Effects of an exercise program on physiological variables and 6 Minute walk test in obesity

Efectos de un programa de ejercicio sobre variables fisiológicas y prueba de caminata en obesidad

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Received: 05-03-25
Accepted: 13-08-25

How to cite in APA

Segura Ordoñez, A., Yara Muñoz, S., Carvajal, N., Lemos Martínez, D. A., Ortega, J. G., & Mosquera, M. (2025). Effects of an exercise program on physiological variables and 6 Minute walk test in obesity. *Retos, 72*, 425-435. https://doi.org/10.47197/retos.v72.114249

Abstract

Introduction: Obesity represents a clinical and public health challenge that requires comprehensive, evidence-based strategies.
Objective: To describe changes in aerobic capacity and physiological variables in adults with grade II and III obesity after participating in a multidisciplinary program that included supervised exercise, nutritional support, and psychological counseling.
Methodology: Prospective longitudinal study based on the medical records of patients who completed 24 or 36 supervised exercise sessions (twice a week, 60 minutes). Aerobic capacity was assessed using the six-minute walk test (6MWT), and anthropometric, hemodynamic, and respiratory variables were recorded before and after the intervention.
Results: Sixty-two patients (83.9% women) were included, of whom 67.7% had at least one comorbidity. After the program, significant reductions in body weight and body mass index ($p < 0.05$) were observed, with moderate to large effect sizes. The 6MWT showed significant improvements in heart rate, respiratory rate, and systolic and diastolic blood pressure, while changes in oxygen saturation were minimal and clinically irrelevant. The distance walked increased by an average of 22 meters, accompanied by modest increases in estimated VO_2 and METs. However, most changes did not reach clinically relevant thresholds.
Conclusions: Completing a multidisciplinary program with supervised moderate-to-vigorous exercise improved some functional and physiological parameters in adults with severe obesity, although the magnitude of the benefits was limited, highlighting the need for longer and more intensive interventions.

Keywords

Exercise; functional capacity; obesity; physiological adaptation; six-minute walk test.

Resumen

Introducción: La obesidad representa un desafío clínico y de salud pública que requiere estrategias integrales basadas en la evidencia.
Objetivo: Describir los cambios en la capacidad aeróbica y en variables fisiológicas de adultos con obesidad grado II y III, tras su participación en un programa multidisciplinario que incluyó ejercicio supervisado, soporte nutricional y acompañamiento psicológico.
Metodología: Estudio longitudinal prospectivo a partir de historias clínicas de pacientes que completaron 24 o 36 sesiones de ejercicio supervisado (dos veces por semana, 60 minutos). La capacidad aeróbica se evaluó mediante el test de caminata de seis minutos (6MWT) y se registraron variables antropométricas, hemodinámicas y respiratorias antes y después de la intervención.
Resultados: Se incluyeron 62 pacientes (83,9% mujeres), de los cuales 67,7% presentaba al menos una comorbilidad. Tras el programa, se observaron reducciones significativas en peso corporal e índice de masa corporal ($p < 0,05$), con tamaños del efecto moderados a grandes. El 6MWT mostró mejoras significativas en frecuencia cardíaca, frecuencia respiratoria y presión arterial sistólica y diastólica, mientras que los cambios en la saturación de oxígeno fueron mínimos y clínicamente irrelevantes. La distancia recorrida aumentó en promedio 22 metros, acompañada de incrementos modestos en VO_2 estimado y METs. No obstante, la mayoría de los cambios no alcanzó umbrales clínicamente relevantes.
Conclusiones: Completar un programa multidisciplinario con ejercicio supervisado a intensidades moderadas-vigorosas mejoró algunos parámetros funcionales y fisiológicos en adultos con obesidad severa, aunque la magnitud de los beneficios fue limitada, lo que resalta la necesidad de intervenciones más prolongadas e intensivas.

Palabras clave

Adaptación fisiológica; capacidad funcional; ejercicio; obesidad; prueba de caminata de seis minutos.

Introduction

Obesity is considered a chronic, complex and multifactorial disease, recognized as a serious global health problem and one of the greatest public health challenges of the 21st century due to its increasing prevalence, high level of disability and death (Cuciureanu et al., 2023), (Temple et al., 2022), (The Lancet Public Health, 2023). In Colombia, it has been estimated that by 2035 the prevalence of this disease will be 40%, with an annual increase of 2.5% in adults and 4.5% in the pediatric population (Lobstein et al., 2023). Genetic factors, poor metabolic adaptation, neuroendocrine abnormalities and important changes in lifestyle, food composition and social inequalities have made this entity one of the most complex pathologies to address due to its large multifactorial component (Lingvay et al., 2023), (García et al., 2020).

The therapeutic approach to obesity is interdisciplinary, individualized and adaptable over time, aimed at having a comprehensive impact on all health outcomes and reducing disability levels as much as possible (Chakhtoura et al., 2023), (Organización Mundial de la Salud (2011)) (World Health Organization (2022)). Nutritional control or exercise has showed regulate the increase or decrease the body weight, and if used together, the results obtained are superior, not only in terms of fat weight reduction, but also in functionality, peak oxygen consumption and aerobic capacity (AC) (Han et al., 2019).

AC is a broad and complex term to define, referring to the complex cardiovascular, respiratory and muscular responses to exercise. Obesity induces deleterious changes in myocardial and blood vessel function in addition to many other musculoskeletal functions, creating a negative impact on health (Powell-Wiley et al., 2021). It is recognized as a strong predictor of mortality and can be objectively quantified through the measurement of maximal oxygen consumption (VO_{2max}), which physiologically is an indicator of the efficiency of the cardiopulmonary system to supply the energy needs of muscle mass (Arena et al., 2020), (Del Buono et al., 2019), (Zhou et al., 2021). However, direct quantification of VO_{2max} to determine the level of AC usually requires specialized equipment and highly trained personnel, so it is not widely available in many health institutions (Fletcher et al., 2013), (Metz et al., 2018).

Walking is the preferred type of physical activity in patients with obesity as it can be easily integrated into daily life, performed at intensities selected by the individual, and does not require specific skills or materials (Hussien et al., 2022), (Kadir et al., 2019). The 6-minute walk test (6MWT) is a simple performance test that consists of walking at a self-selected pace down a 30-meter corridor for 6 minutes. It is simple to implement, well tolerated, and safe (Carvajal et al., 2025). It allows quantification of AC and provides basic information on the response of the cardiovascular, pulmonary, and skeletal muscle systems to a predetermined effort (Powell-Wiley et al., 2021), (ATS Statement., 2002). However, despite being widely used in the performance in various chronic conditions (Troosters et al., 1999), (Enright & Sherrill et al., 1998), the 6MWT use has been little used for follow-up of exercise programs oriented to the obese population and the feasibility of its use has not been well clarified despite exhibiting a good reproducibility with a low coefficient of variation and high intraclass correlation (Ekman et al., 2013), (Larsson et al., 2008).

Although evidence indicates that structured exercise, diet, and weight loss programs in individuals with obesity can improve cardiopulmonary function and, consequently, physiological, hemodynamic, and anthropometric parameters (Pramuno et al., 2025; Amador et al., 2025; Horta-Gim et al., 2025), the influence of obesity severity on these outcomes remains unclear. This study aimed to describe the changes in aerobic capacity and physiological variables in a cohort of adults with obesity who participated in a multidisciplinary intervention including exercise, diet, and psychological support, evaluated using the 6MWT. The study was designed and reported in accordance with the STROBE guidelines for observational research.

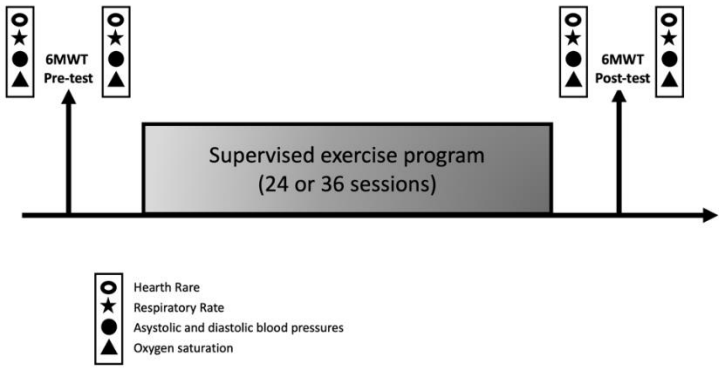
Method

Participants

A retrospective longitudinal study was conducted in the Hospital Universitario del Valle between January and December 2022 based on data registered from an obesity program aimed at weight reduction and lifestyle changes. All participants were evaluated by the Departments of Physical Medicine and Rehabilitation, Nutrition, Psychology and Bariatric Surgery. The sample size was determined by the total number of eligible participants enrolled during the one-year recruitment period; therefore, no a priori sample size calculation was performed.

Participants over 18 years of age with a diagnosis of obesity (BMI>30 kg/m2) with records of 24 or 36 supervised exercise sessions and evaluated by 6MWT at the beginning and at the end of the training sessions were included (see Figure1).

Figure 1. Design of the exercise program



Patients with incomplete records of the variables of interest were excluded. A total of 461 medical records were initially screened, of which 399 were excluded, primarily due to missing or incomplete data on the 6MWT or key physiological and anthropometric variables. The final sample therefore comprised 62 participants who met all inclusion criteria and had complete pre- and post-intervention data. The study was approved by the institutional ethics committee of the Hospital (code: 034-2022) and the health research ethics committee of the Universidad del Valle (code: 012-022).

Primary outcome variables were body weight, BMI, and total distance covered in the 6MWT. Secondary outcomes included hemodynamic parameters: systolic and diastolic blood pressure, heart rate, respiratory rate, blood oxygen saturation (SpO_2), indirect VO_2, and calculation of metabolic equivalent METs. These variables were selected based on their clinical relevance for assessing cardiometabolic health and functional capacity in individuals with obesity.

Procedure

Exercise program: Each patient performed 24 or 36 supervised exercise sessions. The session was divided into 3 phases: warm-up (5 minutes), conditioning (50 minutes) and cool-down (5 minutes), where the FITT strategy (frequency, intensity, time, type of exercise) was used for exercise prescription (Rooney et al., 2023). Frequency: Two or three times a week. Intensity: moderate to vigorous intensity as measured by the Borg scale of perceived exertion, maintained at an average of 13/20 or above. Time: 60 minutes per session. Type: aerobic exercise (30 minutes) with execution of large muscle groups, involving rhythmic and continuous movements performed on treadmills, ellipticals, arm/leg cycloergometers or stationary bicycles. Strength exercise (20 minutes) using free weights with concentric, eccentric and isometric muscle actions in series and repetitions adjusted to the resistance and conditions of each patient.

The six-minute walk test (6MWT): The results were obtained from patients' medical records. According to institutional protocols, the test is performed following the standardized guidelines of the American Thoracic Society (ATS Statement, 2002) and previous recommendations (Ekman et al., 2013; Larsson et

al., 2008). No participant required supplemental oxygen during the test. The predicted walking distance was calculated using the equation proposed by Capodaglio et al. (2013), specifically developed for individuals with obesity and a BMI between 30 and 58 kg/m^2: Predicted distance (m) = (894.2177 − [2.07×Age]) − (51.4489×Sex) − (5.1663×BMI), where Sex is coded as 0 for males and 1 for females. Peak oxygen consumption (VO_2peak) was estimated using the equation described by Burr et al. (2011) for sedentary individuals with a BMI between 19 and 40 kg/m^2: Indirect VO_2 (ml/kg/min) = 4.948+(0.023×6MWD [m]). Perceived exertion and dyspnea during the test were quantified using the Borg scale (Coquart et al., 2012), (Hareendran et al., 2012).

Data analysis

The analysis was performed according to the degree of obesity, due to the inverse relationship between BMI and the distance covered in the 6MWT in patients with grade III obesity (Larsson et al., 2008). The normality of continuous variables was assessed using the Kolmogorov–Smirnov or Shapiro–Wilk test, depending on the sample size of each variable. Descriptive results were reported as means and standard deviations or as medians and interquartile ranges (IQR). According to the distribution of the variables, comparisons between paired measurements were performed using the paired Student's t-test or the Wilcoxon signed-rank test.

For all analyses, a p value ≤ 0.05 was considered statistically significant. Effect sizes were calculated using Rosenthal's r and Cohen's d, interpreted as follows: for Rosenthal's r, |r| < 0.1 = small effect, 0.1–0.3 = medium effect, > 0.5 = large effect; and for Cohen's d, |d| < 0.2 = small effect, 0.2–0.5 = medium effect, > 0.8 = large effect. Statistical analyses were performed using SPSS version 30.0 (IBM Corp., Armonk, NY, USA). Additionally, 95% confidence intervals (95% CI) and the margin of error were calculated for the change in the primary outcomes (body weight, BMI, and walking distance). The minimal detectable effect (MDE) with 80% statistical power was also estimated, following methodological recommendations for fixed sample size studies.

Results

A total of 62 subjects were analyzed and classified according to the degree of obesity. The female sex was predominant and most participants belonged to the health subsidy care system in Colombia. Overall, 67.7% of the sample had at least one comorbidity, 19.4% had two, and 9.7% and 4.8% reported three and four comorbidities, respectively. The most common were arterial hypertension, type 2 diabetes, dyslipidemia, and anxiety disorder or depression. The demographic characteristics of the population are described in Table 1.

Table 1. Demographic characteristics of the population

Variables n =62	Obesity level							
	Grade I		Grade II		Grade III		Total	
	n	(%)	n	(%)	n	(%)	n	(%)
Health Regime								
Subsidized regime	3	(4,8)	23	(37)	35	(56,5)	61	(98,4)
Contributory regime	0	0	1	(1,6)	0	0	1	(1,6)
Ethnicity								
Mongrel	3	(4,8)	19	(31)	26	(41,9)	48	(77,4)
Black	0	0	5	(8,1)	9	(14,5)	14	(22,6)
Sex								
Man	0	0	2	(3,2)	8	12,9	10	(16,1)
Woman	3	(4,8)	22	(36)	27	43,5	52	(83,9)
Pharmacological Treatment								
Antihypertensive	2	(3,2)	7	(11)	16	(25,8)	25	(40,3)
Antihyperglycemic	2	(3,2)	10	(16)	10	(16,1)	22	(35,5)
Antilipemiant	0	0	3	(4,8)	6	(9,7)	9	(14,5)
Antidepressant	0	0	5	(8,1)	2	(3,2)	7	(11,3)
Hypothyroidism	1	(1,6)	2	(3,2)	3	(4,8)	6	(9,7)
Antiobesity	0	0	1	(1,6)	2	(3,2)	3	(4,8)
Antiarrhythmic	0	0	1	(1,6)	2	(3,2)	3	(4,8)

The physiological, hemodynamic, and anthropometric variables before and after the 6MWT are described in Tables 2, 3, and 4. Table 2 presents the variables for the whole sample, while Tables 3 and 4 display results according to obesity classes II and III, respectively.

Table 2. Physiological, hemodynamic and anthropometric variables before and after a 6MWT and before and after an exercise intervention.

Obesity Grade I, II y III, n = 62											
Variables	6MWT initial				6MWT final- exercise period					*p*	Effect
Age (years)	44 (33 - 52)										
Size (cm)	160,5(154-166,1)				160 (154-167,2)					*0,3*	0,131[r]
Weight (Kg)	105,5 (94,7 -121,3)				104,5 (91,1-120,5)					*<0,001*	0,528[r]
Body Mass Index (kg/m^2)	40,9 (37,8 - 45,3)				40,2 (37,5 - 45,6)					*<0,001*	0,524[r]
	pre-Test	*post-Test*	*p*	Effect	*pre-Test*	*post-Test*	*p*	Effet	*Δ pre-post initial*	*Δ pre-post final*	*p**
Systolic Blood Pressure (mmHg)	110 (100-120)	140 (120-150)	*<0,001*	0,780[r]	110 (100-120)	140 (120-150)	*<0,001*	-1,323[d]	20 (10-34)	30 (13-40)	*0,318*
Diastolic Blood Pressure (mmHg)	74 (11)	84 (12)	*<0,001*	0,653[r]	70 (10)	82 (12)	*<0,001*	-0,877[d]	10 (0-20)	10 (0-20)	*0,677*
Heart Rate (bpm)	81 (72-93)	139 (121 - 151)	*<0,001*	0,870[r]	80 (72 - 80)	134 (120-147)	*<0,001*	0,87[r]	53,2(17,4)	51,5(15,4)	*0,443*
Respiratory rate (res/min)	17 (2)	30 (6)	*<0,001*	-2,213[d]	17 (2)	30 (6)	*<0,001*	-2,252[d]	12 (7,5-18)	12 (8-16)	*0,978*
Blood oxygen saturation (SpO_2) (%)	97 (2)	95 (3)	*0,002*	0,412[d]	97 (2)	96 (3)	*0,003*	0,396[d]	-1 (-2-1)	-1 (-2,25-(-1))	*0,682*
Best distance traveled (m)	515 (472 - 568)				545 (506 - 584)					*<0,001*	0,522[r]
Predicted distance (Capadaglio)	511 (445 - 574)				551 (521- 578)					*<0,001*	0,575[r]
Distance achieved as a predicted (%)	98 (93 - 106)				98 (93 - 106)					*0,147*	0,186[r]
Indirect VO_2 (ml/Kg/min)	22,4 (17,3 - 26,1)				23,6 (19,1 - 26,6)					*<0,001*	0,427[r]
METs (ml de O2/kg x min)	6,4(4,9 - 7,5)				6,8 (5,4 - 7,6)					*0,005*	0,356[r]

The results shown in the table are described as mean and standard deviation or median and interquartile range. p*: Comparisons between the delta of the first moment variable versus the delta of the second moment variable. Cohen's effect size d: |d| < 0.2 = small effect; 0.2–0.5 = medium; > 0.8 = large, Rosenthal's r: |r| < 0.1 = small effect; 0.1–0.3 = medium; > 0.5 = large. VO2: Oxygen consumption. 6MWT: Six-minute Walk Test. METs: Metabolic equivalent.

Table 3. Physiological, hemodynamic and anthropometric variables before and after a 6MWT and before and after an exercise intervention.

Obesity Grade II. n = 24											
Variables	6MWT initial				6MWT final- exercise period					*p*	Effect
Age (years)	48 (39 - 53)										
Size (cm)	158,5 (151,3 - 165)				158,5 (151,3 - 165)					*0,866*	0,034[r]
Weight (Kg)	96,3 (88,3 - 102,8)				92,5 (86,3 - 100,8)					*0,006*	0,557[r]
Body Mass Index (kg/m^2)	37,9 (37,3 - 39,4)				37,6 (36 - 38,1)					*0,02*	0,475[r]
	pre-Test	*post-Test*	*p*	Efecto	*pre-Test*	*post-Test*	*p*	Efecto	*Δ pre-post inicial*	*Δ pre-post final*	*p**
Systolic Blood Pressure (mmHg)	110 (100-120)	135 (120-140)	*<0,001*	0,827[r]	110 (93 - 120)	125 (120 - 138)	*<0,001*	0,803[r]	20 (11-30)	20 (10-30)	*0,889*
Diastolic Blood Pressure (mmHg)	73 (10)	83 (10)	*<0,001*	-1,054[d]	69 (9)	77 (9)	*0,005*	-0,627[d]	10 (0-20)	10 (0-20)	*0,387*
Heart Rate (bpm)	83 (76 - 90)	135 (120 - 145)	*<0,001*	0,875[r]	74,5 (71-85)	131 (115 - 137)	*<0,001*	0,875[r]	47,4 (13,9)	49,1 (17,1)	*0,56*
Respiratory rate (res/min)	16 (16-18)	28 (24-34)	*<0,001*	0,876[r]	16 (16-16)	28 (25-32)	*<0,001*	0,859[r]	12,9 (5,4)	11,5 (4,8)	*0,143*
Blood oxygen saturation (SpO_2) (%)	97 (95-98)	96 (95-98)	*0,148*	0,305[d]	96 (95-98)	97 (94 - 97)	*0,379*	0,180[r]	-50 (-2-0)	0 (0-1)	*0,794*
Best distance traveled (m)	528 (489 - 584)				550 (522 - 594)					*0,024*	0,459[r]
Predicted distance (Capadaglio)	515 (468 - 565)				556 (537 - 581)					*<0,001*	0,758[r]
Distance achieved as a predicted (%)	105 (96 -114)				99 (94 -107)					*0,171*	0,279[r]
Indirect VO_2 (ml/Kg/min)	24,9 (22,5 - 27)				26,4 (24,9 - 29,3)					*0,001*	0,653[r]
METs (ml de O2/kg x min)	7,1 (6,4-7,7)				7,5 (7 - 8,3)					*0,013*	0,507[r]

The results shown in the table are described as mean and standard deviation or median and interquartile range. p*: Comparisons between the delta of the first moment variable versus the delta of the second moment variable. Cohen's effect size d: |d| < 0.2 = small effect; 0.2–0.5 = medium; > 0.8 = large, Rosenthal's r: |r| < 0.1 = small effect; 0.1–0.3 = medium; > 0.5 = large. VO2: Oxygen consumption. 6MWT: Six-minute Walk Test. METs: Metabolic equivalent.

Table 4. Physiological, hemodynamic and anthropometric variables before and after a 6MWT and before and after an exercise intervention.

Obesity Grade III. n = 35											
Variables	6MWT initial			6MWT final- exercise period				p		Effect	
Age (years)	39 (30 - 52)										
Size (cm)	161,8 (156 - 168,2)				162 (156 - 170)				0,195		-0,219[r]
Weight (Kg)	118,5 (105,7 - 137,2)				116,5 (104,8 - 133,5)				0,003		-0,504[r]
Body Mass Index (kg/m^2)	45 (41,8 - 49,4)				45,2 (40,6 - 47,8)				0,001		-0,539[r]
	pre-Test	post-Test	p	Efecto	pre-Test	post-Test	p	Efecto	Δ pre-post inicial	Δ pre-post final	p*
Systolic Blood Pressure (mmHg)	119 (110-123)	140 (130 - 153)	<0,001	-0,765[r]	110 (100 - 122)	140 (130 - 159)	<0,001	-1,601[d]	30 (10-40)	30 (20-40)	0,25
Diastolic Blood Pressure (mmHg)	74 (12)	85 (12)	<0,001	-0,813[d]	71 (11)	86 (11)	0,000	-1,104[d]	10 (10-20)	20 (0-20)	0,394
Heart Rate (bpm)	80 (72 - 96)	143 (126 - 155)	<0,001	-0,872[r]	84 (75 -91)	136 (123 - 154)	<0,001	-0,872[r]	58,6 (18)	53,6 (14,4)	0,126
Respiratory rate (res/min)	18 (2)	30 (5)	<0,001	-2,235[d]	17 (2)	31 (6)	<0,001	-2,342[d]	12,8 (7)	13,5 (5,7)	0,367
Blood oxygen saturation (SpO_2) (%)	96 (2)	95 (3)	0,003	0,486[d]	97 (2)	95 (3)	0,016	0,428[d]	-1,6 (-3-1)	-1,20 (-3-1)	0,564
Best distance traveled (m)	499 (450 - 553)				534 (480 - 570)						0,001 -0,548[r]
Predicted distance (Capadaglio)	520 (439 - 589)				545 (499 - 577)						0,02 -0,393[r]
Distance achieved as a predicted (%)	97,2 (86,3 - 106,7)				98 (89 - 104)						0,824 -0,038[r]
Indirect VO_2 (ml/Kg/min)	18,5 (16,4 - 22,7)				19,9 (17 - 23)						0,025 -0,380[r]
METs (ml de O2/kg x min)	5,3 (4,6 - 6,5)				5,6 (4,9 - 6,6)						0,049 -0,333[r]

The results shown in the table are described as mean and standard deviation or median and interquartile range. p*: Comparisons between the delta of the first moment variable versus the delta of the second moment variable. Cohen's effect size d: |d| < 0.2 = small effect; 0.2–0.5 = medium; > 0.8 = large, Rosenthal's r: |r| < 0.1 = small effect; 0.1–0.3 = medium; > 0.5 = large. VO2: Oxygen consumption. 6MWT: Six-minute Walk Test. METs: Metabolic equivalent.

In the 62 participants with class I, II, and III obesity, the intervention program produced a significant reduction in body weight (105.5 [94.7–121.3] kg vs. 104.5 [91.1–120.5] kg; mean change = −1.95 kg; 95% CI: −3.13 to −0.76; margin of error = 1.18 kg; MDE = 1.77 kg; $p < 0.001$; $r = 0.528$, large effect) and BMI (40.9 [37.8–45.3] vs. 40.2 [37.5–45.6]; mean change = −0.73 kg/m^2; 95% CI: −1.25 to −0.22; margin of error = 0.52; MDE = 0.77; $p < 0.001$; $r = 0.524$, large effect).

During the 6MWT, both at baseline and after the intervention, systolic and diastolic blood pressure, heart rate, and respiratory rate increased significantly from pre- to post-test ($p < 0.001$ for all), with large effect sizes. Blood oxygen saturation (SpO_2) showed a small but significant decrease in both assessments: baseline, from 97% [96–98] to 95% [94–97] ($p = 0.002$); post-intervention, from 97% [96–98] to 96% [94–97] ($p = 0.003$). No significant differences were observed between pre–post changes (Δ) in the baseline and post-intervention assessments for hemodynamic variables.

Regarding functional capacity, the distance covered increased by approximately 30 m after the intervention (515 [472–568] m vs. 545 [506–584] m; mean change = 20.5 m; 95% CI: 14.3 to 26.7; margin of error = 6.2 m; MDE = 9.4 m; $p < 0.001$; $r = 0.522$, large effect), indicating a clinically relevant improvement in aerobic performance. The predicted distance according to Capodaglio's equation also increased significantly (511 [445–574] m vs. 551 [521–578] m; $p < 0.001$; $r = 0.575$, large effect). However, the percentage of predicted distance achieved remained close to 100% in both measurements (98% [93–106] vs. 98% [93–106]; $p = 0.147$), with no significant change. Indirect VO_2 increased from 22.4 [17.3–26.1] to 23.6 [19.1–26.6] ml/kg/min ($p < 0.001$; $r = 0.427$, medium effect) and METs increased from 6.4 [4.9–7.5] to 6.8 [5.4–7.6] ($p = 0.005$; $r = 0.356$, medium effect).

When the analysis was restricted to the 24 participants with class II obesity, body weight decreased significantly (96.3 [88.3–102.8] kg vs. 92.5 [86.3–100.8] kg; mean change = −3.8 kg; 95% CI: −6.5 to −1.1; margin of error = 2.7 kg; MDE = 3.9 kg; $p = 0.006$; $r = 0.557$, large effect), as did BMI (37.9 [37.3–39.4] vs. 37.6 [36.0–38.1]; mean change = −0.3 kg/m^2; 95% CI: −0.5 to −0.1; margin of error = 0.2; MDE = 0.3; $p = 0.020$; $r = 0.475$, medium-to-large effect). In this subgroup, systolic and diastolic blood pressure, heart rate, and respiratory rate increased significantly from pre- to post-test in both assessments ($p < 0.001$ for all), with large effect sizes ($r \geq 0.80$). SpO_2 showed no statistically significant changes (baseline:

97% [95–98] to 96% [95–98], p = 0.148; post-intervention: 96% [95–98] to 97% [94–97], p = 0.379). The distance covered increased by approximately 22 m (528 [489–584] m vs. 550 [522–594] m; mean change = 21.2 m; 95% CI: 8.1 to 34.3; margin of error = 13.1 m; MDE = 19.4 m; p = 0.024; r = 0.459, medium effect), and the predicted distance increased more markedly (515 [468–565] m vs. 556 [537–581] m; p < 0.001; r = 0.758, large effect). The percentage of predicted distance achieved decreased slightly, remaining close to or above 100% (105% [96–114] vs. 99% [94–107]; p = 0.171). Indirect VO_2 increased from 24.9 [22.5–27.0] to 26.4 [24.9–29.3] ml/kg/min (p = 0.001; r = 0.653, large effect) and METs from 7.1 [6.4–7.7] to 7.5 [7.0–8.3] (p = 0.013; r = 0.507, large effect).

In the 35 participants with class III obesity, body weight decreased from 118.5 [105.7–137.2] to 116.5 [104.8–133.5] kg (mean change = −2.0 kg; 95% CI: −3.8 to −0.2; margin of error = 1.8 kg; MDE = 2.6 kg; p = 0.003; r = –0.504, large effect) and BMI from 45.0 [41.8–49.4] to 45.2 [40.6–47.8] (mean change = 0.2 kg/m^2; 95% CI: −0.1 to 0.5; margin of error = 0.3; MDE = 0.4; p = 0.001; r = –0.539, large effect). Systolic and diastolic blood pressure, heart rate, and respiratory rate increased significantly from pre- to post-test in both assessments (p < 0.001 for all), with large effect sizes (|d| ≥ 0.80 or r > 0.80). SpO_2 showed a small but significant decrease in both assessments (baseline: 96% [95–98] to 95% [93–97], p = 0.003; post-intervention: 97% [96–98] to 95% [93–97], p = 0.016). The distance covered increased by approximately 32 m (499 [450–553] m vs. 531 [480–572] m; mean change = 31.6 m; 95% CI: 19.4 to 43.8; margin of error = 12.2 m; MDE = 18.0 m; p = 0.001; r = –0.548, large effect). Predicted distance also increased significantly (520 [439–589] m vs. 545 [499–577] m; p = 0.020; r = –0.393, medium effect), but the percentage of predicted distance achieved remained stable (97.2% [86.3–106.7] vs. 98% [89–104]; p = 0.824). Indirect VO_2 increased from 18.5 [16.4–22.7] to 19.9 [17.0–23.0] ml/kg/min (p = 0.025; r = –0.380, medium effect) and METs from 5.3 [4.6–6.5] to 5.6 [4.9–6.6] (p = 0.049; r = –0.333, medium effect).

Across both obesity classes, the intervention program was associated with significant reductions in body weight and BMI, as well as improvements in distance covered, indirect VO_2, and METs. Participants with class II obesity exhibited higher absolute values of distance covered and VO_2 in both assessments, whereas the absolute increase in distance covered was approximately 22 m in class II and 32 m in class III. In both groups, predicted distance increased significantly, but the percentage of predicted distance achieved remained close to 100%, without significant changes. Hemodynamic responses from pre- to post-test during the 6MWT followed similar patterns across obesity.

Discussion

The implementation of a supervised, multidisciplinary program of 24 or 36 sessions in individuals with obesity resulted in significant improvements in functional capacity, accompanied by modest but significant reductions in body weight and BMI across both class II and class III obesity.

In the analysis of the 6MWT, participants with class II obesity exceeded the predicted distance before the intervention (105 %) and maintained values close to the reference after the program (99 %). Those with class III obesity reached 97.2 % of the predicted distance at baseline and 98 % post-intervention. These findings, derived from the predictive equation proposed by Capodaglio et al., 2013 specifically validated in obese populations contrast with equations based on healthy adults and provide a more accurate estimate of expected performance. The fact that both groups reached or approached predicted values suggests that factors other than excess weight, such as cardiometabolic or musculoskeletal comorbidities, may have limited further improvement, consistent with literature highlighting the multifactorial nature of functional limitations in obesity (Sarzani., et al 2024), (Blüher, M. 2025).

From a clinical perspective, the magnitude of change in walking distance is critical. The concept of the minimum clinically important difference (MCID) indicates the smallest change perceived as beneficial by the patient, typically 30–50 m in cardiac and pulmonary disease (Wise et al., 2005). In obesity, thresholds vary, with reports of ≥ 80 m for high-certainty individual improvement (Larsson et al., 2008) and mean increases of 42 m in class III obesity after weight loss programs (Ekman et al., 2013). In our study, distance increased by approximately 22 m in class II and 32 m in class III. Although both values fall below most proposed MCID thresholds, the improvement in class III is close to the lower bound of clinical relevance. The pattern observed (greater absolute gain in class III despite lower baseline

performance) may reflect higher potential for functional recovery in more deconditioned individuals. However, the modest increments, together with increases of less than 1 MET in both groups, suggest that longer or more intensive interventions are needed to achieve changes associated with reduced mortality and health care costs (de Souza et al., 2019), (Jagsz et al., 2025).

Physiological responses during the 6MWT further inform the adaptation to training (O'Connor et al., 2025). Both groups demonstrated significant increases in heart rate, blood pressure, and respiratory rate from pre- to post-test in both assessments, indicating preserved cardiovascular responsiveness. Nevertheless, resting heart rate changes were not uniform between groups, contrasting with the reductions reported in other supervised exercise interventions (Fletcher et al., 2013). The lack of substantial resting HR improvement may relate to the relatively short intervention duration or the persistence of autonomic dysfunction associated with obesity (Olivieri et al., 2024).

Weight management remains a central aim of obesity programs (Lavie et al.,2018). In our total sample, weight decreased by approximately 1 kg, a magnitude consistent with short-term interventions of similar frequency and duration (Ades et al., 2021; den Uijl et al., 2023). Both obesity classes achieved statistically significant reductions in weight and BMI, underscoring the potential of combined exercise, nutrition, and psychological strategies even in severe obesity. Nonetheless, the modest magnitude of anthropometric change highlights the need for longer follow-up and possibly higher training volumes or more rigorous dietary protocols to optimize outcomes. Furthermore, reliance on BMI as the sole anthropometric endpoint may underestimate functional and metabolic gains, reinforcing calls to incorporate broader fitness and physiological assessments into program evaluation (Mayoral et al., 2020; Shah et al., 2012; Kivimäki et al., 2022).

Comorbidity burden likely influenced functional outcomes, more than half of the participants had at least one chronic condition under pharmacological treatment, with hypertension, type 2 diabetes, and dyslipidemia being the most prevalent. These conditions, well-documented as functional performance modifiers, can limit daily activity capacity and attenuate training adaptations (Duntava et al., 2021; Gil-Rojas et al., 2019; Martínez-Torres et al., 2017).

Sociodemographic analysis revealed a predominantly female sample, mostly affiliated with the subsidized health care system, reflecting the higher prevalence of obesity in women and in populations with lower socioeconomic status both globally and in Colombia (Lobstein et al., 2023). The mean age was in the fourth decade of life, aligning with the productive age range in the Colombian population, emphasizing the economic and social burden of obesity on health systems (Hruby et al., 2015; Pérez et al., 2003; Tremmel et al., 2017).

This study has limitations inherent to its retrospective design. Neuromuscular and biomechanical factors that could restrict gait speed and limit 6MWT performance were not specifically assessed (Beriault et al., 2009). Adherence to nutritional and psychological components of the program was not quantified, although all participants received at least one session with both specialties during the study period. Additionally, the total sample size—and particularly the subgroup analyses—was relatively small, potentially increasing variability in the results.

A notable strength of this study is the use of a predictive equation tailored to obese populations (Capodaglio et al., 2013), which enhances the clinical relevance and accuracy of interpreting 6MWT outcomes in this context. Future research should focus on longer-duration, higher-intensity programs, incorporate direct measures of cardiovascular fitness, and explore the interplay between comorbidity burden and functional adaptation.

The findings of this study may be generalizable to adults with class II and III obesity participating in multidisciplinary weight reduction programs in similar hospital-based settings. However, caution should be exercised when extrapolating results to populations with different healthcare systems, cultural contexts, or baseline functional capacities.

Conclusions

In this study, a multidisciplinary weight loss program combining supervised exercise, nutritional counseling, and psychological support led to modest but significant improvements in functional capacity and physiological parameters in adults with class II and III obesity. Both groups increased their 6MWT distance, estimated VO_2, and METs, although the magnitude of change remained below most thresholds for clinical significance described in the literature. Reductions in weight and BMI were observed in the overall sample, with variations between obesity grades, yet without clear evidence of superior outcomes in one group over the other. These findings suggest that, in populations with severe obesity, comorbidities and functional limitations may constrain the clinical impact of short- to medium-term interventions, underscoring the importance of extended and targeted strategies aimed at optimizing cardiovascular and metabolic adaptations beyond improvements in walking distance alone.

Acknowledgements

The authors gratefully acknowledge the Universidad Santiago de Cali, Colombia, and its Health and Movement Research Group for their academic support of this research project, as well as the Ministry of Science, Technology, and Innovation of Colombia (MINCIENCIAS) for supporting the main author through the Becas de Excelencia Doctoral del Bicentenario program.

Financing

This research has been funded by the General Direction of Research of the Universidad Santiago de Cali under call No. DGI-01-2025.

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