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# A Prospective Study on the Management of Nutritional and Metabolic Problems Following Bariatric Surgery

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**KEYWORDS**

bariatric surgery, malnutrition, vitamin deficiency, roux-en-y gastric bypass, sleeve gastrectomy

**ABSTRACT:**

**Background**: The goal of the current research is to examine the short- and long-term effects of three alternative treatments for patients having bariatric surgery as well as variations in weight and parameters of nutrition throughout the preoperative and postoperative phases. Therefore, the study's goal is to control nutritional and metabolic issues that arise after bariatric surgery.

**Methods**: 146 patients who had LMGB, LRYGB, and LSG, between the years 2019 and 2023 were included in this research. Prospective comparisons were made between the demographic and sociodemographic traits of these patients, weight reductions and dietary modifications throughout the pre and post-operative stages, surgical timeframes, hospital stays, clinical complications and metabolic alterations.

**Results**: Vitamin D, folic acid, ferritin, parathyroid hormone levels, and iron, were all significantly different in participants undergoing different surgical procedures according to the homeostasis model (P<.005). There was a statistically significant difference between the surgical procedures in terms of weight loss during the post-operative phase in the 12 months after surgery. At the conclusion of the first year, it was discovered that all three approaches were effective in promoting weight reduction. In comparison to LSG, it was discovered that LRYGB and LMGB were superior, although LSG was greater to the other approaches in terms of deficiency of nutrition. LSG and LMGB were less favorable than the LRYGB approach despite having shorter operating times due to the LSG technique's greater incidence of complications.

**Conclusion**: To assess the effect of bariatric surgery on status of nutrition and to provide suggestions for supplements, long-term prospective studies are required. To prevent iron and vitamin B12 deficiency, anemia, and protein malnutrition after surgery, certain precautions must be taken.

## 1. Introduction

The incidence of obesity is at an alarming level worldwide, and there is no apparent simple solution (WHO fact sheet on obesity, https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight). Both behavioral modifications and pharmaceutical treatments have been shown to be fairly successful, and new studies into the processes that support behavior change [1] and the efficacy of presently being tested medications [2] are encouraging. The positive benefits of medications only last as long as they are used, and drug treatments often have serious adverse effects. Expecting obese youngsters or teens to take medicine for the rest of their lives is most definitely not reasonable.

Bariatric surgery is a desirable choice since it is quick, easy, and low-risk, and it often results in considerable weight reduction that lasts for decades, if not longer. While there is little doubt that bariatric surgery helps individuals who are very obese, there is also a risk of major complications and side effects, and some patients may gain back most, or all the weight lost [3-5]. In addition, the number of bariatric surgeons required to execute it globally is much too low. In order to develop non-operative therapies that recapitulate the positive results of bariatric surgery, it is crucial to understand the processes behind these outcomes.

Short-term excess body weight reduction of 40% to 80% has been documented, depending on the technique and comorbidities have also shown significant improvements [6, 7]. Bariatric surgery has a relatively low frequency of

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complications, with pulmonary embolism, gastrointestinal leak, anastomotic stricture and ulcer, and hernia being the most frequent serious ones. Alarmingly, a rise in the prevalence of obesity has spurred the rise in dyslipidemia, type 2 diabetes, insulin resistance, and cardiovascular diseases [8].

About 252,000 bariatric surgeries were carried out annually in the United States as of 2018. Currently, sleeve gastrectomy accounts for around 61% of main bariatric surgeries, whereas RYGB treatments account for 17%. Less than 2% of cases include biliopancreatic diversion and AGB, respectively. 14% to 15% of all bariatric surgeries performed in the previous 3 years included revisions [9].

LAGB ("laparoscopic adjustable gastric banding"), LSG ("Laparoscopic sleeve gastrectomy"), BPD-DS (laparoscopic biliopancreatic diversion) with or without (BPD) duodenal switch [10], RYGB ("laparoscopic Roux-en-Y gastric bypass"), and single-anastomosis gastric bypass are among the surgical options currently available [11]. Due to its much-decreased risk of incisional hernia, wound infection, pulmonary problems, and venous thromboembolism, laparoscopic bariatric surgery has swiftly exceeded open surgery in popularity since it was first done in the 1990s [12, 13]. The favorable effects of bariatric surgery include complex processes that entail changes to the structure and motility of the digestive tract, dietary and behavioral modifications, as well as changes in gut hormones (like glucagon-like peptide 1, ghrelin, and peptide YY) [14, 15]. Due to unsatisfactory long-term results and high reoperation rates as a result of problems (such as pouch dilatation, slippage, erosion and dysphagia), LAGB has seen a sharp decline in popularity over the last several years. LSG has become more well-liked in the interim [16]. Prior to and after bariatric surgery, dietitians are an essential part of the multidisciplinary team. Previous research has shown that maintaining a regular dietary follow-up helps patients lose weight after surgery and avoids weight gain [17, 18]. Therefore, the study's goal is to address nutritional and metabolic issues after bariatric surgery, from the preoperative to the postoperative phases.

## 2. Methodology

A 5-year prospective study was undertaken in obese patients before and after BS to check for the lack of nutritional and metabolic difficulties given the nature of the problem chosen for the study and the aims to be achieved. The present research comprised a total of 146 patients whose data were accessible. Obese individuals with no prior diagnosis of nutritional deficiencies or metabolic disorders, BMI>35kg/m2, and patients aged 30 to 60 years were included in the study. All explorations were carried out with the purpose of providing medical treatment. Before surgery, all patients completed informed consent forms, and the procedure was accepted by both our hospital and the local ethics commission.

**Table 1:** Frequency based distribution

| Gender | Age | | | Total |
|---|---|---|---|---|
| | 31 to 40 yrs. | 41 to 50 yrs. | 51-60 yrs. | |
| **Females** | 25 | 25 | 30 | 80 |
| **Males** | 21 | 21 | 24 | 66 |
| **Total** | 46 | 46 | 54 | 146 |

### 2. 1. Operation Criteria

Body mass index (BMI) ≥35 kg/m2 as well as two or more co-morbidities were qualified for the procedure. The records were used to extract information about the patient's sex, age, incidence of comorbid conditions, weight, operations history, smoking, employment status, BMI, operative time, surgical technique, presence of complications, hospital stay, morbidity, mortality, and complications. Along with these details, the records of the patients were examined for information on their weight, height, BMI, fasting blood glucose (FBG), hemoglobin, LDL (low density lipoprotein), vitamin B12, HDL (high density lipoprotein), albumin, folate, PTH (parathyroid hormone), vitamin D, and levels of ferritin before and after bariatric surgery.

**Table 2.** Detection of nutritional deficiencies through blood test.

| Blood test | Frequency |
|---|---|
| HbA1c | • Appropriate |

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| | |
|---|---|
| Ferritin | • Third, sixth, and 12 months in the first year<br>• Per year |
| Folate | • Third, six, and 12 months in the first year<br>• Per year |
| Calcium | • Third, sixth, and twelfth months in the first year<br>• Per year |
| Vitamin B1 | • Vitamin B1 (Thiamine) blood levels should not be routinely checked, but doctors should be aware that individuals who have persistent vomiting may develop acute thiamine deficiency, which needs immediate medical attention. |
| Vitamin D | • Third, sixth, and 12 months in the first year<br>• Per year |
| Vitamin B12 | • Six and 12 months in the first year<br>• Annually<br>• If an individual receives intramuscular vitamin B12 injections, monitoring is not necessary. |
| Zinc | • Annually<br>• When experiencing unexplained anaemia, changes in taste sharpness, or hair loss, check your zinc intake. |
| PTH | • Third, six, and 12 months in the first year<br>• Annually |

### 2. 2. Clinical and Biological Assessments

At each assessment, all the patients had standard physical examinations and comprehensive fasting biochemical testing. Patients were often questioned about any clinical signs of nutritional inadequacies, such as changes in hair or skin texture, discomfort in the muscles, paresthesia, or other neurological symptoms. Nutritional supplements as well as therapies for diabetes, dyslipidemia, and hypertension were rigorously tracked. An expert in dietetics evaluated the caloric intake.

### 2. 3. Statistical Analysis

In descriptive research, the subjects' nutritional and metabolic factors were listed. In univariate research, these characteristics were assessed using paired t-tests, or unpaired t-tests as applicable, and analysis of variance (ANOVA), when the distribution was abnormal. The results were shown as mean±SD. Individuals in the experimental group were divided based on their levels of zinc, folate, calcium, PTH, ferritin, vitamins B12, B, B1, B6, and D, as well as an HbA1c concentration measured five years following surgery. The investigation using linear regression looked at the connection between dietary deficiencies and metabolic markers.

## 3. Results of the study

### 3.1. Demographic details

The findings in Table 3 reveal that there were statistically significant differences between the surgical procedures to be done in terms of sex, previous surgical history, and ($P < .05$), but not in terms of smoking, age, job status, BMI or weight ($P > .05$). The choice for LMGB was greatest in both the male and female groups, although the preference for LMGB and LRYGB was greater in the female group (58.1%) than the male group (45%). In individuals who had a history of surgery, the LSG technique demonstrated a greater percentage of choice (74.4%). Additionally, although there was no significant difference (statistically) in surgical procedures to be done and characteristics like morbidities, co-morbidities, or hospital stay, the history of operations was statistically significant, p=.001. (Table 3).

**Table 3: Demographics details**

| | | LMGB (N=55) | LRYGB (N=48) | LSG (N=43) | *p* |
|---|---|---|---|---|---|
| **Gender** | Male | 25 (45%) | 20 (41.6%) | 18 (41%) | |

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| | | | | | |
|---|---|---|---|---|---|
| | female | 30 (55%) | 28 (58%) | 25 (58.1%) | |
| **Age** | Mean ± S.D. | 42.7 ± 10.9 | 41.6 ± 9.8 | 41.0 ± 9.5 | .406 |
| **Comorbid conditions** | Mean ± S.D | 11.0 ± 1.2 | 10.2 ± 1.1 | 8.4 ± 1.5 | .231 |
| **BMI** (kg/m2) | Mean ± S.D | 46.4 ± 4.5 | 45.6 ± 4.8 | 45.1 ± 4.6 | .064 |
| **Employment status** | Yes | 41 (74.5%) | 39 (81.2%) | 29 (67.4%) | .452 |
| | No | 14 (25.45%) | 9 (18.7%) | 14 (32.5%) | |
| **Weight** | Mean ± S.D. | 114.4 ± 14.2 | 118.2 ± 16.8 | 117.5 ± 14.6 | .196 |
| **Smoking** | Yes | 20 (36.3%) | 12 (25%) | 14 (32.5%) | |
| | No | 35 (63.6%) | 36 (75%) | 29 (67.4%) | .182 |
| **Hospital stays** | Mean ± S.D. | 5.0 ± 1.5 | 5.1 ± 1.1 | 5.3 ± 1.3 | .096 |
| **History of operation** | Yes | 21 (38.1%) | 14 (29.1%) | 11 (25.5%) | |
| | No | 34 (61.8%) | 34 (70.8%) | 32 (74.4%) | .001 |
| **Morbidities** | Mean ± S.D. | 9.0 ± 1.2 | 8.2 ± 1.4 | 7.4 ± 1.4 | .126 |

### 3.2. Pre and Post-Operative Evaluation

The FBG or Hb albumin levels assessed before surgery and in the initial (baseline) and 12th postoperative months did not significantly vary across the surgical techniques (P>.05). During the follow-up period, all 3 groups saw a drop in FBG, hemoglobin, and HOMA-IR values. While the measured HOMA-IR prior to surgery and in the 12th post-operative month did not show any significant differences between the treatment methods (P =.531), significant differences were discovered in vitamin D, folic acid, ferritin level, and vitamin B12 during the postoperative phase in the 12th month (p>0.005). LDL and parathormone levels fell in every follow-up, although HDL levels rose in every group after surgery. The post hoc analysis revealed that the LRYGB and LMGB groups saw higher decreases in HOMA-IR in the sixth month than the LSG group (Table 4).

**Table 4: Groups' metabolic characteristics at each follow-up period**

| | **LMGB (N=55)** | | **LRYGB (N= 48)** | | **LSG (N=43)** | | |
|---|---|---|---|---|---|---|---|
| **Clinical parameters** | **Preoperative phase** | **Post operative** | **Preoperative phase** | **Post operative** | **Preoperative phase** | **Post operative** | ***p*** |
| Weight | 117.5 ±14.6 | 85.3 ± 14.3 | 118.2 ± 16.8 | 76.8 ± 25.6 | 114.4 ± 14.2 | 76.2 ± 18.4 | .143 |
| Fasting blood glucose (110 mg/dL‡) | 141.5 ± 69.8 | 89.4 ± 21.6 | 135.3 ± 38.5 | 88.4 ± 11.9 | 130.4 ± 44.6 | 90.6 ± 18.4 | .533 |
| Haemoglobin ≤11.5 g/dL | 13.8 ± 1.2 | 12.6 ± 1.4 | 13.4 ± 1.5 | 12.8 ± 1.2 | 13.4 ± 1.4 | 12.2 ± 1.4 | .422 |
| HOMA-IR | 9.8 ± 6.8 | 2.4 ± 1.0 | 9.6 ± 8.4 | 2.2 ± 1.0 | 9.3 ± 7.8 | 2.1 ± 1.2 | .531 |
| Low density lipoprotein (LDL) | 159.4 ± 74.5 | 106.2 ± 31.6 | 156.9 ± 48.6 | 104.2 ± 20.5 | 158.2 ± 52.2 | 102.4 ± 44.6 | .660 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| High density lipoprotein (HDL) <40 mg/dL | 40.2 ± 8.0 | 49.4 ± 11.5 | 40.8 ± 6.5 | 51.6 ± 10.8 | 41.0 ± 7.5 | 53.2 ± 8.5 | .033 |
| Vit. D <30 ng/mL | 32.2 ± 11.5 | 20.6 ± 14.6 | 32.8 ± 17.9 | 19.5 ± 16.1 | 33.8± 12.6 | 26.2 ± 20.6 | **.001** |
| Vit. B12 <145 pmol/L | 422.5 ± 156.3 | 284.4 ± 86.2 | 438.8 ± 164.2 | 280.6 ± 55.3 | 442.4 ± 196.8 | 296.1 ± 140.8 | **.021** |
| Albumin <3.5 g/dL | 4.4 ± 0.2 | 4.5 ± 0.2 | 4.4 ± 0.2 | 4.5 ± 0.4 | 4.5 ± 0.2 | 4.3 ± 0.1 | .599 |
| Folic acid <7.0 nmol/ | 14.3 ± 4.2 | 8.0 ± 4.6 | 14.6 ± 4.1 | 8.8 ± 4.0 | 14.1 ± 4.0 | 10.8 ± 4.8 | **.001** |
| Parathyroid hormone >69 ng/mL | 37.2 ± 17.4 | 68.8 ± 22.5 | 38.8 ± 24.6 | 71.7 ± 16.7 | 42.4 ± 25.2 | 49.5 ± 26.4 | **.001** |
| Iron | 86.5 ± 34.0 | 47.6 ± 25.0 | 88.2 ± 31.6 | 50.4 ± 25.4 | 89.3 ± 32.3 | 68.6 ± 35.2 | **.001** |
| Ferritin levels <4.6 ng/mL | 138.5 ± 48.6 | 82.6 ± 52.6 | 140.8 ± 56.4 | 85.6 ± 28.6 | 135.5 ± 48.2 | 91. ± 41.5 | **.002** |

### 3.3. Incidence of Nutritional Deficiencies

Results for the majority of nutritional markers that fell below the laboratory's low normal range were uncommon in our cohort, both before and after surgery. Iron (measured by transferring saturation) and vitamin B12 and D deficits were the most prevalent deficiencies. Although these impairments were common before surgery, they did not substantially deteriorate 1 year later after LMGB and were even less common following LSG (Table 4). The LRYGB and LSG groups had a higher reduction in iron levels than the LMGB group. The ferritin level evaluated in the 12th month differed significantly across the surgical techniques (P =.002). Compared to LSG, the LRYGB and LOAGB groups had a larger drop. In the LRVGB group, vitamin B12 levels were decreased one year postoperatively compared to preoperatively (Table 4). Other dietary deficits are uncommon and need not be monitored often. Some micronutrient deficits, like those in copper and zinc, are difficult to detect and commonly confused by shortages in other nutrients, making them challenge to diagnose. However, clinicians should be aware of the likelihood and frequency of several dietary deficits in patients with obesity and type 2 diabetes.

### 3.4. Clinical complications

Some of the patients in our research had difficulties. 33.3% of patients getting LMGB, 23.2% of patients undergoing LSG, and 36.3% of patients having LRVGB reported experiencing discomfort with their skin's texture. 41.8% of patients receiving LMGB surgery, 39.5% of patients undergoing LRVGB surgery, and 35.5% of patients undergoing LSG surgery had hypertension found after the procedure. Other problems also emerged, including the fact that 31% of patients had dyslipidemia overall, 10.9% of patients had neurological symptoms, 21% of patients had renal illness, and 19% of patients had thyroid disease. After surgery, 24% of patients had breathing issues. The LMGB group experienced the most complications, despite the fact that there was no statistically significant difference between the groups (Table 5).

**Table 5: clinical complication**

| **Comorbidities** | | **LMGB** | **%** | **LRVGB** | **%** | **LSG** | **%** | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|---|
| Skin texture discomfort | Yes | 20 | 36.36 | 16 | 33.33 | 10 | 23.25 | 46 | 31.50 |
| | No | 35 | 63.63 | 32 | 66.66 | 33 | 76.74 | 100 | 68.49 |
| Discomfort in muscles | yes | 28 | 50.90 | 31 | 64.58 | 25 | 58.13 | 84 | 57.53 |
| | No | 27 | 49.09 | 17 | 35.41 | 18 | 41.86 | 62 | 42.46 |
| Paraesthesia | Yes | 15 | 27.27 | 11 | 22.91 | 8 | 18.60 | 34 | 23.28 |
| | No | 40 | 72.72 | 37 | 77.08 | 35 | 81.39 | 112 | 76.71 |
| Neurological symptoms | Yes | 8 | 14.54 | 5 | 10.41 | 3 | 6.976 | 16 | 10.95 |
| | No | 47 | 85.45 | 43 | 89.58 | 40 | 93.02 | 130 | 89.04 |
| dyslipidaemia | Yes | 18 | 32.72 | 17 | 35.41 | 11 | 25.58 | 46 | 31.50 |
| | No | 37 | 67.27 | 31 | 64.58 | 32 | 74.41 | 100 | 68.49 |
| Hypertension | Yes | 23 | 41.81 | 19 | 39.58 | 14 | 32.55 | 56 | 38.35 |
| | No | 32 | 58.18 | 29 | 60.41 | 29 | 67.44 | 90 | 61.64 |
| Kidney disease | Yes | 16 | 29.09 | 8 | 16.66 | 7 | 16.27 | 31 | 21.23 |
| | No | 39 | 70.90 | 40 | 83.33 | 36 | 83.72 | 115 | 78.76 |
| Thyroid disease | yes | 12 | 21.81 | 10 | 20.83 | 6 | 13.95 | 28 | 19.17 |
| | No | 43 | 78.18 | 38 | 79.16 | 37 | 86.04 | 118 | 80.82 |
| Respiratory disease | yes | 18 | 32.72 | 9 | 18.75 | 9 | 20.93 | 36 | 24.65 |
| | No | 37 | 36.36 | 39 | 81.25 | 34 | 79.06 | 110 | 75.34 |

## 4. Discussion

Due to two primary considerations, nutritional deficiencies are very readily developed after BMS: (I) malabsorption brought on by gastrointestinal anatomic alteration (gastric restriction and change in gut hormones); and (II) patient noncompliance with supplements and treatments. In the current research, which was carried out in India, the 5-year results for 55 patients who had laparoscopic small gastric bypass, 48 patients who underwent laparoscopic Roux-En-Y gastric bypass, and 43 patients who underwent laparoscopic sleeve gastrectomy were assessed. The LSG group lost weight more quickly in the first year, and there was a significant difference in the first-year weight reduction between the 2 groups. There were no appreciable changes between the groups, however the reduction of weight in the fifth year was somewhat greater in the LSG group. The FBG% was 89.4±21.6 (mg/dL) in the LMGB group, 88.4 ±11.9 (mg/dL) in the LRYGB group, and 90.6 ±18.4 (mg/dL) in the LSG group at the conclusion of the 1-year interval in a research comparison of the 1st year results in study. In the LMGB group, the Hb% was 12.6 ± 1.4 (g/dL), in the LRYGB group, it was 12.8 ±1.2 (g/dL), and in the LSG group, it was 12.2 ±1.4 (g/dL). The weight reduction in the LSG group was greater at the conclusion of the one-year time, and these findings varied across the groups at statistically significant levels [19]. At the end of the year-long term of our experiment, there was no significant difference (statistically) between the groups, however LSG had experienced higher weight loss. Numerous studies have shown that people who are fat or overweight lack certain micronutrients, with the

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lack being more severe in those who are very obese (BMI > 40 kg/m2) [20].

Thus, micronutrient and vitamin deficiencies are often identified in obese people considering bariatric surgery. Before having bariatric surgery, 232 people had their blood levels of vital micronutrients such magnesium, calcium, zinc, the vitamins B1, D3, and B3, copper, selenium, and parathyroid hormone tested by Ernst et al. [21]. The findings indicated that people had extremely severe micronutrient deficiencies. Of the participants, 25.4% had vitamin D3 insufficiency, 32.6% had selenium shortage, 24.6% had zinc deficiency, and 18.1% had vitamin B12 deficit.

Due to continuous low-grade inflammation, which is a hallmark of obesity, which boosts the creation of hepcidin, which prevents the body from absorbing iron, iron deficiency is also frequent in obese individuals [22,23].

In a trial of patients (287) conducted in Germany, the EWL% had statistically significant differences between the groups at the end of the first year, being 57.3 ± 19.0 in LSG and 66.2 ±13.9 in MGB [24]. The Body mass index decrease in the first 3 to 6 months was larger in the MGB group than in the LSG in research by Milone et al. [25] including 160 patients in Italy. 114 individuals were included in research by Schweiger et al. [26] in which the plasma levels of numerous traces, elements minerals, and vitamins, were analyzed. It was found that 35% of the participants had low levels of iron, while 24% had low levels of folic acid and/or ferritin, 3.6% had low levels of vitamin B12, 2% had low levels of phosphorus, and 0.9% had low levels of calcium. Only 19% of people had adequate levels of hemoglobin, which is below 12 gm/dL for women and below 14 gm/dL for men. These thresholds matched the World Health Organization's definition of anemia. At the same time, 39% of patients reported having elevated parathyroid hormone levels [27].

In all surgical methods, vitamin B12 levels dropped over time, however in the 12th month, the LSG group had greater levels than the other groups. The LRYGB and LMGB groups had a higher drop than the LSG group. Similar to our findings, most investigations indicated that the LRYGB group had considerably lower vitamin B12 levels than the LSG [28-30]. Women having bariatric surgery had reduced blood levels of several critical minerals, vitamins, trace elements, and proteins, including zinc (73.9%), folic acid (25.2%), prealbumin (21.7%), and vitamin D (67.8%), according to research by De Luis et al. [31]. According to the research described, vitamin deficiencies are thus extremely prevalent in obese people and must be considered both before and after the operation [32,33]. As stated by Skroubis et al. [34], no folate deficiency was discovered in the participants before or after surgery, but folate deficiencies have been observed by others after GBP [35,36]. Following bilio-pancreatic diversion, deficiencies in fat-soluble vitamins have been reported [37], whereas following GPB, fat-soluble vitamin concentrations are seldom tracked [38,39].

In our research, the duration of hospital stay was 5.3 ± 1.3 hr (LSG), 5.1 ± 1.1 hr (LRYGB), and 5.0 ± 1.5 hr (LMGB), with LRYGB having the longest operational time and LMGB having the shortest. German research comparing LOAGB and LSG in patients revealed lower operating durations in LOAGB (81.7 ± 25.3) than in LSG (112.1 ± 33.5), in contrast to publications demonstrating considerably longer surgical times in LRYGB and comparable to that described in present study [40-42].

All follow-up intervals showed a decline in vitamin D levels. The LSG group had mean vitamin D levels that were greater than those of the other groups in the 12th month, at 26.2± 20.6 (ng/mL). The LRYGB and LMGB groups had a higher drop than the LSG group. Only the 12th month, when the result was more than 30.5 ± 9.9ng/mL in the LSG the group than in the group of LRYGB, showed a significant difference in another research where the data of the postoperative months 1, 3, and 6 and 12 were analyzed, as in our investigation.

According to recent research by Homan and colleagues [43], patients with BPD/DS and BPD commonly had anemia, and deficiencies in fat-soluble vitamins persisted even after vitamin therapy and after surgery. It is crucial to keep in mind that inadequate supplementation is linked to poorer results, which is why it was suggested to allow for lifelong monitoring at a dedicated bariatric clinic and maybe improved vitamin supplementation [44]. The second research focused on nutritional deficiency after SG, that has been found to lower fat and absorption of protein by 72% and 25%, respectively. Zinc and other fat-soluble vitamins are less likely to be absorbed as a result [45].

## 5. Conclusion

At the conclusion of the first year, it was discovered that all 3 approaches were helpful in promoting weight reduction, although LSG was notable to the others in terms of nutritional deficits. For a more accurate assessment of the nutritional effects of each bariatric procedure, it is essential to differentiate between (1) deficiency of nutrition related to obesity, such as vitamin D, B12, or other vitamins deficits, (2) deficits made worse by restrictive procedures, such as iron deficits, and folic acid (3) deficits that appear to be unique to malabsorptive measures, such as protein malnutrition, fat-soluble vitamin deficiencies, and vitamin B12 deficits. To assess the effect of bariatric surgery on nutritional status and to provide suggestions for supplements, long-term prospective studies are required.

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