Early Online

The European Research Journal 2025 Original Article

DOI: https://doi.org/10.18621/eurj.1626472 *Pulmonary Medicine*

Improvements in functional exercise performance at 6 months following bariatric surgery: A prospective cohort study

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ABSTRACT

Objectives: Successful weight loss after bariatric surgery has been associated with a variety of improvements in health status. Delayed heart rate recovery after the six-minute walking test (6MWT) is associated with morbidity and mortality in various cardiac and respiratory diseases. We aimed to evaluate the effect of bariatric surgery on functional exercise performance and autonomic dysfunction in patients who had undergone laparoscopic sleeve gastrectomy.

Methods: Pre-operative and post-operative (6 months) demographics, comorbidities, weight, and height of the patients undergoing laparoscopic sleeve gastrectomy were recorded. All patients underwent a 6MWT. 6MWT was performed according to the American Thoracic Society standards. Additionally, heart rate (HR) and oxygen saturation were assessed at rest, at the end of the test, and in the first minute following testing. Autonomic dysfunction was assessed by heart rate recovery (HRR), which was calculated as the difference between the maximum HR reached during the 6MWT and the HR at the first minute after the test. Patients were classified depending on whether their HRR was slow (HRR<12 beats, "delayed recovery") or more rapid (HRR≥12 beats, "non-delayed recovery").

Results: A total of 62 patients were prospectively enrolled. The mean age of the patients was 36.8±9.1 years and 74% were female. Pre-operative and post-operative body mass indices were 48.5±5.2 kg/m2 and 34.4±3.5 kg/m2, respectively (P<0.001). Excess weight loss was 52.7±12.7%. Post-operative six-minute walking distance significantly improved compared to pre-operative period (406±48 meters vs. 443±52 meters, P<0.001). Compared with pre-operative period, perceived breathlessness and fatigue at the end of the 6MWT decreased from 1.3±1.5 to 0.4±0.9 Borg units (P<0.001), and 3.2±2.1 to 0.8±1.4 Borg units (P<0.001), respectively. We observed a remarkable, but statistically non-significant increase in the number of patients in the delayed HRR group from 21% (n=13) to 42% (n=26) in the postoperative period, compared to the preoperative assessment (P=0.12).

Conclusions: Laparoscopic sleeve gastrectomy is associated with rapid weight loss and improvements in perceived exertional dyspnea, fatigue and six-minute walking distance at 6 months after surgery. Failure of the heart rate to fall after cessation of exertion, a delayed HRR, has previously been found to be associated with increased mortality in cardiac failure. Further investigation is required to examine the physiological mechanisms involved in autonomic dysfunction, and consequences of delayed HRR after rapid weight loss by bariatric surgery.

Keywords: Exercise performance, six-minute walking test, heart recovery rate, bariatric surgery

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How to cite this article: Gorek Dilektasli A, Coşkun F, Karadag M, Dilektasli E. Improvements in functional exercise performance at 6 months following bariatric surgery: A prospective cohort study. Eur Res J. 2025. doi: 10.18621/eurj.1626472

Received: January 30, 2025
Accepted: February 4, 2025
Published Online: February 8, 2025

Obesity is linked to various health conditions, early mortality, reduced functional capacity, and diminished quality of life [1-4]. Bariatric surgery is a well-established intervention for the treatment of severe obesity, resulting in substantial weight loss and improvements in obesity-related comorbidities such as type 2 diabetes, hypertension, and obstructive sleep apnea [5, 6]. Beyond its metabolic benefits, bariatric surgery also has profound effects on physical function, a key determinant of quality of life and long-term health outcomes [7]. Improvements in functional exercise performance following bariatric surgery have gained attention as they reflect enhanced mobility, reduced biomechanical limitations, and better overall health [8, 9].

The six-minute walk test (6MWT) is a practical, reliable, and widely used tool for evaluating functional exercise capacity in clinical and research settings [10]. As a submaximal exercise test, it measures the distance an individual can walk on a flat surface in six minutes, providing an integrated assessment of cardiorespiratory, musculoskeletal, and metabolic function [11]. Its simplicity, safety, and minimal equipment requirements make it particularly suitable for bariatric surgery patients, who often experience significant functional limitations prior to surgery [12]. Moreover, the 6MWT has been shown to be sensitive to detecting changes in functional capacity over time, making it an ideal metric for evaluating the impact of bariatric surgery on physical function [8, 9].

Patients with severe obesity frequently demonstrate reduced 6MWT performance due to the combined effects of excess body weight, joint pain, and reduced cardiorespiratory fitness [13]. Postoperatively, the substantial weight loss associated with bariatric surgery alleviates biomechanical strain and enhances physical activity levels, contributing to measurable improvements in walking capacity [14]. The 6MWT can therefore serve as a valuable tool to quantify these improvements and track the recovery of functional mobility over time. Additionally, better functional performance, as captured by the 6MWT, is strongly associated with increased physical activity participation, which supports long-term weight maintenance and overall health [15].

This study focuses on the changes in 6MWT performance at 6 months following bariatric surgery, highlighting its role as a reliable and clinically relevant measure of functional recovery in this population.

METHODS

Study Design and Population

We prospectively enrolled patients willing to participate and were diagnosed with obesity (body mass index [BMI] over 35 kg/m2) meeting national institutes of health criteria admitted for bariatric surgery operation consecutively between 01 August 2015 to 15 December 2017. Patients were evaluated for weight loss, functional exercise performance, and autonomic function at baseline and at a 6-month follow-up visit. The study was approved by the institutional ethics committee (2014/10/08), and all participants provided written informed consent before enrollment. Patients with a follow-up of 6 months were included in the final study population. Patients with loss in follow-up were excluded from the study. Patients with previous history of bariatric operation such as gastric band, gastric sleeve or all other types of laparoscopic, open, primary, or revision procedures were excluded from the study. After exclusions the patients with sleeve gastrectomy, were selected for further analysis. After preoperative preparations and obtaining the patients dietary habits, the patients that were operated with sleeve gastrectomy, selected as the best suitable option for those patients. Pre-operative and post-operative (6 months) demographics, weight, and height of the study participants were recorded. Comorbid conditions, including diabetes mellitus, hypertension, musculoskeletal complaints, and OSAS, were assessed before and after surgery. Improvement or resolution of these conditions was determined through clinical evaluation and medical records review at the 6-month follow-up visit. All patients underwent a six-minute walking test at baseline and at the 6-months follow-up visit.

Weight Loss and Body Composition Measurements

Body weight and BMI were recorded preoperatively and at the 6-month follow-up visit. The percentage of excess weight loss (EWL%) was calculated using the formula:

EWL (%)=(preoperative weight-postoperative weight) / (preoperative weight-ideal weight) × 100, where ideal weight corresponds to a BMI of 25 kg/m².

Excess BMI loss (EBMIL) was also calculated as the percentage reduction in excess BMI over the follow-up period.

The 6-Minute Walking Test

The 6MWT was conducted in accordance with the American Thoracic Society (ATS) guidelines to assess functional exercise capacity [10]. The test was performed on a flat, straight, indoor corridor measuring 30 meters in length, marked at regular intervals. Participants were instructed to walk as far as possible within six minutes at their own pace while being allowed to slow down or rest if needed. A trained evaluator provided standardized verbal encouragement at specific time intervals (every minute), following ATS recommendations [10].

Participants were advised to avoid vigorous exercise before testing. Dyspnea and fatigue were measured using the Borg scale both before and immediately after the test. Oxygen saturation (SpO_2) and blood pressure were documented before and after the test. Total walking distance (6MWD) in meters was recorded as the primary outcome. Heart rate (HR) was recorded before the test, at the end of six minutes, and one-minute post-test to assess heart rate recovery (HRR). Any adverse symptoms, such as dizziness, chest pain, or excessive fatigue, were closely monitored, and the test was stopped if necessary for safety reasons [10].

Autonomic dysfunction was assessed by HRR, which was calculated as the difference between the maximum HR reached during the 6MWT and the HR at the first minute after the test. Patients were classified depending on whether their HRR was slow (HRR<12 beats, "delayed recovery") or more rapid (HRR >12 beats, "non-delayed recovery") [16].

The primary endpoint of the study was change in the six-minute walking distance, whereas the secondary endpoint was the diagnosis of the failure of heart rate recovery.

Statistical Analysis

Data were analyzed using SPSS version 21.0 (SPSS Inc., Chicago, IL, USA). The data were analyzed for normal distribution of continuous variables by using histograms and the Kolmogorov–Smirnov and the Shapiro-Wilk tests. Continuous variables with normal distribution were reported as mean±standard deviation (SD) and the ones with abnormal distribution were reported as medians and interquartile ranges (IQR). Categorical variables were reported as frequencies and percentages. The paired t-test was used for within-group comparisons, while categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate. A P value <0.05 was considered statistically significant.

To explore factors influencing changes in six-minute walking distance (Δ6MWD) and HRR, generalized linear regression models were utilized. A generalized linear regression model examined relationships between Δ6MWD and patient characteristics, including gender, age, EWL%, hypertension, diabetes, musculoskeletal complaints, smoking status, and pre-test oxygen saturation A second generalized linear regression model evaluated the association between HRR and patient characteristics, including gender, age, and EWL%, to determine factors influencing changes in autonomic function after surgery. Lastly, a multiple linear regression model was used to identify factors associated with HRR failure postoperatively, defined as HRR < 12 beats. Independent variables included gender, age, EWL%, smoking status, postoperative hypertension, and postoperative diabetes. Results were presented as odds ratios (Exp(B)) with 95% confidence intervals (CI).

RESULTS

Study Population

A total of 62 patients were included in the study, with a mean age of 36.8 ± 9.1 years. The majority of participants were female (74.2%). Baseline comorbidities were common, with 22.6% of patients diagnosed with hypertension, 16.1% with diabetes mellitus, 59.7% reporting musculoskeletal complaints, and 8.1% diagnosed with obstructive sleep apnea syndrome (OSAS). Tobacco use was reported by 14.5% of participants (Table 1).

Weight Loss and Body Composition Changes

At 6 months following laparoscopic sleeve gastrectomy, patients demonstrated significant weight loss. The mean preoperative weight of 131.2±18.7 kg

Table 1. **Baseline characteristics of the study participants (n=62)**

Characteristics	Data
Age (years)	36.8±9.1
Gender (female), n (%)	46 (74.2)
Co-morbidities, n (%)	
Smoking	9 (14.5)
OSAS	5 (8.1)
HT	14 (22.6)
DM	10 (16.1)
Musculoskeletal complaints	37 (59.7)
Smoking status, n (%)	
Never smoker	34 (54.8)
Ex-smoker	19 (30.6)
Current smoker	9 (14.5)
ing history (pack years^{-1})	0.0 [IQR 25-75: 0.0-12.0]

Data are shown as numbers (%) or mean±standard deviations or medians [interquartile range 25 -75]. DM=diabetes mellitus, HT=hypertension, OSAS= obstructive sleep apnea syndrome

decreased to 93.0±12.0 kg (P<0.001), and BMI declined from 48.5±5.2 kg/m² to 34.4±3.5 kg/m² (P<0.001). EWL was 52.7±12.7%, while EBMIL was 60.1±12.8%. Additionally, the percentage reduction in total weight and BMI was 28.8±6.6% and 29.1±6.7%, respectively (Table 2).

Resolution of Comorbidities

Substantial improvements in obesity-related comorbidities were observed in the postoperative follow up visit at 6 months (Table 3). The prevalence of diabetes mellitus decreased significantly from 16.1% preoperatively to 6.5% postoperatively (P=0.031). Hypertension showed a similar trend, with its prevalence dropping from 22.6% to 8.1% (P=0.004). Musculoskeletal complaints were notably reduced, with prevalence decreasing from 59.7% preoperatively to 22.6% postoperatively (P<0.001). While the proportion of patients with OSAS decreased from 8.1% to 1.6% (P=0.125).

Functional Exercise Performance

Functional exercise performance improved significantly after surgery. The 6MWD increased from 406±48 meters preoperatively to 443±52 meters postoperatively (P<0.001), representing a marked enhancement in mobility and physical capacity (Fig. 1). Patients also reported substantial reductions in per-

Table 2. **Changes in weight and body mass index following bariatric surgery**

	Preoperative	Postoperative	P value
Weight	131.2±18.7	93.0±12.0	<0.0001
BMI	48.5±5.2	34.4±3.5	<0.0001
Weight loss %	28.8±6.6		
BMI loss %	29.1±6.7		
EBMI loss %	60.1±12.8		
EWL %	52,7±12,7		

Data are shown as mean±standard deviation. BMI=body mass index, EBMI=excess BMI, EWL=excess weight loss

Table 3. **Resolution of comorbidities in the postoperative follow-up**

Comorbidities	Preoperative	Postoperative	P value
	10 (16.1)	4 (6.5)	**0.031**
HT	14 (22.6)	5 (8.1)	**0.004**
OSAS	5 (8.1)	1 (1.6)	0.125
Musculoskeletal complaints	37 (57.7)	14 (22.6)	**<0.0001**

Data are shown as numbers and (%). DM=diabetes mellitus, HT=hypertension, OSAS= obstructive sleep apnea syndrome

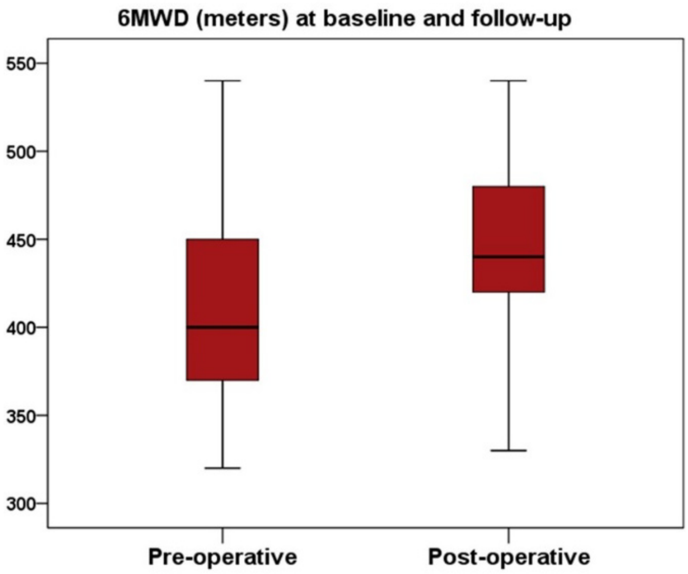

Fig. 1. **Comparison of six-minute walk distance (6MWD) at baseline and six-month Follow-up.**

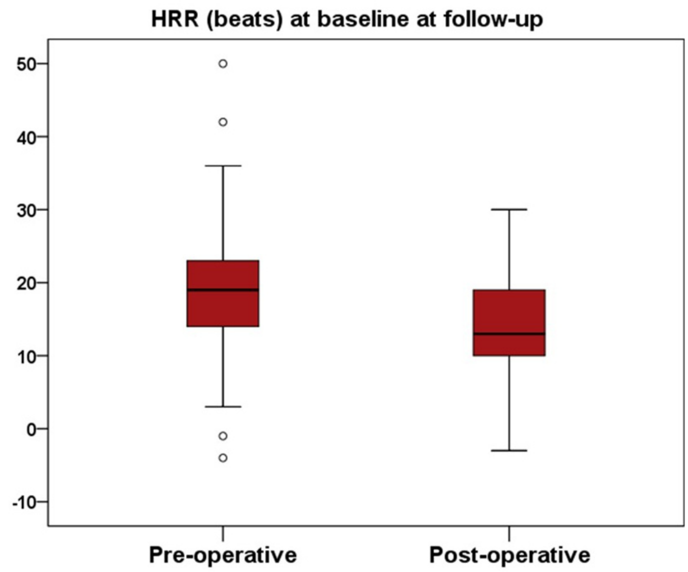

Fig. 2. **Comparison of heart rate recovery (HRR) at baseline and six-month follow-up.**

Table 4. **Change in dyspnea, fatigue scores assessed by the Borg scale and oxygen saturation and heart rate before and after bariatric surgery**

	Preoperative		Postoperative		P value*
	Pre-test	Post-test*	Pre-test	Post-test*	
Dyspnea	0.3±0.6	1.3±1.5	0.2±0.6	0.4±0.9	**<0.0001**
Fatigue	0.6±0.8	3.2±2.1	0.4±0.9	0.8±1.4	**<0.0001**
SpO_2	96.8±1.2	95.7±2.0	97.4±1.5	96.9±1.2	0.145
HR	81.8±10. 4	125.8±9.3	81.5±10.8	114.3±13.4	0.523

Data are shown as mean±standard deviation. SpO_2=oxygen saturation, HR=heart rate.
Dyspnea and fatigue were evaluated on Borg scale ranging from 0 to 10.
*represents paired t-test comparisons between preoperative post-test measurements and postoperative post-test measurements

ceived exertional dyspnea and fatigue during the 6MWT. Breathlessness, measured using the Borg scale, decreased from 1.3±1.5 preoperatively to 0.4±0.9 postoperatively (P<0.001). Similarly, fatigue scores decreased from 3.2±2.1 to 0.8±1.4 (P<0.001). These findings reflect the improved functional status and reduced effort associated with physical activity following significant weight loss.

Dyspnea and fatigue were assessed using the Borg scale before and after bariatric surgery (Table 4). Preoperatively, dyspnea scores increased from 0.35±0.63 at rest to 1.26±1.46 post-exercise, while fatigue scores increased from 0.58±0.78 to 3.21±2.09. Following surgery, significant reductions were observed in both dyspnea and fatigue levels. Postoperatively, dyspnea increased only slightly from 0.24±0.59 at rest to 0.37±0.89 post-exercise, while fatigue scores rose from 0.45 ±0.93 pre-test to 0.77±1.44 post-test. Both reductions were statistically significant (P<0.0001). These findings indicate that bariatric surgery led to a substantial improvement in perceived exertional dyspnea and fatigue during physical activity.

Heart Rate Recovery and Autonomic Function

HRR, an indicator of autonomic function, was evaluated during the 6MWT. HRR was significantly reduced from 18.9±9.8 beats to 13.7±7.5 beats at follow-up compared to baseline tests (P=0.001) (see Fig. 2). Patients were classified into two groups based on HRR: delayed recovery (HRR<12 beats) and non-delayed recovery (HRR≥12 beats). Preoperatively, 21% (n=13) of patients were in the delayed recovery group. Postoperatively, this proportion increased to 42% (n=26), indicating a trend toward delayed recovery at 6 months; however, this change was not statistically significant (P=0.12).

Factors Influencing the Change in Six-Minute Walking

Table 5. General linear regression model for predictors of Δ6MWD

	B	Exp (B), CI (95%)	P value
Gender			
Male	ref	-	-
Female	-0.09	8.82 (1.00-1.02)	0.907
Age	-0.15	0.86 (0.46-1.59)	0.627
Smoking status			
Current smoking	ref	-	-
Ex-smoking	13.46	700.29 (0.00-1.02)	0.162
Never smoking	10.85	516.49 (0.00-1.74)	0.220
EWL%	0.24	1.89 (1.18-3.01)	0.007
Hypertension	2.05	7.81 (9.03-6750.07)	0.768
Diabetes mellitus	-11.49	1.02 (1.45-2292.17)	0.241
Joint pain	-7.69	0.00 (1.98-1050.49)	0.303
SpO_2 at baseline	-0.53	0.59 (0.00-70.16)	0.827

Distance (Δ6MWD)

A generalized linear regression model was used to examine the relationship between patient characteristics and Δ6MWD following weight loss (Table 5). The model included gender, age, EWL%, hypertension, diabetes, musculoskeletal complaints, smoking status, and pre-test oxygen saturation as independent variables. Importantly, we observed a significant association EWL% and Δ6MWD (B=0.637, P=0.007), indicating that a greater reduction in excess weight was linked to a more pronounced improvement in six-minute walking distance. The odds ratio for EWL% (Exp(B)=1.891, 95% CI: 1.187-3.013) suggests that for each 1% increase in EWL, there was an approximately 89% greater likelihood of improving 6MWD by 1 meters postoperatively. Age and gender did not significantly influence Δ6MWD (P=0.627, P=0.907, respectively). Hypertension (P=0.768), diabetes (P=0.241), and musculoskeletal complaints (P=0.303) showed no statistically significant effects on Δ6MWD, indicating that these comorbidities did not independently predict postoperative improvements in exercise performance (Table 5). Smoking status was not significantly associated with Δ6MWD (P=0.220 for non-smokers, P=0.162 for smokers). Moreover, pre-test oxygen saturation (P=0.827) was not a significant predictor of postoperative functional improvement.

Heart Rate Recovery (HRR) and Functional Improvement

Another generalized linear model was evaluated the association between HRR and patient characteristics, including gender, age, and EWL%, data not shown. We observed that there was no significant relationship between EWL and changes in HRR (B= -0.016, P=0.872). Age and gender were not significant predictors of HRR changes (B=0.060, P=0.728 and B= -0.221, P=0.938, respectively).

Last of we analyzed factors influencing the likelihood of HRR failure postoperatively, with variables including gender, age, percentage of EWL%, smoking status, postoperative hypertension, and postoperative diabetes in the following multiple linear regression model (data not shown). The model did not identify any significant predictors of postoperative HRR failure among the variables studied, including gender (B=0.448, P=0.482), age (B= -0.017, P=0.598), EWL% (B=0.027, P=0.258), smoking status (B=0.893, P=0.338), and the presence of postoperative hypertension (B= -1.150, p = 0.368) or diabetes (B= -0.314, P=0.812). These findings suggest that factors outside the scope of this model may play a more substantial role in determining HRR outcomes after surgery.

DISCUSSION

Our study demonstrates significant improvements in functional exercise capacity, weight loss, and resolution of obesity-related comorbidities six months after laparoscopic sleeve gastrectomy. Our findings highlight the benefits of bariatric surgery not only in metabolic outcomes but also in physical function, as reflected by changes in the six-minute walking distance and heart rate recovery.

Patients achieved substantial weight loss, with an average EWL of 52.7%. The reduction in BMI from 48.5±5.2 to 34.4±3.5 kg/m² aligns with previous studies demonstrating the efficacy of bariatric surgery in achieving significant weight reduction [17, 18]. In parallel, substantial improvements were observed in comorbidities such as hypertension, diabetes, and musculoskeletal complaints. These findings are consistent with previous research showing bariatric surgery's role in improving obesity-related comorbidities, particularly through weight loss and metabolic adaptations [18, 19].

The significant increase in 6MWD from 406±48 meters to 443±52 meters reflects enhanced functional exercise capacity and mobility after surgery. This improvement is likely due to reduced biomechanical strain, better cardiorespiratory fitness, and alleviation of joint pain associated with weight loss [9, 20, 21]. The reduction in dyspnea and fatigue, as measured by the Borg scale, further underscores the positive impact of weight loss on physical function. These results corroborate prior studies emphasizing the role of weight loss in improving physical performance and quality of life postoperatively [9, 20, 22, 23].

Generalized linear regression analysis identified EWL% as a significant predictor of improvement in 6MWD. For every 1% increase in EWL, there was an 89% greater likelihood of improving 6MWD by 1 meter postoperatively. These findings are in line with previous studies and emphasize the critical role of weight loss in enhancing functional capacity, likely by reducing the biomechanical burden on joints and improving metabolic efficiency [21]. Other factors, including gender, age, comorbidities (e.g., hypertension, diabetes, musculoskeletal complaints), smoking status, and pre-test oxygen saturation, were not significant predictors. This suggests that the magnitude of weight loss is the primary driver of functional improvement, consistent with prior reports [21, 24].

Our findings demonstrated significant improvements in perceived exertional dyspnea and fatigue, as assessed by the Borg scale, following bariatric surgery. Our findings indicate that patients experienced reduced respiratory effort and muscle fatigue during physical activity six months postoperatively, highlighting the positive impact of weight loss on functional exercise performance. Dyspnea, or breathlessness, is a common symptom in individuals with obesity, attributed to multiple physiological mechanisms, including increased work of breathing, reduced lung volumes, and impaired respiratory muscle function [25]. Preoperatively, patients exhibited significantly higher dyspnea scores post-exercise, which aligns with previous studies indicating that individuals with obesity experience increased ventilatory demand during physical exertion. Postoperatively, the reduced dyspnea scores suggest improvements in pulmonary mechanics, including increased lung compliance and decreased respiratory resistance, which are known benefits of weight loss [26, 27].

Fatigue is another significant limiting factor in the physical performance of individuals with obesity. The excessive adipose tissue burden increases the metabolic cost of movement and contributes to musculoskeletal strain, leading to earlier onset of fatigue [28]. In our study, preoperative fatigue scores increased after exercise, suggesting that obesity is associated with reduced endurance and increased exertional effort. However, postoperatively, patients demonstrated a marked reduction in fatigue levels, suggesting enhanced exercise tolerance and efficiency of movement. This is likely due to reduced mechanical load, improved cardiovascular function, and better neuromuscular coordination following significant weight loss [28, 29]. These findings are in line with previous studies showing improvements in muscle function and reduced exertional effort after bariatric surgery [30].

The statistically significant reductions in both dyspnea and fatigue postoperatively indicate that bariatric surgery not only improves metabolic and cardiovascular health but also enhances perceived exertional effort during physical activity. These improvements can have substantial implications for increasing daily physical activity levels and long-term weight maintenance. Studies have shown that reduced perceived exertion encourages greater participation in physical activity, thereby reinforcing weight loss outcomes and improving overall quality of life [30].

Obesity is strongly linked to a heightened risk of cardiovascular mortality, which is partly attributed to increased sympathetic nervous system activity [31]. Bariatric surgery has been shown to improve long-term survival in individuals with severe obesity; however, the underlying mechanisms driving this benefit remain under investigation. HRR following exercise serves as an indicator of autonomic balance, reflecting the interplay between sympathetic and parasympathetic regulation [32]. Impaired HR recovery is a well-established predictor of elevated mortality risk, whereas improved HR recovery is associated with better overall prognosis [31, 32]. In our study, HRR decreased significantly postoperatively, from 18.9±9.8 beats to 13.7±7.5 beats. Despite this reduction in the rate recovery, there was an increased proportion of patients classified as having delayed recovery (HRR<12 beats), rising from 21% to 42%. However, this trend was not statistically significant, indicating that other factors may contribute to postoperative HRR changes. The lack of significant predictors for HRR improvement or failure in our models, including EWL%, age, gender, and comorbidities, suggests that autonomic recovery may involve complex mechanisms beyond the variables analyzed in this study. Previous research has indicated that factors such as preoperative fitness levels and autonomic system remodeling may influence HRR outcomes [15]. Previous studies suggested that these changes are likely driven by an increase in cardiac vagal tone, accompanied by a reduction in resting sympathetic activity and a more rapid withdrawal of sympathetic stimulation following exercise [31]. Improvements in these physiological parameters appear to be independently associated with the extent of weight loss and improvement in metabolic features [31, 33].

Limitations

Our study has several limitations. The relatively small sample size and single-center design may restrict the generalizability of our findings. Additionally, the observational nature of the study prevents us from establishing causal relationships between the predictors and improvements in functional and autonomic recovery. Dyspnea and fatigue were assessed using the Borg scale, which, while useful for subjective evaluation, may introduce variability due to individual perception differences. Furthermore, we did not perform direct pulmonary function tests or muscle strength assessments, which could have provided more objective physiological insights into the observed reductions in dyspnea and fatigue. Future research should incorporate cardiopulmonary exercise testing and muscle strength measurements to better elucidate the mechanisms underlying these improvements.

Another limitation is the relatively short follow-up period of six months. Long-term follow-up is essential to assess the durability of functional gains and to further explore the factors influencing HRR outcomes after bariatric surgery. Despite these limitations, our study provides valuable insights into the determinants of functional improvement following weight loss. Unlike most prior studies that focus solely on postoperative changes, we employed a multiple linear regression model to identify EWL% as a significant predictor of 6MWD improvement, independent of age, gender, smoking status, and comorbidities. This robust statistical approach reinforces the critical role of weight loss in enhancing mobility and physical performance. Future studies with larger, multi-center cohorts and extended follow-up periods are warranted to validate these findings and further investigate the long-term effects of bariatric surgery on functional and autonomic outcomes.

CONCLUSION

In conclusion, our study highlights the significant benefits of laparoscopic sleeve gastrectomy on functional exercise capacity, weight loss, and the resolution of obesity-related comorbidities six months postoperatively. Patients experienced substantial weight reduction and improvements in comorbidities such as hypertension, diabetes, and musculoskeletal complaints, aligning with prior evidence supporting bariatric surgery as an effective intervention for severe obesity. The increase in 6MWD reflects enhanced functional capacity and reduced effort associated with physical activity. Importantly, excess weight loss percentage emerged as a critical determinant of improvement in 6MWD, underscoring the role of weight loss in enhancing mobility and physical function. Conversely, other variables such as age, gender, smoking status, and comorbidities did not independently predict improvements in exercise capacity, emphasizing the primary influence of weight reduction. Although HRR, a marker of autonomic function, showed a significant postoperative reduction, no specific predictors of HRR changes were identified. This indicates the complexity of autonomic adaptations following bariatric surgery, warranting further investigation. Our findings underscore the importance of achieving substantial weight loss to enhance functional performance and quality of life in bariatric surgery patients. Future studies with larger sample sizes and extended follow-up periods are needed to explore long-term outcomes and elucidate the mechanisms underlying improvements in autonomic function.

Ethical Statement

The study was approved by the Bursa Yüksek İhtisas Training and Research Hospital Clinical Research Ethics Committee (Decision no: 2014/10/08 and date: 14.05.2014), and all participants provided written informed consent before enrollment.

Authors' Contribution

Study Conception: AGD, ED; Study Design: AGD, ED; Supervision: AGD, ED, FC, MK; Funding: AGD, ED, FC, MK; Materials: AGD, ED, FC; Data Collection and/or Processing: AGD, ED; Statistical Analysis and/or Data Interpretation: AGD, ED; Literature Review: AGD, ED, MK; Manuscript Preparation: AGD; and Critical Review: AGD, ED, FC, MK.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

Acknowledgment

This work is presented as a "thematic poster presentation" in the American Thoracic Society International Conference in May 18-23, 2018 at San Francisco, USA.

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