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Psychiatric Manifestations after Sleeve Gastrectomy and Their Relationship with Nutritional Deficiencies: A Retrospective Cohort Study

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Abstract

Background

Psychiatric morbidity may occur after sleeve gastrectomy (SG), and micronutrient deficiencies may contribute. This study evaluated new-onset psychiatric disorders after SG and their association with postoperative nutritional deficiencies.

Methods

This retrospective cohort study included 50 patients with BMI ≥ 35 kg/m² who underwent laparoscopic SG between August 2023 and August 2025 and completed at least 6 months of follow-up. Patients with preoperative psychiatric illness were excluded. Psychiatric diagnoses were established using Structured Clinical Interview for DSM Disorders. Vitamin D, vitamin B12, thiamine, folate, and iron were assessed. Associations were evaluated using Fisher's exact test, odds ratios (ORs) with 95% CIs, and univariable binary logistic regression.

Results

Eight patients (16%) developed a psychiatric disorder: depression in 6 (75%), anxiety disorder in 1 (12.5%), and binge-eating disorder in 1 (12.5%). Patients with psychiatric disorders had lower serum folate (5.1 ± 3.7 vs 11.3 ± 3.6 ng/mL; P = 0.002) and thiamine (79.9 ± 25.7 vs 117.6 ± 31.5 nmol/L; P = 0.004). Thiamine deficiency (OR 13.44, 95% CI 2.56–70.58; P = 0.003) and vitamin B12 deficiency (OR 5.54, 95% CI 1.21–25.38; P = 0.030) were associated with psychiatric disorders. All patients with folate deficiency had psychiatric manifestations (P < 0.001), although OR was not estimable. Lower thiamine and folate levels were associated with psychiatric disorders.

Conclusions

New-onset psychiatric disorders occurred in 16% of patients during follow-up. Lower postoperative thiamine and folate levels and deficiencies of thiamine and vitamin B12 were associated with psychiatric morbidity. These findings support nutritional and psychiatric surveillance after SG, while larger prospective studies are needed to clarify causality.

Key Points

New-onset psychiatric disorders occurred in 16% of patients during postoperative follow-up after sleeve gastrectomy.

Depression accounted for 75% of psychiatric disorders identified in the cohort.

Lower thiamine and folate levels were associated with postoperative psychiatric disorders.

Thiamine and vitamin B12 deficiencies were associated with psychiatric morbidity; the folate association requires confirmation in larger studies.

Introduction

Obesity is a worldwide epidemic, and bariatric and metabolic surgery is considered the primary treatment for achieving sustained weight loss and managing obesity-related health problems. Among available procedures, sleeve gastrectomy and Roux-en-Y gastric bypass are the most commonly performed, and SG has become the most frequent bariatric procedure in the world (Angrisani et al., 2017), a trend confirmed across all IFSO chapters in recent surveys (Angrisani et al., 2024). In the United States, primary SG accounted for 68.8% of metabolic and bariatric procedures (140,339 cases) reported to the national quality registry in 2021 (Brown et al., 2024).

Obesity and psychiatric illness are closely and bidirectionally linked. In a study of patients seeking obesity treatment, obese individuals had a 55% increased risk of developing depression over time, whereas depressed individuals had a 58% increased risk of becoming obese (Luppino et al., 2010). Depression is approximately twice as common among individuals with obesity (46.2%) as among those of normal weight (25.5%) (Blasco et al., 2020), and a point prevalence of 23% has been reported among obese patients in primary care (Carey et al., 2014). Among patients presenting for bariatric surgery, depression is diagnosed in 36% of cases and anxiety in 11% (Monte et al., 2018), up to 50% of candidates report some form of disordered eating (Sarwer&Heinberg, 2020), and approximately 10% report a lifetime history of suicide attempts (Chen et al., 2012).

Bariatric surgery generally improves psychiatric symptoms in the early postoperative period: in a prospective evaluation of patients on antidepressant or anxiolytic therapy who underwent SG, anxiety symptoms improved in more than 50% of subjects and depressive symptoms in 67%, commonly on the same or a reduced dose (Monte et al., 2018). Similarly, in the largest carefully assessed cohort to date, the prevalence of Axis I psychiatric disorders fell from 30% before surgery to 17% and 18% at 2 and 3 years postoperatively (Kalarchian et al., 2016). However, the picture is not uniformly favorable. A recent prospective study found that although SG improved quality of life, the point prevalence of mental health complications one year after surgery remained relatively higher than in the general population, with no significant improvement in anxiety and depression scores on the Hospital Anxiety and Depression Scale (Elyasinia et al., 2025). New-onset severe depression and anxiety in the early postoperative period requiring pharmacological treatment have also been reported after SG (Çöpür et al., 2021). Long-term concerns include an approximately 1.98-fold increased risk of suicide after bariatric surgery compared with usual obesity care, with suicide attempts occurring on average 3.8–3.9 years postoperatively, and a fivefold higher risk of alcohol abuse after gastric bypass in the Swedish Obese Subjects study (Neovius et al., 2018). Proposed mechanisms underlying these late psychiatric risks include neuroendocrine

alterations, exacerbation of depression and anxiety due to micro- and macronutrient deficiencies, and maladaptive eating behaviors.

Micronutrient deficiencies are a well-recognized consequence of SG, even though the anatomy of the intestinal tract is left unaltered. In a double-blind randomized trial, about three-quarters of patients showed at least one micronutrient deficiency during the first year after SG despite routine multivitamin supplementation (Heusschen et al., 2020). Contributing factors include reduced food intake, decreased hydrochloric acid and intrinsic factor secretion, vomiting, poor food choices, and food intolerance (Krzizek et al., 2021). In a comparative study of 505 patients undergoing RYGB or SG, vitamin B12, hemoglobin, and ferritin levels were generally better preserved after SG than after RYGB, yet vitamin B12 deficiency remained present in 4.69% of SG patients at 6 months and 0.93% at 12 months. Vitamin D deficiency was highly prevalent in both groups, affecting 49.2% of SG patients within the first year in one series (Vieira de Sousa et al., 2024). Long-term follow-up shows that deficiencies accrue over time: in a 10-year prospective observation, the prevalence of iron (9.0% to 18.7%), folic acid (1.3% to 11.6%), and vitamin B12 (7.1% to 17.4%) deficiencies increased significantly after bariatric surgery (Humięcka et al., 2025).

A substantial body of evidence links the nutrients most affected by SG to psychiatric morbidity. Vitamin B12 deficiency produces characteristic neuropsychiatric syndromes including slow cerebration, confusion, memory changes, delirium, depression, and acute psychotic states (Hector&Burton, 1988; Lachner et al., 2012), and neuropsychiatric disorders due to cobalamin deficiency occur in the absence of anemia or macrocytosis in 28% of affected patients (Lindenbaum et al., 1988). Deficiencies of vitamins B9 and B12 are implicated in depression, cognitive decline, psychosis, peripheral neuropathy, and myelopathy through disturbances of DNA synthesis, methylation reactions, neurotransmitter production, and myelin synthesis (Han et al., 2025). Folate deficiency is found in 15–38% of adults with depressive disorders (Alpert&Fava, 1997), and more than half (52%) of severely depressed inpatients show raised total plasma homocysteine, a functional marker of folate and B12 deficiency (Bottiglieri et al., 2000). In the population-based Rotterdam Study, vitamin B12 deficiency and hyperhomocysteinemia were both related to depressive disorders, with the B12 association appearing independent of physical comorbidity (Tiemeier et al., 2002). Iron deficiency anemia is associated with a 1.52-fold increased adjusted hazard of psychiatric disorders, including anxiety, depression, sleep, and psychotic disorders (Lee et al., 2020), and iron deficiency is often associated with nonspecific symptoms such as fatigue that overlap with psychiatric presentations (Levin&Gattari, 2023). Vitamin D, a neurosteroid with receptors in brain regions implicated in depression, has been associated with depressive symptoms in meta-analytic work (Anglin et al., 2013). Thiamine (vitamin B1) deficiency can cause Wernicke encephalopathy — characterized by the triad of ataxia, eye movement disorders, and mental status change — an acute neuropsychiatric emergency reported after bariatric procedures (Oudman et al., 2018), with case series documenting persistent affective and cognitive sequelae, including Korsakoff syndrome, after SG (Gutiérrez-Rey et al., 2024). Among trace elements, the evidence most strongly supports an association between zinc deficiency and risk of depression (Wang et al., 2018).

Despite this convergence of evidence, considerably less is known about depression and anxiety symptoms after SG than after RYGB, and few studies have directly examined whether postoperative nutritional deficiencies are associated with psychiatric manifestations specifically after sleeve gastrectomy. The aim of this study was therefore to evaluate the incidence of new-onset psychiatric disorders after SG and to investigate their relationship with postoperative nutritional deficiencies.

Methods

Study design and setting. This retrospective cohort study was conducted at the Department of General Surgery, the study institution, Cairo, Egypt, and was designed and reported in accordance with the Strengthening the Reporting of Cohort Studies in Surgery guidelines (Agha et al., 2019). Data were retrospectively retrieved from patients' medical records, the institutional bariatric surgery database, outpatient follow-up clinics, the laboratory information system, and psychiatric assessment records. All patients underwent primary laparoscopic sleeve gastrectomy according to the standardized institutional bariatric surgery protocol and were followed in specialized bariatric outpatient clinics.

Study population and duration: Consecutive patients who underwent laparoscopic SG between August 2023 and August 2025 were screened for eligibility; only patients who completed at least 6 months of postoperative follow-up were included, permitting adequate assessment of postoperative nutritional status and psychiatric manifestations. **Inclusion criteria** were: age 20–60 years; preoperative BMI ≥ 35 kg/m²; primary laparoscopic SG; completion of at least 6 months of postoperative follow-up; and availability of complete clinical, laboratory, and psychiatric records. **Exclusion criteria** were: previous psychiatric illness diagnosed before surgery; previous bariatric or gastric surgery; active malignant disease; endocrine disorders that could influence nutritional status or body weight; major postoperative complications, particularly staple-line leakage; missing or incomplete medical records; and loss to follow-up. After application of the eligibility criteria, 50 patients with complete demographic, clinical, biochemical, and psychiatric data were included in the final analysis. For analytical purposes, patients were classified into two groups: **Group I** (patients who developed new-onset psychiatric manifestations after LSG, n = 8) and **Group II** (patients without postoperative psychiatric manifestations, n = 42).

Data collection

Demographic variables (age, sex) and anthropometric measurements (preoperative body weight, preoperative BMI, postoperative BMI) were recorded. BMI was calculated as weight (kg)/height (m)².

Nutritional assessment: Postoperative laboratory values were reviewed for all patients: serum vitamin D (ng/mL), serum vitamin B12 (pg/mL), whole blood thiamine (nmol/L), serum folate (ng/mL), and serum iron (µg/dL). For categorical analysis, nutritional deficiencies were defined according to the following accepted laboratory reference thresholds, applied uniformly throughout the analysis:

Micronutrient	Deficiency threshold
Vitamin D	< 30 ng/mL
Vitamin B12	< 200 pg/mL
Thiamine (vitamin B1)	< 70 nmol/L
Folate	< 4 ng/mL
Iron	< 60 µg/dL

Psychiatric assessment

Postoperative psychiatric evaluation was performed using the Structured Clinical Interview for DSM Disorders, Research Version, a structured diagnostic interview considered among the most reliable instruments for psychiatric diagnosis. The assessment was directed toward identifying new-onset psychiatric disorders developing after LSG. Recorded diagnoses included major depressive disorder, anxiety disorder, binge-eating disorder, or no psychiatric disorder, established according to Diagnostic and Statistical Manual of Mental Disorders diagnostic criteria.

Outcome measures: The primary outcome was the incidence of new-onset psychiatric manifestations following LSG, diagnosed using SCID-I in patients without a previous psychiatric history. Secondary outcomes were: postoperative serum levels of vitamin D, vitamin B12, thiamine, folate, and iron; the prevalence of postoperative micronutrient deficiencies; the association between postoperative nutritional deficiencies and newly developed psychiatric manifestations; and the correlation between serum micronutrient levels and psychiatric disorders.

Quality control and ethics: All patient records were reviewed independently before data entry, and laboratory results were verified against original laboratory reports whenever available. Patient identifiers were replaced with anonymous study codes to maintain confidentiality. The study protocol was approved by the Research Ethics Committee of the Faculty of Medicine, the study institution, and was conducted in accordance with the Declaration of Helsinki and its subsequent amendments (World Medical Association, 2013). Informed consent was obtained from participants; because of the retrospective observational design, patient management was not influenced by study participation, and all data were anonymized prior to analysis.

Statistical analysis

Analyses were performed using Python (SciPy version 1.17 and Statsmodels) (Seabold&Perktold, 2010). Continuous variables were summarized as mean ± standard deviation for normally distributed data and as median (minimum–maximum) otherwise; normality was assessed using the Shapiro–Wilk test. Group comparisons were performed using the Welch independent-samples t-test or the Mann–Whitney U test as appropriate, and categorical associations were evaluated using Fisher's exact test given the small expected cell counts. Univariate binary logistic regression was used to estimate ORs with 95% CIs for

predictors of new-onset psychiatric disorders. Because only eight psychiatric events occurred, multivariable logistic regression was intentionally restricted to an exploratory approach to avoid overfitting. A two-sided $P < 0.05$ was considered statistically significant.

Results

Study population: A total of 50 patients who underwent laparoscopic SG were included: 34 females (68%) and 16 males (32%), with a mean age of 34.2 ± 7.2 years. Mean preoperative weight was 114.0 ± 19.3 kg and mean preoperative BMI 46.9 ± 7.0 kg/m². Postoperatively, mean BMI decreased to 34.7 ± 4.5 kg/m², representing a mean BMI reduction of 12.1 ± 4.6 kg/m², equivalent to approximately 25.4% of baseline BMI (Table 1)

Table 1
Demographic and anthropometric characteristics

Variable	Value
Number of patients	50
Age (years)	34.2 ± 7.2
Female	34 (68%)
Male	16 (32%)
Preoperative weight (kg)	114.0 ± 19.3
Preoperative BMI (kg/m²)	46.9 ± 7.0
Postoperative BMI (kg/m²)	34.7 ± 4.5
BMI reduction (kg/m²)	12.1 ± 4.6

Incidence of postoperative psychiatric disorders

Eight of 50 patients (16%) developed a new psychiatric disorder during postoperative follow-up, whereas 42 patients (84%) did not. Depression was the most frequent diagnosis, occurring in 6 patients (75% of affected patients); one patient (12.5%) developed an anxiety disorder and one (12.5%) developed binge-eating disorder (Table 2; Fig. 1).

Table 2
Distribution of psychiatric disorders

Diagnosis	Number	Percentage
Depression	6	75%
Anxiety disorder	1	12.5%
Binge-eating disorder	1	12.5%
Total	**8**	**100%**

Comparison between patients with and without psychiatric disorders

No statistically significant differences were observed between groups regarding age (35.5 ± 4.8 vs 34.0 ± 7.6 years; P = 0.179), preoperative body weight (117.1 ± 16.4 vs 113.5 ± 20.0 kg; P = 0.588), preoperative BMI (47.3 ± 8.8 vs 46.8 ± 6.7 kg/m²; P = 0.832), postoperative BMI (36.1 ± 5.6 vs 34.5 ± 4.3 kg/m²; P = 0.467), or BMI reduction (11.2 ± 4.0 vs 12.3 ± 4.8 kg/m²; P = 0.721). Although male patients showed a higher proportion of psychiatric disorders than females (62.5% vs 26.2%), this difference did not reach statistical significance (P = 0.092) (Table 3**)**.

Table 3
Comparison of demographic characteristics between groups

Variable	Psychiatric disorder (n = 8)	No psychiatric disorder (n = 42)	P value
Age (years)	35.5 ± 4.8	34.0 ± 7.6	0.179
Male sex	62.5%	26.2%	0.092
Preoperative weight (kg)	117.1 ± 16.4	113.5 ± 20.0	0.588
Preoperative BMI (kg/m²)	47.3 ± 8.8	46.8 ± 6.7	0.832
Postoperative BMI (kg/m²)	36.1 ± 5.6	34.5 ± 4.3	0.467
BMI reduction (kg/m²)	11.2 ± 4.0	12.3 ± 4.8	0.721

Comparison of postoperative micronutrient levels

Patients with psychiatric disorders demonstrated significantly lower serum folate (5.1 ± 3.7 vs 11.3 ± 3.6 ng/mL; P = 0.002) and thiamine (79.9 ± 25.7 vs 117.6 ± 31.5 nmol/L; P = 0.004) levels than patients without psychiatric disorders **(**Table 4; Fig. 2**).** Serum vitamin B12 was lower among affected patients (245.1 ± 123.3 vs 322.6 ± 147.1 pg/mL), but the difference did not reach statistical significance (P = 0.070). No significant differences were observed for vitamin D (32.8 ± 11.0 vs 30.3 ± 11.1 ng/mL; P = 0.451) or serum iron (70.9 ± 34.0 vs 89.5 ± 40.9 µg/dL; P = 0.199).

Table 4
Comparison of postoperative micronutrient levels

Micronutrient	Psychiatric disorder	No psychiatric disorder	P value
Vitamin D (ng/mL)	32.8 ± 11.0	30.3 ± 11.1	0.451
Vitamin B12 (pg/mL)	245.1 ± 123.3	322.6 ± 147.1	0.070
Thiamine (nmol/L)	79.9 ± 25.7	117.6 ± 31.5	**0.004***
Folate (ng/mL)	5.1 ± 3.7	11.3 ± 3.6	**0.002***
Iron (µg/dL)	70.9 ± 34.0	89.5 ± 40.9	0.199

Association between micronutrient deficiency and psychiatric disorders

Using predefined laboratory cut-off values, thiamine deficiency was significantly associated with postoperative psychiatric disorders (OR 13.44; 95% CI 2.56–70.58; P = 0.003), as was vitamin B12 deficiency (OR 5.54; 95% CI 1.21–25.38; P = 0.030). All patients with folate deficiency developed psychiatric disorders (P < 0.001); because no folate-deficient patient remained free of psychiatric manifestations, the OR was not estimable (zero cell). No statistically significant association was found between psychiatric disorders and vitamin D deficiency (OR 0.39; 95% CI 0.06–2.53; P = 0.407) or iron deficiency (OR 1.55; 95% CI 0.35–6.91; P = 0.683) (Table 5).

Table 5
Association between micronutrient deficiencies and psychiatric disorders

Deficiency	Odds ratio (OR)	95% CI	P value
Vitamin D	0.39	0.06–2.53	0.407
Vitamin B12	5.54	1.21–25.38	**0.030***
Thiamine	13.44	2.56–70.58	**0.003***
Folate	Not estimable	—	**< 0.001***
Iron	1.55	0.35–6.91	0.683

Logistic regression analysis

On univariable binary logistic regression using continuous micronutrient levels, lower serum thiamine was significantly associated with increased odds of psychiatric disorders (OR 0.958 per unit; 95% CI 0.929–0.989; P = 0.008), as was lower serum folate (OR 0.618 per unit; 95% CI 0.452–0.845; P = 0.003). Vitamin B12 level was not a significant predictor (OR 0.995; 95% CI 0.988–1.002; P = 0.184) (Table 6**)**

Table 6
Univariable logistic regression analysis

Variable	Odds ratio (OR)	95% CI	P value
Thiamine	0.958	0.929–0.989	**0.008***
Folate	0.618	0.452–0.845	**0.003***
Vitamin B12	0.995	0.988–1.002	0.184

*Statistically significant (P < 0.05).

Discussion

In this retrospective cohort of 50 patients without documented preoperative psychiatric illness, 16% developed a new psychiatric disorder after laparoscopic sleeve gastrectomy, with depression accounting for three-quarters of all events. Patients who developed psychiatric disorders had significantly lower postoperative serum folate and thiamine levels, and categorical thiamine deficiency (OR 13.44), vitamin B12 deficiency (OR 5.54), and folate deficiency (all affected patients; P < 0.001) were significantly associated with psychiatric morbidity. Lower serum folate and thiamine levels were associated with psychiatric disorders on logistic regression. These findings support the hypothesis that postoperative deficiencies of B-complex vitamins contribute to new-onset psychiatric manifestations after SG.

Incidence of psychiatric disorders after sleeve gastrectomy

The 16% incidence of new-onset psychiatric disorder in our cohort is broadly consistent with published estimates of incident psychiatric morbidity after bariatric surgery. Depressive symptoms generally improve in the early postoperative period, with improvements peaking in the medium term, but a subset of patients experiences worsening or recurrence, and long-term management must account for potential adverse psychological effects of surgery (Budin et al., 2025). In a national nested case-control study, bariatric surgery was associated with a 50% increased hazard of de novo depression (HR 1.50; 95% CI 1.32–1.71) among patients without pre-existing depression, a finding directly comparable to the 12% new-onset depression rate observed here (Arhi et al., 2021). A large matched-cohort analysis similarly found that the risk of postoperative psychiatric disorders increased after both SG and RYGB, with a 33% greater relative increase after RYGB (Becerra et al., 2022). Population-level data indicate that the association between bariatric surgery and hospitalization with psychiatric diagnoses is procedure-dependent, suggesting distinct vulnerabilities among patient cohorts (Sumithran et al., 2023), and a 12-year nationwide cohort study reported an elevated risk of major depressive disorder after bariatric surgery (adjusted HR 1.70; 95% CI 1.27–2.27), driven predominantly by malabsorptive procedures and emerging more than four years postoperatively (Lu et al., 2018). Finally, a systematic review and meta-analysis found that although bariatric surgery may improve depression, anxiety, and non-normative eating, it is associated with a small increase in suicides and substance use disorders, with low to very low certainty of evidence (van Reekum et al., 2025; Law et al., 2023), and bariatric patients exhibit higher

suicide rates than the general population (4.1 per 10,000 person-years) (Peterhänsel et al., 2013). Taken together, the present findings support the growing consensus that psychiatric surveillance should be a routine component of post-bariatric follow-up rather than a preoperative screening exercise only.

Demographic and anthropometric factors

No significant associations were found between new-onset psychiatric disorders and age, preoperative weight or BMI, postoperative BMI, or the magnitude of BMI reduction. Although a greater proportion of male patients developed psychiatric disorders (62.5% vs 26.2%), the difference was not statistically significant (P = 0.092) and may reflect the small sample size. These results suggest that the degree of obesity and the amount of weight lost are not the principal determinants of postoperative mental health outcomes; rather, psychiatric manifestations after SG are likely to result from a complex interaction of biological, nutritional, hormonal, and psychosocial factors, including micronutrient deficiency and maladaptive eating behaviors. Accordingly, postoperative psychological surveillance should not be limited to patients with poor weight-loss outcomes but should be incorporated into the routine multidisciplinary follow-up of all bariatric patients.

Micronutrient status and psychiatric disorders: One of the most important findings of this study was the significant association between postoperative micronutrient status and the development of psychiatric disorders. The prominence of the B-vitamin axis is biologically coherent: thiamine, folate, and vitamin B12 participate directly in the synthesis of serotonin, dopamine, noradrenaline, and gamma-aminobutyric acid, and their deficiency disrupts homocysteine methylation, producing hyperhomocysteinemia linked to depression, anxiety, and cognitive decline (Al Mansoori et al., 2021). Folate is an essential cofactor in one-carbon metabolism, required for DNA synthesis, methylation reactions, and neurotransmitter production; folate deficiency is found in 15–38% of adults with depressive disorders, and more than half of severely depressed inpatients show raised total plasma homocysteine. The complete concordance between folate deficiency and psychiatric disorders observed in our cohort, although based on a small number of deficient patients, is consistent with this pathway. Thiamine deficiency impairs cerebral glucose metabolism and ATP production, and although florid presentations such as Wernicke encephalopathy are the best-recognized complication of bariatric surgery, milder chronic depletion has increasingly been linked to depression, anxiety, irritability, fatigue, and cognitive impairment — a spectrum consistent with the strong association observed here. Vitamin B12 deficiency was associated with psychiatric disorders at the categorical threshold (OR 5.54) despite the non-significant group comparison of continuous levels, a pattern that may reflect limited statistical power or the gradual depletion of hepatic B12 stores, which typically develops over years rather than in the early postoperative period.

In contrast, neither vitamin D nor iron showed significant associations in this cohort, diverging from segments of the wider literature in which vitamin D deficiency in particular has been linked to depression (Dionisie et al., 2025). This discrepancy may reflect the relatively small number of affected patients, adequate postoperative supplementation with relatively preserved vitamin D concentrations in this

population, or a genuinely stronger discriminating signal carried by the B-vitamin axis within this follow-up window. Iron deficiency, despite its established role in dopamine synthesis, oxygen transport, and cerebral metabolism, has a less consistent relationship with clinically diagnosed depression and anxiety than folate or thiamine, consistent with our null findings. These results suggest that postoperative psychiatric morbidity is more closely related to deficiencies affecting neurotransmitter and cerebral energy metabolism than to deficiencies primarily influencing oxygen transport or musculoskeletal health.

Micronutrient deficiency as a predictor of psychiatric disorders

Categorical deficiency analysis identified thiamine deficiency as the strongest predictor of new-onset psychiatric disorders (OR 13.44), and continuous regression confirmed that psychiatric risk increases progressively as serum folate and thiamine concentrations decline, even before severe biochemical deficiency is reached. Although several confidence intervals were wide, reflecting the modest sample size and limited number of events, the intervals for thiamine and vitamin B12 deficiency did not include unity, supporting clinical significance. Vitamin B12 did not independently predict psychiatric disorders on regression, possibly because its metabolism is shared with folate through one-carbon pathways, because its effect was mediated by the same biochemical route, or because postoperative B12 deficiency develops gradually owing to substantial hepatic stores. The limited number of psychiatric events (n = 8) precluded multivariable modeling, which would have been vulnerable to overfitting; univariable regression therefore represents an appropriate approach for this sample size.

Clinical implications

These findings support routine postoperative surveillance of micronutrient status in SG patients, consistent with guidance from the American Association of Clinical Endocrinologists, The Obesity Society, and the American Society for Metabolic & Bariatric Surgery recommending nutritional monitoring and psychological evaluation in the perioperative period (Mechanick et al., 2013), and with European recommendations for post-bariatric medical management. Given that a substantial minority of bariatric candidates present with disordered eating and psychiatric comorbidity, and that new-onset psychiatric disorders can develop in patients with no prior psychiatric history, extending structured psychiatric and nutritional assessment into the postoperative period appears prudent. Correcting an identifiable micronutrient deficiency — particularly of thiamine, folate, or vitamin B12 — may represent a valuable, reversible adjunct in patients presenting with new or worsening psychiatric symptoms after SG, and early recognition is essential because several neuropsychiatric manifestations of these deficiencies may become irreversible if treatment is delayed.

Strengths

The study specifically addresses psychiatric outcomes after SG, an area comparatively less studied than after RYGB. Psychiatric diagnoses were established using the structured SCID-I interview rather than self-report symptom scales, minimizing misclassification; five micronutrients were measured simultaneously, permitting comparison of their relative contributions; and complementary analytic

approaches (group comparisons, OR estimation with CIs, and logistic regression) provided more robust evidence than simple descriptive comparisons.

Limitations

This study has several limitations. First, the sample size was small (50 patients; 8 psychiatric events), reducing statistical power and producing relatively wide confidence intervals for some estimates. Second, the retrospective observational design precludes establishment of a definitive causal relationship between micronutrient deficiencies and psychiatric disorders; reverse causality, in which psychiatric symptoms reduce dietary intake and thereby precipitate deficiencies, cannot be excluded. Third, the study was conducted at a single tertiary referral center, which may limit generalizability. Fourth, several potential confounders — socioeconomic status, educational level, dietary adherence, physical activity, smoking, alcohol consumption, family history of psychiatric illness, and adherence to vitamin supplementation — were not systematically evaluated. Fifth, although patients with known preoperative psychiatric disorders were excluded, subtle or undiagnosed preoperative psychiatric conditions could not be entirely excluded. Sixth, the minimum 6-month follow-up may have underestimated the incidence of psychiatric disorders and of vitamin B12 deficiency, which can develop several years after surgery. Finally, the association between folate deficiency and psychiatric disorders, although striking, was based on a very small number of deficient patients and a zero contingency cell, and should be interpreted cautiously pending confirmation in larger prospective studies.

Conclusions

New-onset psychiatric disorders occurred in 16% of patients after laparoscopic sleeve gastrectomy, with depression the predominant diagnosis. Postoperative deficiencies of thiamine (OR 13.44), vitamin B12 (OR 5.54), and folate (all affected patients) were significantly associated with psychiatric morbidity, and lower serum folate and thiamine levels were associated with psychiatric disorders. No associations were observed with demographic characteristics, anthropometric parameters, or the magnitude of weight loss. These findings suggest that routine postoperative monitoring of folate, thiamine, and vitamin B12 status, together with structured screening for psychiatric symptoms, may facilitate early identification and treatment of at-risk patients. Prospective, adequately powered multicenter studies with preoperative psychiatric and nutritional baselines, longer follow-up, and randomized supplementation trials are warranted to confirm a causal relationship between nutritional deficiencies and psychiatric manifestations after SG.

Declarations

Ethics approval: The study protocol was approved by the Research Ethics Committee of the Faculty of Medicine at the study institution.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Funding: None to declare.

Conflict of interest: None to declare.

Author contributions: Blinded for peer review.

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Figures

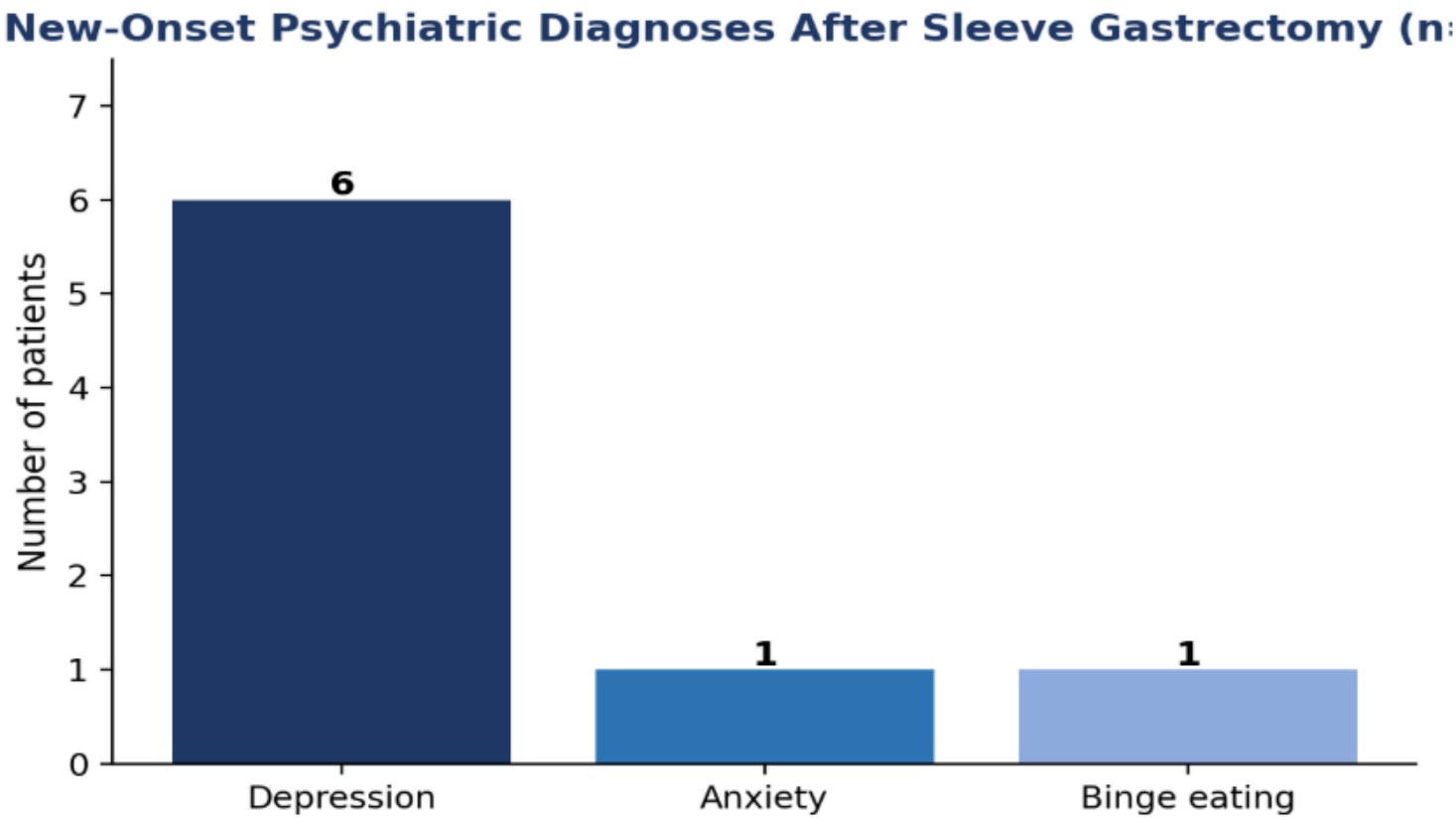


Figure 1

Distribution of new-onset psychiatric disorders among patients after laparoscopic sleeve gastrectomy (n = 8 of 50). Depression was the most frequent new diagnosis (6/8 patients, 75%), followed by anxiety disorder (1/8, 12.5%) and binge-eating disorder (1/8, 12.5%)

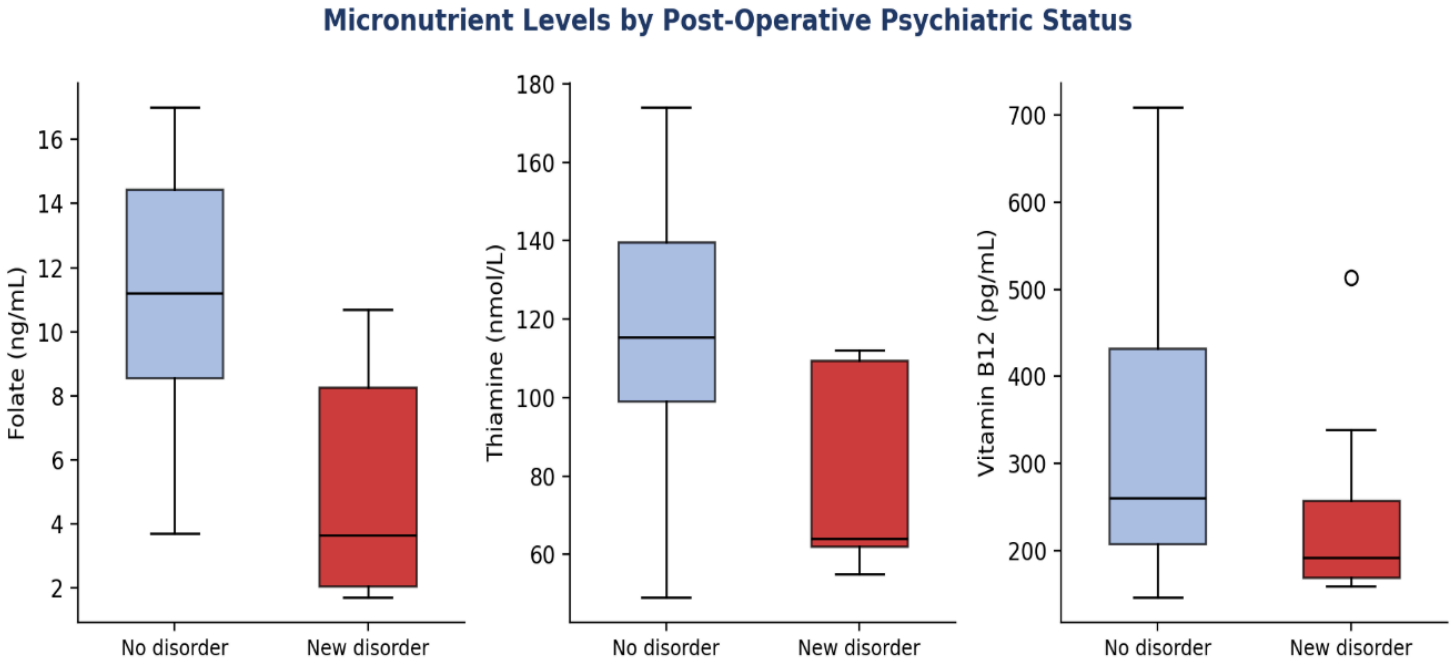


Figure 2

Comparison of postoperative serum folate, thiamine, and vitamin B12 levels between patients with (n = 8) and without (n = 42) new-onset psychiatric disorders after laparoscopic sleeve gastrectomy. Patients with psychiatric disorders had significantly lower serum folate (5.1 ± 3.7 vs 11.3 ± 3.6 ng/mL; P = 0.002) and thiamine (79.9 ± 25.7 vs 117.6 ± 31.5 nmol/L; P = 0.004).