 4.40	51.88 ± 5.88	49.22 ± 4.66	46.75 ± 8.77	<.001
Muscle mass* (kg)	45.46 ± 9.51	40.63 ± 7.72	45.24 ± 7.90	46.56 ± 9.36	46.52 ± 11.67	.080
LVEF* (%)	43.00 ± 13.58	38.71 ± 13.9	39.82 ± 14.21	45.22 ± 12.45	44.46 ± 14.10	.085
Total cholesterol*	157.1 ± 38.8	163.9 ± 46.23	163.7 ± 42.59	151.5 ± 37.5	157.0 ± 35.78	.685
HDL* (mg/dL) ^{c, d, e}	41.64 ± 10.27	50.72 ± 10.14	40.50 ± 9.24	39.50 ± 9.72	41.23 ± 10.14	.014
LDL* (mg/dL)	82.27 ± 30.58	86.80 ± 32.64	83.28 ± 31.46	75.64 ± 30.98	86.96 ± 29.43	.543
Triglycerides* (mg/dL) ^c	147.4 ± 62.90	105.9 ± 37.19	160.7 ± 65.76	163.5 ± 70.6	138.8 ± 52.55	.033
Hemoglobin* (g/dL)	15.26 ± 12.21	12.37 ± 2.77	21.69 ± 27.16	14.00 ± 2.47	13.89 ± 2.23	.207
Fasting blood glucose* (mg/dL)	106.3 ± 26.41	97.00 ± 21.40	100.6 ± 13.23	112.5 ± 30.64	107.0 ± 30.17	.448
Glycosylated hemoglobin* (%)	6.184 ± 1.340	6.111 ± 0.98	5.909 ± 0.71	6.211 ± 0.67	6.41 ± 2.32	.832
BUN* (mg/dL)	22.27 ± 9.724	19.66 ± 4.932	22.87 ± 8.13	20.55 ± 12.94	24.33 ± 9.41	.835

*Values are expressed as means ± standard deviation.

Post hoc tests (statistically significant between-group differences, P < .05):

^a normal-weight vs. obese;^b overweight vs. obese;^c underweight vs. overweight;^d underweight vs. normal-weight;^e underweight vs. obese;^f normal-weight vs. overweight.

Abbreviations: BMI, body mass index; BUN, blood urea nitrogen; HDL, high-density lipoprotein; LDL, low-density lipoprotein; LVEF, left ventricular ejection fraction; MMII, lower limbs.

Table 3. Functional aerobic capacity of the patients

Characteristic	Total Participants n = 170	Underweight n = 21	Normal Weight n = 39	Overweight n = 71	Obese n = 39	P value
Resting FR (rpm)	16.66 ± 1.85	16.43 ± 1.50	16.72 ± 2.18	16.51 ± 1.84	17.03 ± 1.70	.505
Final FR, 6MWT (rpm)	24.74 ± 3.32	24.95 ± 3.36	25.41 ± 3.21	24.65 ± 3.46	24.13 ± 3.09	.385
Resting SpO ₂ (%) ^{a, b}	96.1 ± 1.79	96.0 ± 1.84	96.3 ± 1.20	96.4 ± 1.49	95.3 ± 2.45	.014
Final SpO ₂ , 6MWT	95.25 ± 2.151	95.81 ± 1.78	95.03 ± 2.22	95.51 ± 2.15	94.69 ± 2.19	.139
Resting HR (bpm)	72.27 ± 13.14	65.24 ± 14.4	73.9 ± 13.64	72.61 ± 12.56	73.77 ± 12.21	.064
Final HR, 6MWT (bpm)	98.37 ± 16.68	89.24 ± 15.13	100.3 ± 16.45	100.1 ± 16.17	98.08 ± 17.56	.052
Resting SBP (mmHg)	121.3 ± 14.46	119.6 ± 21.39	120.4 ± 12.58	123.5 ± 14.58	119.2 ± 11.11	.423
Final SBP, 6MWT ^c	132.3 ± 17.22	125.4 ± 19.12	129.8 ± 16.34	136.5 ± 17.09	130.8 ± 15.91	.031
Resting DBP (mmHg)	74.36 ± 10.14	71.86 ± 12.59	73.31 ± 8.37	76.61 ± 10.57	72.67 ± 9.00	.098
Final DBP, 6MWT ^c	78.71 ± 11.63	74.14 ± 11.67	76.00 ± 8.81	81.41 ± 12.41	78.97 ± 11.64	.025
Distance, 6MWT (m) ^c	250.6 ± 47.01	231.5 ± 42.8	243.2 ± 48.59	260.89 ± 45.1	249.40 ± 47.93	.049
VO ₂ e, 6MWT (mL/kg/min) ^c	7.68 ± 0.78	7.36 ± 0.70	7.56 ± 0.80	7.86 ± 0.75	7.66 ± 0.80	.045
METs, 6MWT	2.19 ± 0.22	2.11 ± 0.20	2.167 ± 0.23	2.244 ± 0.21	2.197 ± 0.22	.064
STS test (repetitions)	17.56 ± 4.48	15.14 ± 4.53	17.51 ± 4.34	18.10 ± 4.30	17.95 ± 4.66	.058

Values are expressed as mean ± standard deviation.

Post hoc tests (statistically significant group differences, $P < .05$):

^a normal-weight vs. obese;

^b overweight vs. obese;

^c underweight vs. overweight.

Abbreviations: 6MWT, 6-minute walk test; bpm, beats per minute; DBP, diastolic blood pressure; FR, respiratory frequency; rpm, revolutions per minute; HR, heart rate; METs, Metabolic Equivalents of Task; RR, respiratory rate; SBP, systolic blood pressure; SpO₂, peripheral oxygen saturation; STS, sit-to-stand; VO₂e, estimated oxygen uptake.

In this study, no significant differences between BMI groups were observed on the PHQ-9; however, higher scores were found in the obese group, suggesting that depressive symptoms may be more prevalent among obese patients (31). These findings have been associated with higher rates of depression in individuals with obesity, potentially related to weight-related stigma and psychosocial burden (32,33). Nevertheless, further research

examining related factors such as self-care behaviors is needed to better understand how these variables differ or interact across BMI groups (7).

Previous studies have identified a high prevalence of nutritional deficit among patients with HF (29). In this context, it is essential to continue investigating additional variables that provide a multidimensional perspective of patients. This underscores the

Table 4. Physical activity, quality of life, and depression in patients

Characteristic	Total Participants n = 170	Underweight n = 21	Normal Weight n = 39	Overweight n = 71	Obese n = 39	P value
DASI Total	29.10 ± 16.11	25.00 ± 14.98	30.04 ± 15.92	30.36 ± 16.38	28.10 ± 16.55	.561
DASI VO ₂ max	22.11 ± 6.93	20.35 ± 6.44	22.51 ± 6.85	22.65 ± 7.05	21.68 ± 7.12	.561
DASI METs	6.32 ± 1.98	5.82 ± 1.84	6.43 ± 1.96	6.47 ± 2.01	6.19 ± 2.03	.562
MLHFQ Physical ^b	14.79 ± 10.94	16.67 ± 9.45	15.08 ± 10.54	12.20 ± 9.87	18.21 ± 12.97	.036
MLHFQ Emotional	7.71 ± 6.56	8.10 ± 6.64	8.85 ± 6.08	6.18 ± 5.91	9.13 ± 7.69	.073
MLHFQ Total ^b	34.56 ± 23.88	37.00 ± 18.64	36.67 ± 23.71	28.80 ± 21.2	41.62 ± 28.97	.043
PHQ-9	5.88 ± 5.26	4.90 ± 3.65	5.33 ± 4.56	5.54 ± 5.13	7.59 ± 6.54	.134

Post hoc tests (statistically significant group differences, $P < .05$):

^b overweight vs. obese.

Abbreviations: DASI, Duke Activity Status Index; MLHFQ, Minnesota Living with Heart Failure Questionnaire; PHQ-9, Patient Health Questionnaire-9; VO₂ max, maximal oxygen uptake.

importance of considering factors beyond purely cardiovascular criteria when making clinical decisions and designing interventions. Muscle wasting and poorer functional performance highlight the need to strengthen comprehensive care strategies that complement pharmacological treatment with nonpharmacological approaches, such as cardiac rehabilitation and targeted nutritional interventions based on diet and supplementation.

In the present study, patients with HF who were overweight demonstrated better scores across MLHFQ domains, which may reflect the better performance of these patients on the 6MWT. Notably, differences observed in the emotional subdomain suggest a relatively preserved emotional component, supporting the absence of clinically significant depressive symptoms in this group (30,34). The MLHFQ is valuable not only in clinical assessment but also as a prognostic tool with predictive relevance for hospitalization risk and long-term complications. These outcomes should therefore be considered during follow-up in patients with HF (35).

Limitations

A major limitation of this study is the lack of assessment of participants' dietary habits. Specifically, controlling for and characterizing macronutrient intake carbohydrates, fats, and proteins could have provided more precise information and enhanced the clinical relevance of the results. Additionally, the uneven distribution of participants across subgroups represents another limitation, as this distribution may have affected the comparability of the findings. Future studies should aim to improve sample homogeneity in order to strengthen internal validity and enhance the generalizability of the results.

Conclusion

This study provides valuable insights into the relationship between BMI and clinical outcomes in patients with HF participating in CR programs. The findings support the notion that overweight and obese individuals may exhibit better functional aerobic capacity and HRQoL compared with underweight patients, possibly due to greater muscle mass and improved cardiorespiratory efficiency. However, the presence of higher blood pressure and metabolic alterations in these groups highlights the need for careful clinical monitoring. The results emphasize the importance of individualized and multidimensional management strategies that integrate physical activity, nutritional interventions, and psychological support. Future studies with larger and more homogeneous samples, as well as dietary assessments, are necessary to optimize and clarify the mechanisms underlying the obesity paradox and to optimize rehabilitation outcomes in this population.

Resumen

Objetivo: Se ha descrito una mejor supervivencia en pacientes obesos con insuficiencia cardíaca (IC). Sin embargo, se desconoce si esta aparente ventaja se acompaña de un mejor estado funcional y otros desenlaces clínicamente relevantes. El objetivo fue determinar diferencias en variables clínicas,

capacidad aeróbica funcional y calidad de vida relacionada con la salud en pacientes con IC según diferentes IMC. **Material y métodos:** Estudio descriptivo transversal en el que se compararon 4 grupos de pacientes con IC según IMC (bajo peso, peso normal, sobrepeso y obesidad). Se evaluaron variables sociodemográficas y clínicas mediante el Duke Activity Status Index, el Minnesota Living with Heart Failure Questionnaire (MLHFQ) y el Patient Health Questionnaire-9 (PHQ-9). Se evaluó la capacidad aeróbica funcional. El estudio fue aprobado por el comité de ética y los participantes firmaron consentimiento informado. **Resultados:** Se incluyeron 170 pacientes; la mayoría fueron hombres. La hipertensión arterial fue más frecuente en el grupo con obesidad 33(84,6%; $P = .032$). Los obesos presentaron mayor perímetro abdominal ($103,9 \pm 10,66$ cm) y mayor porcentaje de grasa corporal ($34,44 \pm 7,33\%$; $P < .05$). El colesterol HDL fue mayor en peso normal ($50,72 \pm 10,14$ mg/dL; $P < .05$). El grupo de bajo peso recorrió la menor distancia ($231,5 \pm 42,8$ m), mientras que el grupo con sobrepeso recorrió la mayor ($260,89 \pm 45,1$ m; $P < .05$). El grupo con obesidad presentó puntuaciones más altas en el MLHFQ. **Conclusiones:** El sobrepeso se asoció con mejor desempeño funcional, aunque la obesidad mostró mayor carga de riesgo cardiovascular y peores puntuaciones de calidad de vida.

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