Journal of Pioneering Medical Sciences
Received: March 11, 2026 | Accepted: October 27, 2026 | Published: November 05, 2026
Volume 15, Issue 10, Pages 232-237

DOI https://doi.org/10.47310/jpms2026151024



A Comprehensive Study Psychological Outcomes, Eating Behaviors, Weight Maintenance, and Post-Anesthesia Neurocognitive Events Following Gastric Balloon Placement: An Observational Study

Alfatih Mohamed Ahmed Alnajib[1], Fauwaz Fahad Alrashid[2], Shahad Ali Alhuthaili[3], Musaab Abdalla Elhussein Mohammed[4], Tariq Mahmood[5], Muhammad Ahmad Khan[6], Faisal Abdulrhman Atiah Alanzi[7], Moayad Mheed Awad Alharbi[8], Wael Nahi Alnomasi[9], Farida Habib Khan[10], Yasser Awadallah Yasein[11], Basem Salama[12] and Fahmida Khatoon[13*]

[1]Department of Surgery, College of Medicine, University of Ha'il, Kingdom of Saudi Arabia
[1]Department of Surgery Alneelain University, Faculty of Medicine Khartoum, Sudan
[2]Department of Surgery, College of Medicine, University of Ha'il, Kingdom of Saudi Arabia
[3,7,8,9]College of Medicine, University of Ha'il, Kingdom of Saudi Arabia
[4]Department of Anesthesia, SMC healthcare, Riyadh, Saudi Arabia
[5,6]Department of Anesthesia, King Khalid Hospital, Ha'il, Saudi Arabia
[10]Family and Community Medicine, College of Medicine, University of Ha'il, Saudi Arabia
[11]Public Health and Community Medicine, Faculty of Medicine, Al-Azhar University, Cairo, Egypt
[12]Department of Community and family Medicine, Arar, Faculty of Medicine, Northern Border, Saudi Arabia
[12]Faculty of Medicine, Al-Azhar University, Egypt

Author Designation: [1]Assistant Professor, [2]Associate Professor, [3,7,8,9]Student, [10,12]Professor, [5]Registrar, [6]Consultant,

*Corresponding author: Fahmida Khatoon (e-mail: drfahmida24@gmail.com).

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Abstract **Background:** Obesity is a multifactorial condition with significant physical and psychological consequences. Gastric balloon placement is a minimally invasive intervention that promotes weight loss, but its psychological, behavioral, and neurocognitive post-operative impacts—including post-anesthesia delirium (PAD)—require detailed evaluation. **Objective:** To assess the psychological effects, behavioral changes, and incidence of post-anesthesia delirium associated with gastric balloon placement performed under general anesthesia, focusing on body image, eating habits, and long-term weight maintenance. **Methods:** This cross-sectional analytical study included 230 patients who underwent gastric balloon placement under general anesthesia for obesity treatment. Post-anesthesia delirium was evaluated in the post-anesthesia care unit (PACU) using standardized screening. Psychological outcomes, eating behavior, and weight maintenance were systematically tracked Diagnostic criteria evaluated exclusively via the CAM-ICU (Confusion Assessment Method for the ICU) by trained anesthesiologists in the PACU. **Results:** Significant improvements were observed in psychological parameters, with body image scores increasing from 3.1±0.8 to 4.2±0.7 and self-esteem from 2.9±0.7 to 4.0±0.6 ($p<0.001$). Anxiety and depression scores decreased from 3.8±0.9 to 2.6±0.8 and 3.5±0.8 to 2.4±0.7, respectively. Post-anesthesia delirium was identified in 8.7% of patients (n=20) in the PACU, correlating significantly with higher baseline pre-procedural anxiety ($r = 0.42$, $p<0.01$) and age >45 years. Behavioral changes included improved portion control (73.0%), healthier dietary adherence (67.8%), and increased physical activity (58.3%). Mean weight loss was 13.8±4.6%, with a BMI reduction of 5.2±1.9. Weight maintenance (>6 months) was achieved in 70.4% of patients. post-anesthesia delirium was assessed via CAM-ICU in the PACU. The multivariable logistic regression result for age >45 years is now reported with an adjusted effect estimate: Adjusted Odds Ratio (aOR) = 2.45, 95% CI: 1.08–5.54, $p = 0.031$. **Conclusion:** Gastric balloon placement under general anesthesia significantly improves psychological well-being, promotes positive behavioral changes, and supports effective weight loss. Post-anesthesia delirium represents a notable transient recovery complication in a subset of patients, emphasizing the need to integrate PACU neurocognitive monitoring alongside long-term behavioral and psychological management.

Key Words Obesity, Gastric Balloon, Weight Loss, Psychological Outcomes, Post-Anesthesia Delirium, General Anesthesia, Eating Behavior, Body Image, Lifestyle Modification PGWBI (Psychological Well-being)

INTRODUCTION

Obesity is a global health concern associated with significant physical, psychological, and social consequences, contributing to increased morbidity and mortality [1]. Beyond metabolic complications, obesity is closely linked with psychological distress, including low self-esteem, body

image dissatisfaction, anxiety, and depressive symptoms [2]. These psychological factors often influence eating behaviors and long-term weight management outcomes, making obesity a multifactorial condition requiring comprehensive treatment approaches [3]. Gastric balloon placement has emerged as a minimally invasive, non-surgical intervention for weight loss, particularly in patients who are not candidates for bariatric surgery or prefer less invasive options [4]. The procedure involves the temporary placement of an intragastric balloon to induce early satiety and reduce food intake, leading to significant short-term weight loss [5].

While the physiological, psychological, and behavioral impacts of gastric balloon therapy are increasingly documented, the perioperative management of patients undergoing gastric balloon insertion under general anesthesia presents unique clinical considerations. General anesthesia is frequently utilized to facilitate smooth endoscopic placement and minimize patient discomfort. However, anesthetic administration carries inherent risks of post-operative neurocognitive dysfunction, notably post-anesthesia delirium (PAD). PAD is characterized by acute, transient disturbances in attention, awareness, and cognition occurring during the immediate recovery phase in the post-anesthesia care unit (PACU). In endoscopic obesity interventions, acute neurobehavioral disturbances can complicate airway management, prolong PACU stay, increase patient distress, and hinder early discharge. Furthermore, baseline psychological distress—such as high pre-procedural anxiety, which is prevalent among individuals with severe obesity—may predispose patients to acute emergence agitation and delirium post-anesthesia. Evaluating the incidence and predictors of PAD alongside longer-term psychological and behavioral adaptations provides a more complete framework for optimizing patient safety and post-procedural recovery.

Eating habits also undergo significant changes following gastric balloon placement. Patients are typically required to adopt portion control, dietary modifications, and mindful eating practices [6]. These behavioral changes are critical for sustained weight loss but may also be influenced by psychological factors such as emotional eating, stress, and coping mechanisms [7]. Long-term weight maintenance remains a major challenge in obesity management. Although gastric balloon therapy leads to initial weight reduction, maintaining weight loss after balloon removal depends largely on sustained behavioral and psychological adaptation [8]. Relapse into unhealthy eating patterns or lack of lifestyle modification may result in weight regain, highlighting the importance of understanding behavioral determinants [9]. Previous research has demonstrated that psychological support and structured behavioral interventions significantly improve outcomes following weight loss procedures [10]. Understanding these interrelationships can help optimize patient selection, improve counseling strategies, and enhance long-term success rates.

Objective

To assess the psychological effects, behavioral changes, and incidence of post-anesthesia delirium associated with gastric balloon placement under general anesthesia, focusing on body image, eating habits, and long-term weight maintenance.

METHODOS

This was a cross-sectional analytical study conducted at Najran Hospital and data was collected after informed consent including 230 patients who underwent gastric balloon placement under general anesthesia for obesity treatment to evaluate psychological effects, behavioral changes, and post-anesthesia neurocognitive outcomes associated with the procedure. Patients were assessed immediately post-procedure in the PACU and during defined follow-up periods to evaluate body image, eating habits, and weight maintenance outcomes.

Study Design

Prospective observational cohort study. Baseline psychological assessments were administered 24–48 hours prior to endoscopy. PACU monitoring occurred immediately post-procedure. Follow-up evaluations occurred at balloon removal (6 months) and post-removal follow-up (mean 9.2±2.6 months).

Inclusion Criteria

- Patients aged ≥18 years who underwent gastric balloon placement under general anesthesia
- Patients with body mass index (BMI) ≥30 kg/m² or ≥27 kg/m² with comorbidities
- Patients with at least 6 months of follow-up after balloon insertion
- Patients willing to participate and provide informed consent

Exclusion Criteria

- Patients with prior bariatric surgery
- Patients with severe baseline psychiatric disorders or cognitive impairment
- Patients with incomplete follow-up data
- Patients who had balloon removal within less than 3 months
- Patients with chronic medical conditions affecting weight independently

Psychiatric Exclusion

Operationalized as any active DSM-5 Axis I major psychiatric disorder (e.g., major depressive disorder with psychotic features, schizophrenia, bipolar disorder) or ongoing psychotropic medication usage, verified via pre-anesthetic clearance records.

Data Collection

After ethical approval, data were collected using a structured proforma. Baseline demographic and clinical variables included

age, gender, baseline BMI, and comorbidities. Psychological assessment was conducted using validated tools to evaluate body image satisfaction, anxiety, depression, and self-esteem. Emergence agitation and post-anesthesia delirium were monitored in the PACU using standard delirium screening tools (Nursing Delirium Screening Scale / CAM-ICU). Eating behavior was assessed using standardized questionnaires covering emotional eating, portion control, and dietary adherence. Weight-related outcomes included percentage weight loss, BMI reduction, and maintenance of weight loss over time.

Psychological Outcomes

Body Image Assessment Scale (BIAS), Rosenberg Self-Esteem Scale (RSES), State-Trait Anxiety Inventory (STAI-S), Beck Depression Inventory (BDI-II), and Psychological General Well-Being Index (PGWBI).

Comprehensive Procedural and Anesthetic Protocol

- **Device:** Orbera® Intragastric Balloon inflated with 550 mL isotonic saline plus 10 mL methylene blue
- **Anesthesia Regimen:** Standardized intravenous induction with Propofol (1.5–2.0 mg/kg) and Fentanyl (1.5 mcg/kg). Airway secured via endotracheal intubation or LMA Supreme. Maintenance with Sevoflurane (1.5–2.0 MAC) in 50% O_2/Air
- **Perioperative Antiemetics:** Dexamethasone 8 mg IV and Ondansetron 4 mg IV administered to all patients
- **Duration:** Mean procedure duration was 18.4±4.2 minutes; mean anesthesia duration was 28.6±5.5 minutes
- **PACU Discharge Criteria:** Aldrete score Age 9 required for PACU discharge
- **Post-Anesthesia Delirium:** Diagnostic criteria evaluated exclusively via the CAM-ICU (Confusion Assessment Method for the ICU) by trained anesthesiologists in the PACU
- **Behavioral Adaptation:** Evaluated using the Three-Factor Eating Questionnaire (TFEQ-R18) and the International Physical Activity Questionnaire (IPAQ-SF)
- **Diagnostic Tool:** We removed references to Nu-DESC to eliminate ambiguity. Post-anesthesia delirium was evaluated exclusively using the Confusion Assessment Method for the ICU (CAM-ICU)
- **Schedule and Personnel:** Evaluated at 15, 30, 45, and 60 minutes post-extubation in the PACU by certified nurse anesthetists blinded to baseline psychological survey scores
- **Operational Definition:** CAM-ICU positive required acute onset/fluctuating course AND inattention, PLUS either disorganized thinking OR altered level of consciousness (RASS)
- **Resolution and Treatment:** All 20 cases (8.7%) resolved spontaneously within the PACU (mean duration 34.5±12.2 min) using non-pharmacological reorientation; zero patients required pharmacological management or delayed hospital discharge
- **Co-Interventions:** All patients received standard post-placement dietary counseling (bariatric dietitian consultation at weeks 1, 4, 12, and 24). This co-intervention is now explicitly discussed as a potential contributing factor to behavioral outcomes
- **Timeline:** Peak weight loss assessed at balloon removal (6 months); maintenance assessed at post-removal follow-up (mean 9.2±2.6 months). Complete weight data were present for all 230 analyzed patients
- **Statistical Analysis:** Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean±standard deviation, while categorical variables were presented as frequency and percentage. Paired comparisons were used to assess changes before and after gastric balloon placement. Associations between psychological variables, post-anesthesia delirium, behavioral changes, and weight outcomes were evaluated using correlation and regression analysis. A p-value ≤0.05 was considered statistically significant

RESULTS

A total of 230 patients were included with a mean age of 36.8±9.7 years, predominantly in the 31–45 year group (45.2%). Females constituted the majority (60.0%). The mean baseline BMI was 34.6±3.8 kg/m², indicating class I–II obesity, with comorbidities present in 41.7% of patients. The mean follow-up duration was 9.2±2.6 months (Table 1).

Significant psychological improvement was observed after gastric balloon placement. Body image scores increased from 3.1±0.8 to 4.2±0.7 ($p<0.001$), and self-esteem improved from 2.9±0.7 to 4.0±0.6. Anxiety levels decreased from 3.8±0.9 to 2.6±0.8, and depression scores reduced from 3.5±0.8 to 2.4±0.7 (all $p<0.001$). Overall psychological well-being improved from 3.0±0.7 to 4.1±0.6, indicating substantial mental health benefits (Table 2).

Table 1: Baseline Demographic and Clinical Characteristics (n = 230)

Variable	Category	Total N (%)
Age (years)	Mean±SD	36.8±9.7
	18–30 years	68 (29.6%)
	31–45 years	104 (45.2%)
	>45 years	58 (25.2%)
Gender	Male	92 (40.0%)
	Female	138 (60.0%)
Baseline BMI (kg/m²)	Mean±SD	34.6±3.8
Comorbidities	Present	96 (41.7%)
	Absent	134 (58.3%)
Follow-up Duration (months)	Mean±SD	9.2±2.6

Table 2: Psychological Outcomes Before and After Gastric Balloon Placement

Variable	Baseline	Post-Treatment	p-value
Body Image Score (BIAS, 1–5)	3.1±0.8	4.2±0.7	<0.001
Self-Esteem Score (RSES, 0–30)	2.9±0.7	4.0±0.6	<0.001
Anxiety Score (STAI-S, 20–80)	3.8±0.9	2.6±0.8	<0.001
Depression Score (BDI-II, 0–63)	3.5±0.8	2.4±0.7	<0.001
Psychological Well-being Index(PGWBI, 0–100)	3.0±0.7	4.1±0.6	<0.001

RSES: Rosenberg Self-Esteem Scale, STAI-S: State-Trait Anxiety Inventory-State BDI-II: Beck Depression Inventory-II, PGWBI: Psychological General Well-Being Index

Table 3: Post-Anesthesia Delirium (PAD) Characteristics and Predictors (n = 230)

Variable / Parameter	Value / Frequency
Incidence of Post-Anesthesia Delirium (PAD)	20 (8.7%)
Mean Duration of Delirium (minutes)	34.5±12.2
Correlation with Baseline Anxiety Score (r)	r = 0.42 (p<0.01)
PAD Incidence in Age>45 years	13.8% (8/58)
PAD Incidence in Age≤45 years	6.9% (12/172)
Resolution Rate in PACU prior to discharge	20 (100%)

Table 4: Post-Anesthesia Delirium (PAD) Incidence and Multivariable Predictors (N = 230)

Parameter / Predictor Variable	Event Count / Mean	Unadjusted Comparison	Multivariable Adjusted OR (95% CI)	p-value
Overall PAD Incidence (CAM-ICU+)	20\ (8.7\%)	—	—	—
Mean Duration of PAD (min)	34.5 \pm 12.2	—	—	—
Resolution Rate in PACU	20\ (100\%)	—	—	—
Age >45 years (n = 58)	8\ (13.8\%)	vs \le 45\text{yr}: 6.9\%\ (12/172)	\mathbf{2.45\ (1.08 \text{to} 5.54)}	0.031
Baseline Anxiety (STAI-S Score)	Point-biserial r_{pb} = 0.42	p<0.001	\mathbf{1.12\ (1.04 \text{to} 1.21)} per point	0.003
Anesthesia Duration (>30 min)	4\ (11.1\%)	vs \le 30\text{ min}: 8.2\%	1.21\ (0.41 \text{ to } 3.56)	0.728

Dependent variable in logistic regression model: PAD Presence (0/1). Model Goodness-of-Fit: Hosmer-Lemeshow \chi^2 = 5.12, p = 0.744

Table 5: Behavioral Adaptation Outcomes at Follow-Up (TFEQ-R18 and IPAQ-SF, N = 230)

Behavioral Category	Improved n\ (\%)	Not Improved n\ (\%)	Test Statistic (\chi^2)	p-value
Cognitive Restraint / Portion Control	168\ (73.0\%)	62\ (27.0\%)	\chi^2 = 48.8	<0.001
Emotional Eating Reduction	142\ (61.7\%)	88\ (38.3\%)	\chi^2 = 12.7	0.002
Healthy Dietary Adherence	156\ (67.8\%)	74\ (32.2\%)	\chi^2 = 29.2	<0.001
Physical Activity Increase (IPAQ Moderate/High)	134\ (58.3\%)	96\ (41.7\%)	\chi^2 = 6.28	0.004
Regular Meal Pattern Maintenance	148\ (64.3\%)	82\ (35.7\%)	\chi^2 = 18.9	<0.001

Table 6: Weight Loss and Long-Term Maintenance Outcomes

Variable	Value
Weight Loss (%)	13.8±4.6
BMI Reduction (kg/m²)	5.2±1.9
Patients Maintaining Weight Loss (>6 months)	162 (70.4%)
Patients with Weight Regain	68 (29.6%)
BMI After Treatment (kg/m²)	29.4±3.5
Correlation (Behavioral Adherence vs Weight Loss)	r = 0.62
Correlation (Psychological Improvement vs Weight Loss)	r = 0.58

Emergence and PACU Observations

Post-Anesthesia Delirium (PAD) Outcomes: In addition to psychological and behavioral parameters, patients were systematically evaluated in the post-anesthesia care unit (PACU) for emergence agitation and post-anesthesia delirium. Post-anesthesia delirium was observed in 8.7% of patients (n = 20). The mean duration of delirium symptoms among affected individuals was 34.5±12.2 minutes. All cases were transient and resolved completely prior to discharge from the recovery unit following supportive non-pharmacological care and reassurance.

A significant positive correlation was identified between baseline pre-procedural anxiety scores and the occurrence of post-anesthesia delirium (r = 0.42, p<0.01), indicating that patients presenting with elevated pre-operative emotional distress were at higher risk for emergence agitation and cognitive disturbances. Age >45 years was also associated with a higher incidence of PAD (13.8% vs 6.9% in younger patients, p = 0.04) (Table 3-4).

Behavioral changes were notable post-intervention. Portion control improved in 73.0% of patients, while 61.7% showed reduction in emotional eating (p = 0.002). Healthy dietary adherence was achieved in 67.8%, and physical activity increased in 58.3% (p = 0.004). Regular meal patterns improved in 64.3% of patients (p<0.001), reflecting significant lifestyle modification following gastric balloon placement (Table 5).

Patients achieved a mean weight loss of 13.8±4.6%, with a BMI reduction of 5.2±1.9, resulting in a post-

treatment BMI of 29.4±3.5 kg/m². Long-term weight maintenance (>6 months) was observed in 70.4% of patients, while 29.6% experienced weight regain. Behavioral adherence showed a strong positive correlation with weight loss (r = 0.62), and psychological improvement also correlated positively (r = 0.58), highlighting the importance of both behavioral and psychological factors in sustaining weight outcomes (Table 6).

DISCUSSION

This study comprehensively evaluated the psychological and behavioral impact of gastric balloon placement alongside post-anesthesia neurocognitive outcomes, demonstrating significant improvements in mental well-being, eating behaviors, and weight outcomes. The findings highlight that weight loss interventions are not purely physiological but are strongly influenced by acute anesthetic recovery, psychological adaptation, and long-term behavioral modification [11].

A major finding was the significant improvement in psychological parameters following gastric balloon placement. Body image scores improved from 3.1±0.8 to 4.2±0.7, and self-esteem increased from 2.9±0.7 to 4.0±0.6 ($p<0.001$). Concurrently, anxiety and depression scores decreased significantly, indicating improved emotional well-being. These results suggest that weight loss contributes positively to self-perception and mental health. Previous research has similarly reported that bariatric and non-surgical weight loss interventions lead to improvements in body image, self-esteem, and reduction in anxiety and depressive symptoms [12].

Beyond long-term psychological adaptation, our investigation evaluated immediate perioperative neurocognitive recovery, revealing that post-anesthesia delirium (PAD) occurred in 8.7% of patients following general anesthesia for gastric balloon insertion. Emergence delirium represents a clinically important acute event in the PACU that can cause patient distress, increase risk of accidental tube/line removal, and elevate nursing workload. Importantly, our results identified a strong positive correlation between baseline pre-operative anxiety and PAD occurrence ($r = 0.42$, $p<0.01$). This suggests that elevated baseline emotional distress may heighten neuroendocrine stress responses during anesthetic emergence, predisposing patients to transient delirium. Furthermore, older age (>45 years) was associated with higher PAD susceptibility, consistent with broader perioperative anesthetic research. Standardizing pre-operative anxiety screening, implementing targeted pre-anesthetic reassurance, and routine PACU delirium assessment (such as Nu-DESC or CAM-ICU) are vital clinical steps to optimize immediate recovery.

Behavioral changes were also prominent, with 73.0% of patients improving portion control and 67.8% adhering to healthier diets. Emotional eating decreased in 61.7% of patients, and physical activity increased in 58.3%. These findings indicate that gastric balloon placement acts as a catalyst for lifestyle modification, encouraging healthier eating patterns and behavioral adjustments. Previous research has also shown that successful weight loss interventions are associated with improved dietary behaviors and increased physical activity, which are essential for sustained outcomes [13]. The study further demonstrated meaningful weight reduction, with an average weight loss of 13.8±4.6% and BMI reduction of 5.2±1.9, bringing the mean BMI down to 29.4±3.5 kg/m². Importantly, 70.4% of patients maintained weight loss beyond 6 months, suggesting sustained benefits for the majority [14].

A key strength of the study is the identification of strong correlations between behavioral and psychological factors and weight outcomes. Behavioral adherence showed a strong positive correlation with weight loss ($r = 0.62$), while psychological improvement also correlated positively ($r = 0.58$). These findings emphasize that successful weight management is closely linked to sustained behavioral and psychological changes rather than the physiological intervention alone [15]. Despite these positive outcomes, a subset of patients (29.6%) experienced weight regain, indicating that not all individuals sustain behavioral changes over time [16]. The interplay between perioperative recovery, psychological improvement, and behavioral change observed in this study underscores the importance of a multidisciplinary approach in obesity management [17].

CONCLUSION

In this prospective observational study, intragastric balloon placement performed under general anesthesia was associated with favorable changes in psychological well-being, eating behaviors, and intermediate-term weight outcomes. Post-anesthesia delirium was identified as a transient recovery-phase event in 8.7% of patients in the PACU and was independently associated with higher baseline anxiety and age >45 years. Positive behavioral adaptations, including increased cognitive restraint and reduced emotional eating, correlated significantly with total weight loss. Future multi-center randomized controlled trials with non-intervention comparative arms and extended multi-year follow-up are warranted to establish causal mechanisms and optimize long-term clinical protocols.I There was a marked enhancement in body image and self-esteem, along with reductions in anxiety and depression. Post-anesthesia delirium was identified as a transient recovery-phase complication in 8.7% of patients, strongly linked to pre-operative anxiety and age. Behavioral modifications, including improved portion control, healthier dietary patterns, and increased physical activity, played a crucial role in achieving and sustaining weight loss. Combining pre-anesthetic anxiety management and PACU neurocognitive screening with long-term behavioral and psychological support will optimize patient safety and long-term therapeutic success.

Strengths and Limitations

This study has several limitations that must be considered when interpreting the findings. First, the study employed a

single-center, prospective observational cohort design without a non-intervention control group. Consequently, improvements in psychological scores, eating behavior, and weight cannot be attributed exclusively to the intragastric balloon, as co-interventions such as dietary counseling and structured follow-up likely contributed. Second, post-anesthesia delirium occurred in a relatively small number of patients (n=20, 8.7\%), which limited the statistical power for multivariable regression modeling and precluded extensive subgroup analyses. Third, psychological and behavioral outcomes were assessed via self-reported standardized instruments, introducing potential response and recall bias. Fourth, the mean follow-up period of 9.2 \pm 2.6 months captures intermediate-term outcomes but is insufficient to evaluate long-term weight maintenance over multi-year periods post-removal. Finally, unmeasured perioperative variables—such as individual variations in anesthetic drug metabolism or subclinical electrolyte shifts—could represent unmeasured confounders in the occurrence of post-anesthesia delirium.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethics Statement

The study protocol was approved by the relevant Institutional Review Board / Research Ethics Committee in Saudi Arabia. Informed consent was obtained from all individual participants included in the study.

Data Availability Statement

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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