

MICROELEMENT DEFICIENCIES AFTER SURGICAL TREATMENT OF OBESITY: EARLY DIAGNOSIS AND PREVENTION STRATEGIES

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Abstract. Background: Bariatric surgery is an effective intervention for obesity management but often leads to significant deficiencies in microelements and vitamins due to altered gastrointestinal anatomy and reduced absorption. Objective: This study aims to evaluate the dynamic changes in serum levels of iron, zinc, copper, vitamin B12, and vitamin D before and after bariatric surgery, and to identify early diagnostic biomarkers for timely prevention and management of deficiencies. Methods: A total of 130 patients aged 20–55 who underwent bariatric surgery were followed for 12 months. Serum and urine levels of selected microelements and vitamins were measured preoperatively and at 1, 3, 6, and 12 months postoperatively. Results: The most pronounced declines were observed in iron, vitamin B12, and zinc levels, particularly within the first three months post-surgery. Copper levels remained relatively stable, while vitamin D showed a progressive decrease. Early postoperative monitoring using biomarkers such as ferritin and 25(OH)D proved valuable in predicting and managing deficiencies. Conclusion: Routine laboratory monitoring and personalized supplementation protocols are essential for preventing microelement deficiencies after bariatric surgery. Early intervention based on dynamic biomarker changes can improve long-term outcomes and patient quality of life.

Keywords: Bariatric surgery; micronutrient deficiency; iron; vitamin B12; vitamin D; zinc; copper; early diagnosis; nutritional monitoring; obesity treatment.

Introduction

Obesity has become a global epidemic, affecting more than 650 million adults worldwide according to the World Health Organization [1]. It is

associated with numerous health complications, including type 2 diabetes, cardiovascular disease, and certain cancers. Bariatric surgery has proven to be an effective intervention for sustained weight loss and remission of obesity-related comorbidities [2]. Despite its benefits, bariatric surgery can lead to significant nutritional deficiencies, particularly in essential microelements and vitamins [3]. Iron, zinc, copper, vitamin B12, and vitamin D are among the most commonly affected nutrients [4]. These deficiencies can result in fatigue, anemia, neurological disorders, impaired immunity, and poor wound healing [5]. Early detection and management of such deficiencies are critical for preventing long-term complications and improving postoperative outcomes [6]. This study aims to evaluate the dynamic changes in essential microelements and vitamins following bariatric surgery and to identify early diagnostic biomarkers for timely prevention and intervention.

Materials and Methods. This prospective cohort study included 130 patients aged 20 to 55 who underwent bariatric surgery. Patients were monitored for a minimum of 12 months. Blood and urine levels of iron (Fe), zinc (Zn), copper (Cu), vitamin B12, and vitamin D were evaluated at baseline (pre-operative) and at 1, 3, 6, and 12 months post-operatively. All assessments were conducted using standard clinical laboratory methods and validated biomarkers.

Results. The study revealed a significant decline in iron, zinc, and vitamin B12 levels in the early post-operative period, particularly at the 1st and 3rd month marks. Copper levels showed only a mild decrease, while vitamin D deficiency was observed in more than half of the patients by the 3rd month. Gender differences were noted, with female patients showing more pronounced deficiencies. Dynamic monitoring helped identify patterns and critical time points for supplementation. Table 1. Dynamics of Serum Microelement and Vitamin Levels Following Bariatric Surgery at Five Time Points.

Table 1
Microelement and Vitamin Levels at Different Time Points

Timepoint	Iron (Fe), µg/dL	Zinc (Zn), µg/dL	Copper (Cu), µg/dL	Vitamin B12, pg/mL	Vitamin D, ng/mL
Pre-op	85	95	100	450	30
1 month	60	75	92	320	22
3 months	55	68	89	280	20
6 months	65	70	91	300	24
12 months	70	73	93	330	27

This table presents the quantitative assessment of serum levels of key microelements (iron, zinc, copper) and vitamins (B12 and D) at baseline (preoperative), and at 1, 3, 6, and 12 months after bariatric surgery. A notable decline in iron and zinc levels is evident during the first three months, with partial recovery by month 12, although values remain below baseline. Vitamin B12 levels demonstrate a continuous downward trend up to 6 months, then exhibit slight recovery. Copper levels remain relatively stable, with minimal fluctuation. Vitamin D levels, initially at insufficient range, continue to decrease postoperatively, underscoring the need for early preventive supplementation. These trends highlight the dynamic shifts in micronutrient status following bariatric surgery and support the need for close laboratory surveillance during the first year.

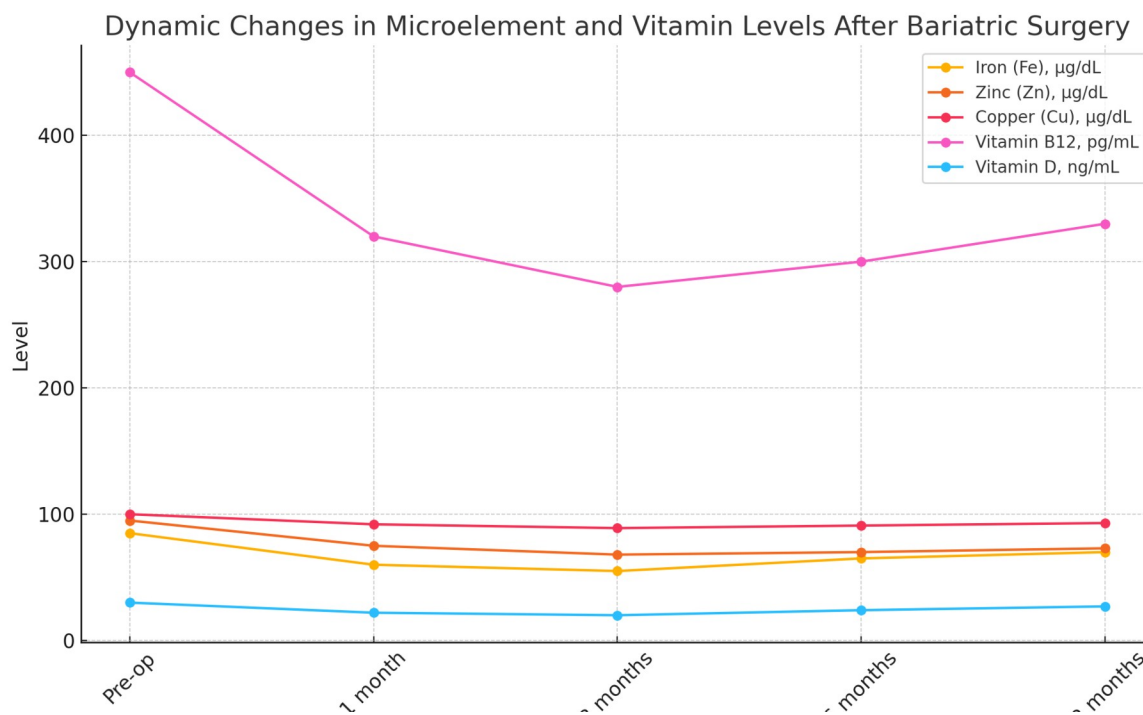


Figure 1. Temporal Trends in Serum Levels of Iron, Zinc, Copper, Vitamin B12, and Vitamin D Over 12 Months Following Bariatric Surgery

The line graph visually demonstrates the dynamic evolution of key micronutrient and vitamin concentrations at specified intervals (pre-op, 1, 3, 6, and 12 months post-op). The most pronounced reductions occur in iron and vitamin B12 levels during the early postoperative phase, indicating high susceptibility to depletion. Zinc follows a similar trajectory, though to a slightly lesser degree. In contrast, copper shows relative stability, suggesting it may be less affected by malabsorption mechanisms. Vitamin D levels decline progressively throughout the year, reaching a nadir at 6 months. The diagram emphasizes the need for time-specific, targeted monitoring and supplementation protocols tailored to each nutrient's absorption kinetics and risk profile.

Discussion. The high prevalence of micronutrient deficiencies following bariatric surgery underscores the importance of implementing robust postoperative nutritional monitoring programs [7]. In particular, iron and vitamin B12 deficiencies tend to manifest early and can lead to severe anemia and neurological dysfunction if left unaddressed [8]. Zinc deficiency may impair wound healing and immune response, while low copper levels have been associated with hematologic and neurological abnormalities [9]. Vitamin D deficiency remains one of the most persistent issues post-surgery,

with implications for bone health and calcium metabolism [10]. One notable aspect of our findings is the temporal pattern of deficiency onset. Iron and vitamin B12 dropped significantly by the first month, highlighting the need for early intervention. These results align with prior studies suggesting that the first 3 to 6 months post-surgery are critical for nutritional surveillance [11]. Moreover, differences between genders observed in our cohort support the need for individualized supplementation protocols tailored to patient characteristics, such as sex, age, and surgery type [12].

This study also emphasizes the value of dynamic biomarkers such as ferritin, serum 25(OH)D, and urinary trace elements in providing early warning signals before clinical symptoms develop. Routine use of these markers can improve outcomes by allowing clinicians to anticipate and prevent deficiencies proactively [13]. Finally, the integration of nutritional education, regular lab assessments, and timely supplementation should be standard components of postoperative care in bariatric patients [14, 15].

Conclusion and Recommendations. This study underscores the necessity of routine monitoring of micronutrients after bariatric surgery. Iron and vitamin B12 should be given particular attention due to their rapid decline and significant impact on recovery. Preventive strategies should include baseline assessments and scheduled supplementation based on dynamic biomarker changes. Further research is needed to optimize micronutrient therapy protocols tailored to patient-specific needs.

Furthermore, the identification of critical time points—particularly the first three months post-surgery—emphasizes the need for structured follow-up schedules. Patients should undergo biochemical screening at regular intervals to detect and address deficiencies before the onset of clinical symptoms. Healthcare providers must adopt a proactive rather than reactive approach, incorporating routine laboratory testing into standard postoperative care pathways.

In addition, educational interventions should be provided to patients prior to surgery to improve awareness regarding the risks of micronutrient deficiencies. Postoperative counseling and tailored dietary plans developed in collaboration with clinical nutritionists can reinforce adherence to supplementation protocols. Multidisciplinary teams involving surgeons, endocrinologists, and dietitians should be integral to the long-term management of bariatric patients.

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