Published in final edited form as:

Obes Surg. 2017 May ; 27(5): 1131–1136. doi:10.1007/s11695-016-2364-0.

Nutrient Deficiency 10 Years Following Roux-en-Y Gastric Bypass: Who's Responsible?

J. Hunter Mehaffey, MD¹, Rachel L. Mehaffey, MD², Mathew G. Mullen, MD¹, Florence E. Turrentine, PhD RN MSc¹, Steven K. Malin, PhD^{3,4}, Bruce Schirmer, MD¹, Andrew M. Wolf, MD², and Peter T. Hallowell, MD¹

¹Department of Surgery, University of Virginia, Charlottesville, VA, USA

²Department of Internal Medicine, University of Virginia, Charlottesville, VA, USA

³Department of Kinesiology, University of Virginia, Charlottesville, VA, USA

⁴Division of Endocrinology & Metabolism, University of Virginia, Charlottesville, VA, USA

Abstract

Objective(s)—Monitoring and prevention of long-term nutrient deficiency after Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) remains ill defined due to limited surgical follow-up after bariatric surgery. This study compared nutrient supplementation as well as surgeon and primary care physician (PCP) follow-up between patients with short-term versus long-term follow-up.

Methods—All patients undergoing LRYGB at a single institution in 2004 (long-term group, n=281) and 2012–2013 (short-term group, n=149) were evaluated. Prospectively collected database, Electronic Medical Record (EMR) review and telephone survey were used to obtain follow-up for both cohorts. Multivariate logistic regression was used to assess factors independently predicting multivitamin use.

Results—Complete follow-up was achieved in 172 (61%) long-term and 107 (72%) short-term patients. We demonstrate a significant difference ($p < 0.0001$) in time since last surgeon follow-up (13.3 ± 7.8 vs 86.9 ± 39.9 months) for the long-term group with no difference in PCP follow-up, (3.1 ± 4.3 vs 3.7 ± 3.4). Nutrient supplementation was higher in the short-term group, including multivitamin (70.3% vs 58.9%, $p < 0.05$), iron (84.2% vs 67.1%, $p = 0.02$) and calcium (49.5% vs 32.9%, $p = 0.01$). After adjusting for interval since surgery, %EBMI, and current comorbidities logistic regression ($c = 0.797$) demonstrated shorter time since last surgeon visit was independently predictive of multivitamin use ($p = 0.001$).

Dr. J. Hunter Mehaffey MD, University of Virginia, Box 800709, Charlottesville, Virginia 22903, P: 828-779-3929, F: 434-243-5791, jhm9t@virginia.edu.

Conflicts of Interest

The authors declare no conflict of interest

Conflict of Interest Statement

No authors have conflicts of interest with the contents of this study.

Ethical Approval

For this type of study formal consent is not required. Institutional IRB Protocol #17132 approved this study

Informed Consent

Due to the retrospective nature of this study we used waiver of consent to view deidentified medical records.

Conclusions—While it appears patients prefer to follow-up with their PCP this study reveals a large disparity in malnutrition screening and nutrient supplementation following LRYGB. Therefore, implementation of multidisciplinary, best-practice guidelines to recognize and prevent malnutrition is paramount in the management of this growing population of high-risk patients.

Introduction

Bariatric surgery has become a common treatment for morbid obesity in the United States as evidenced by approximately 113,000 patients undergoing this weight loss procedure each year[1]. Roux-en-Y Gastric Bypass (RYGB) surgery is arguably more effective than other procedures for weight-loss and comorbidity resolution[2–6]. While alterations in gut physiology following RYGB may induce endocrine mediated mechanisms that facilitate weight management and improved cardiometabolic health[7], understanding of how nutrients *per se* impacts health remains poorly understood. In fact, long-term follow-up in formerly morbid obese high-risk populations on malnutrition, vitamin, and nutrient supplementation are lacking[8, 9]. This is clinically relevant as nutritional deficiencies occur in 30–70% of patients and require chronic surveillance and nutrient replacement.

A number of studies have examined the short-term (i.e. less than 5 year) impact of macro- and micro-nutrient deficiency following RYGB[9–12]. Indeed, protein calorie malnutrition is a major concern and can be recognized by signs such as edema, hypoalbuminemia, anemia, and hair loss. Moreover, vitamin deficiencies are reported and can lead to peripheral neuropathy (folate, B₁₂), Wernicke Encephalopathy (B₁), metabolic bone disease (Vitamin D, calcium), and iron deficient anemia. These are clinically concerning since nutrient deficiency and malnutrition worsens over time[13]. As a result, it is common to advise patients' post-RYGB to add multivitamin supplementation to their diet to prevent health complications. To date, however, no study has examined the long-term nutrient supplementation regimen of post-RYGB patients to understand potential nutritional needs over time. In addition, a majority of patients no longer follow-up with their surgeon or bariatric team as demonstrated by the 10–15% 10-year follow-up rate[6, 14, 15]. This is potentially problematic for the metabolic health of the patient and may place greater medical care demand on other health professionals, including the primary care physician (PCP). But, whether patients seek more care from their PCP than surgeon is unknown. Therefore, the purpose of this study was to compare micronutrient supplementation and medical care visits for individuals at 2- and 10-years following RYGB. We hypothesized that fewer patients in the long-term group would receive nutrient surveillance and/or treatment, and patients would be more likely to see the PCP than their bariatric surgeon.

Methods

Patients

A prospectively collected database approved by the Institutional Review Board (IRB# 17132) at our academic medical center of all patients undergoing weight loss surgery was queried for this cross-sectional analysis. We identified patients undergoing RYGB performed at our institution between 1/1/2004 – 12/31/2004 and 7/1/12 – 9/30/13 to understand short-term (i.e. 2 years) and long-term (i.e. 10 years) effects of RYGB on nutritional

supplementation needs. Nutritional supplementation was used as an index for malnutrition screening. Our overall database included the patient name, patient phone number, age, sex, pre-operative weight, pre-operative comorbidities (e.g. type 2 diabetes, cardiovascular disease, etc.), and long-term nutrition and BMI. Electronic Medical Record (EMR) review was used to assess anthropometrics and clinical biochemistries and telephone survey data were obtained for patients lost to onsite follow-up. All subjects received nutritional counseling by a registered dietitian prior to hospitalization, and our nutritionists, psychologists, bariatric surgeons, and surgery teams cleared subjects for bariatric surgery. The RYGB procedure was previously described by our team[15]. All patients provided verbal consent and the IRB granted waiver of consent for medical record review.

Telephone Follow-up

Trained medical personnel followed a standardized phone script to call patients lost to onsite follow-up. Multiple attempts were made to contact patients on different days and times using all telephone numbers listed in their electronic medical record. If the telephone numbers listed were disconnected, an online people search tool (Intelius People Search, Bellevue, WA) was used to locate patients most recent contact information using publically available records such as census data, property records, and telephone records.

Anthropometrics

Height and weight measures were obtained on a calibrated scale and wall-mounted stadiometer at baseline, 2 and 10 years. Body mass index (BMI) was calculated as body mass (kg) divided by height (m)². An ideal BMI of 25 kg/m² was used for calculation of percent excess BMI reduction (%EBMI).

Health Care Professional and Blood Analysis

Subjective data on bariatric surgeon vs. PCP follow-up was collected through telephone survey. Routine blood work with or without nutrient testing was also captured from fasted samples through retrospective chart review. Blood work analysis included a complete blood count (CBC) defined as: total white blood cells, red blood cells, hemoglobin, and hematocrit. Medication information was also collected as well as comorbidities.

Statistical Analysis

The primary outcome for this study was multivitamin supplementation at 2- and 10-years. Secondary outcomes included bariatric surgeons versus PCP visits by patient in addition to body weight and CBC. Statistical analysis was performed using appropriate parametric and nonparametric tests. Multivariate logistic regression was then used to identify independent predictors of multivitamin supplementation. A p-value of <0.05 was used for statistical significance. SAS version 9.4 (SAS Institute, Cary NC) was used for statistical analyses.

Results

Pre-operative Demographics

There were 281 patients undergoing RYGB in the 10-year follow-up group (1/1/2004 – 12/31/2004) and 149 patients in the 2-year follow-up group (7/1/2012 – 9/30/2013). Complete follow-up was achieved in 172 (61%) long-term and 107 (72%) short-term patients. No major difference for clinical demographics between the groups was detected (Table 1), including preoperative BMI for the 2- vs 10-year groups (51.5 ± 9.8 vs. 50.1 ± 8.1 kg/m², $p=0.24$).

Nutrient Supplementation and Testing

Nutrient supplementation was significantly higher in the short-term vs. long-term group, including: multivitamins ($p=0.05$), iron ($p=0.02$), and folate ($p=0.006$) (Table 2). Although we observed no statistical difference in circulating zinc levels or the proportion of patients receiving vitamin B-12 or vitamin D supplementation, calcium supplementation was higher in short- vs. long-term patients ($p=0.01$).

Health Care Professional and Blood Analysis

Time since last surgeon follow-up was significantly less in the short-term vs. long-term group (13.3 ± 7.8 vs. 86.9 ± 39.9 months, $p<0.001$), and there was no difference in the last PCP follow-up (3.1 ± 4.3 vs. 3.7 ± 3.4 months, $p = 0.21$). Additionally, the short-term group had a more recent CBC assessment compared with the long-term group (12.2 ± 6.2 vs. 33.2 ± 10.9 months $p<0.0001$). The %EBMI was reduced more in the short-term vs. long-term group (71.2 vs. 58.2% , $p < 0.001$).

Multivariate Logistic Model

Using logistic regression we controlled for time since surgery, %EBMI reduction, preoperative comorbidities, as well as time since last PCP and Bariatric Surgeon visit to determine predictors of multivitamin use. Table 4 demonstrates the odds ratios for each predictor with time since last bariatric surgeon visit being the strongest prognosticator (OR 0.97, $p<0.001$). Both preoperative GERD and %EBMI reduction correlated but were not predictive of multivitamin use. The model had moderate discriminatory power ($c = 0.797$).

Discussion

The major finding from this study was that bariatric surgeon follow-up with independently predictive of multivitamin use. Additionally, iron, B-12, folate, and calcium supplementation were lower at 10 vs. 2-year post-RYGB in formerly morbidly obese adults. Iron deficiency is the most common complication following RYGB and frequently leads to anemia in males and females, especially of menstruating age[16, 17]. A prospective study by Brolin et al. demonstrated oral iron supplementation post-operatively reduced the incidence of iron deficiency anemia in patients routinely monitored for this complication over two years[18]. However, there are no data available on patients at 10 years to understand the long-term effects of RYGB on iron deficiency. In our study, patients within 2 years of surgery had a CBC measured to screen for anemia during the previous year and nearly 82% of people

consumed iron supplements, suggesting low risk for anemia. In contrast, patients at 10 years post-RYGB surgery averaged three years since their last CBC and had significantly less iron supplementation. Together, our findings suggest that long-term RYGB patients may experience greater risk for anemic like complications related to chronic fatigue that can significantly affect physical daily activity. Further research is required to determine if iron supplementation, and/or increased consumption of iron-rich foods overtime in post-RYGB patients can prevent iron deficiency symptoms and contribute to the preservation of weight loss.

B-vitamins and zinc are important micronutrients that contribute to energy metabolism and immune health. Folate, B12, and zinc deficiency after RYGB is a well-known phenomenon[19, 20], and collectively have been suggested to contribute to increased incidences of fatigue and neuropathy[20]. Unfortunately, the optimal supplementation regimen to prevent such conditions has not been elucidated. Nonetheless, recent work by Moore et al. highlights the significance of increased (>1000%) folate and B12 levels on body weight parameters and laboratory indices following 3 months of supplementation post-RYGB[21]. The long-term effects of this rapid rise in micronutrient levels are unclear and require further investigation in a prospective fashion. Nonetheless, we report here for the first time at 10 years that our patients were significantly less likely to be taking folate or B12 supplementation. These findings suggest that patients 10 years following RYGB surgery may be at higher risk for B-vitamin related deficiency disorders. Although our study did not specifically capture data on neurological complications seen with vitamin B deficiencies, it is worth noting that less than 10% of patients in each group had zinc levels examined postoperatively. Moreover, the percentage of people achieving their ideal BMI at 10 years relative to 2-years suggests that people most likely increased food intake, and this rise in nutrient intake may have offset changes in nutritional supplementation needs. Nevertheless, if our findings persist over time, then people may be at increased risk for micronutrient deficiencies due to anatomical changes in the gastrointestinal tract that increases the likelihood for neurological disorders.

Vitamin D deficiency is commonly reported in obese patients, especially those undergoing RYGB surgery[10]. This is clinically concerning because vitamin D deficiency has been linked to not only bone mineral loss, but also increased risk of hypertension and type 2 diabetes[22]. Moreover, alterations in calcium absorption increase risk for bone disorders during weight loss [9]. As a result, alterations in nutrient intake post-RYGB may adversely impact vitamin D and calcium related metabolic health. Several studies have examined the effect of vitamin D and calcium supplementation before and after surgery to determine the impact on bone metabolism, metabolic health and parathyroid hormone (PTH) levels[23]. Overall, the results from these studies suggest that vitamin D plays a critical role in bone metabolism, regulation of body calcium, and amelioration of hypertension after RYGB[23, 24]. In fact, Carlin et al. demonstrated that 50,000 IU of Vitamin D weekly after RYGB corrects Vitamin D depletion in women and attenuates cortical bone loss. [25]. In the current study, we did not observe significant differences in Vitamin D supplementation at 2- or 10-years post-RYGB, likely due to the fact that Vitamin D supplementation has become commonplace in the general population. However, we did find that calcium supplementation was significantly lower at 10 compared to 2-years. This finding is consistent with increased

rates of bone loss following RYGB however we are unaware of prospective studies examining supplementation after RYGB[24]. We did not perform assessments of bone mineral density in the current study via DEXA, but our findings are consistent with Santos et al[26]. Thus, additional work is warranted in patients to understand the effect of calcium supplementation on preservation of bone mineral density to prevent osteoporosis and bone disorders.

There are many underlying causes for the major Bariatric surgeons are more focused on the metabolic effects and complications of RYGB. At our institution a Registered Dietician (RD) also sees patients during follow-up visits for further counseling on the importance of nutrient supplementation. Additionally, at our center it is standard work for all patients to have a CBC and electrolytes checked at each follow-up appointment. A standard PCP visit lacks this multidisciplinary approach; consequently, there is likely to be less emphasis on appropriate micronutrient supplementation and targeted laboratory monitoring. Primary care physicians face many challenges in their clinic including addressing multiple chronic medical conditions, preventative screening and often several patient complaints. With the agenda already so busy during these visits, it is often difficult for primary care physicians to address all these concerns in addition to the unique challenges that face this specific population. Taken together, our results suggest it is critical to develop a standardized multidisciplinary approach to address patient's needs in order to prevent the late complications of RYGB.

There are several limitations to this study that may affect our interpretations. First, the decline in nutrient supplementation at 10 years may be the result of increased food intake. Although people at 10 years were less likely to achieve ideal BMI and increased food may over time offset needs for nutrition supplementation, it remains possible that alterations in gut physiology could promote malabsorption of various nutrients. Therefore, our findings of differences in body weight at 2 vs. 10-years post RYGB do not negate the possibility that micronutrient deficiency. Second, our cross-sectional analysis was retrospective in nature and may limit the generalization of findings to individuals who complete follow up visits. Nevertheless, the database we used to track patients undergoing RYGB surgery has been prospectively collected for the past 30 years and is regularly updated when patients are seen in follow-up. There have been efforts to maintain yearly follow-up beyond 2 years but due to the large referral base, the geographic distance of many patients from our medical center, the role of PCP in following these patients on a regular basis, and the cost and time of visits for the patient who feels well and in good health, achieving better follow-up in person has been challenging. Third, telephone survey follow-up may have improved the yield of clinical outcomes, but it is limited by a lack of objectivity. However, telephone follow-up has been validated in the bariatric population and provides useful information about metabolic health of individuals unable to attend onsite medical visits [27]. Fourth, nutrition assessment of macronutrients was not obtained in this study. Yet the consumption of low-carbohydrate (i.e. more protein) vs. higher carbohydrate diets has had little difference on weight loss post bariatric surgery up to 1 year post-op [28]. As a result, it is unclear if macronutrient differences should be a nutritional focus vs. emphasis on well balanced diets to alter metabolic risk.

In conclusion, we report a critical gap in micronutrient monitoring and supplementation between 2-and 10-year following RYGB. In addition, we show here for the first time a major disparity between bariatric team and PCP follow up that is independently associated with multivitamin use. This study represents the first 10-year nutrient reporting and highlights need to focus medical nutritional care toward life-long health of patients following RYGB. Taken together, we show that individuals undergoing RYGB may have higher risks for malnutrition screening and require increased medical nutrition attention to prevent metabolic health issues related to anemia, neuropathies, and bone disorders. Therefore further work is required to identify optimal multidisciplinary follow-up strategies with registered dietitians, exercise physiologists, PCP and bariatric surgeons to promote life-long healthy weight management and metabolic disease prevention.

Acknowledgments

Source of Funding:

Funded through NIH T32 training Grant

References

1. Livingston EH. The incidence of bariatric surgery has plateaued in the U.S. *Am J Surg.* 2010; 200(3):378–85. [PubMed: 20409518]
2. Pories WJ, Mehaffey JH, Staton KM. The surgical treatment of type two diabetes mellitus. *Surg Clin North Am.* 2011; 91(4):821–36. viii. [PubMed: 21787970]
3. Ikramuddin S, et al. Roux-en-Y gastric bypass vs intensive medical management for the control of type 2 diabetes, hypertension, and hyperlipidemia: the Diabetes Surgery Study randomized clinical trial. *JAMA.* 2013; 309(21):2240–9. [PubMed: 23736733]
4. Ricci C, et al. Early impact of bariatric surgery on type II diabetes, hypertension, and hyperlipidemia: a systematic review, meta-analysis and meta-regression on 6,587 patients. *Obes Surg.* 2014; 24(4):522–8. [PubMed: 24214202]
5. Buchwald H, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA.* 2004; 292(14): 1724–37. [PubMed: 15479938]
6. Mehaffey JH, et al. Outcomes of laparoscopic Roux-en-Y gastric bypass in super-super-obese patients. *Surg Obes Relat Dis.* 2015; 11(4):814–9. [PubMed: 25980328]
7. Malin SK, et al. Improved acylated ghrelin suppression at 2 years in obese patients with type 2 diabetes: effects of bariatric surgery vs standard medical therapy. *Int J Obes (Lond).* 2014; 38(3): 364–70. [PubMed: 24166065]
8. Yu J, et al. The long-term effects of bariatric surgery for type 2 diabetes: systematic review and meta-analysis of randomized and non-randomized evidence. *Obes Surg.* 2015; 25(1):143–58. [PubMed: 25355456]
9. Bal BS, et al. Nutritional deficiencies after bariatric surgery. *Nat Rev Endocrinol.* 2012; 8(9):544–56. [PubMed: 22525731]
10. Gudzone KA, et al. Screening and diagnosis of micronutrient deficiencies before and after bariatric surgery. *Obes Surg.* 2013; 23(10):1581–9. [PubMed: 23515975]
11. Alexandrou A, et al. Cross-sectional long-term micronutrient deficiencies after sleeve gastrectomy versus Roux-en-Y gastric bypass: a pilot study. *Surg Obes Relat Dis.* 2014; 10(2):262–8. [PubMed: 24182446]
12. Poitou Bernert C, et al. Nutritional deficiency after gastric bypass: diagnosis, prevention and treatment. *Diabetes Metab.* 2007; 33(1):13–24. [PubMed: 17258928]
13. Shah M, Simha V, Garg A. Review: long-term impact of bariatric surgery on body weight, comorbidities, and nutritional status. *J Clin Endocrinol Metab.* 2006; 91(11):4223–31. [PubMed: 16954156]

14. Obeid NR, et al. Long-term outcomes after Roux-en-Y gastric bypass: 10- to 13-year data. *Surg Obes Relat Dis*. 2015
15. Mehaffey JH, et al. 10-Year Outcomes After Roux-en-Y Gastric Bypass. *Ann Surg*. 2015
16. Del Villar Madrigal E, et al. Anemia after Roux-en-Y gastric bypass. How feasible to eliminate the risk by proper supplementation? *Obes Surg*. 2015; 25(1):80–4. [PubMed: 24996802]
17. Blume CA, et al. Nutritional profile of patients before and after Roux-en-Y gastric bypass: 3-year follow-up. *Obes Surg*. 2012; 22(11):1676–85. [PubMed: 22684818]
18. Brolin RE, et al. Prophylactic iron supplementation after Roux-en-Y gastric bypass: a prospective, double-blind, randomized study. *Arch Surg*. 1998; 133(7):740–4. [PubMed: 9688002]
19. Brolin RE, et al. Are vitamin B12 and folate deficiency clinically important after roux-en-Y gastric bypass? *J Gastrointest Surg*. 1998; 2(5):436–42. [PubMed: 9843603]
20. Majumder S, et al. Vitamin B12 deficiency in patients undergoing bariatric surgery: preventive strategies and key recommendations. *Surg Obes Relat Dis*. 2013; 9(6):1013–9. [PubMed: 24091055]
21. Moore CE, Sherman V. Effectiveness of B vitamin supplementation following bariatric surgery: rapid increases of serum vitamin B12. *Obes Surg*. 2015; 25(4):694–9. [PubMed: 25270794]
22. Beckman LM, et al. Serum 25(OH) vitamin D concentration changes after Roux-en-Y gastric bypass surgery. *Obesity (Silver Spring)*. 2013; 21(12):E599–606. [PubMed: 23526677]
23. da Rosa CL, et al. Routine supplementation does not warrant the nutritional status of vitamin d adequate after gastric bypass Roux-en-Y. *Nutr Hosp*. 2013; 28(1):169–72. [PubMed: 23808446]
24. Sinha N, et al. Increased PTH and 1.25(OH)(2)D levels associated with increased markers of bone turnover following bariatric surgery. *Obesity (Silver Spring)*. 2011; 19(12):2388–93. [PubMed: 21617641]
25. Carlin AM, et al. Treatment of vitamin D depletion after Roux-en-Y gastric bypass: a randomized prospective clinical trial. *Surg Obes Relat Dis*. 2009; 5(4):444–9. [PubMed: 18996761]
26. Santos MT, et al. [Changes in bone metabolism markers in women after Roux-en-Y gastric bypass]. *Arq Bras Endocrinol Metabol*. 2012; 56(6):376–82. [PubMed: 22990642]
27. Harper J, et al. What happens to patients who do not follow-up after bariatric surgery? *Am Surg*. 2007; 73(2):181–4. [PubMed: 17305299]
28. Swenson BR, et al. The effect of a low-carbohydrate, high-protein diet on post laparoscopic gastric bypass weight loss: a prospective randomized trial. *J Surg Res*. 2007; 142(2):308–13. [PubMed: 17631904]

Questions

What is already known about this subject? Please remember to also include this between the title page and structure abstract in your paper.

- Nutrient Deficiency is prevalent after bariatric surgery
- Bariatric Surgeons screen and aggressively treat nutrient deficiencies.
- Bariatric surgeons have poor long-term follow-up

What does this study add? Please remember to also include between the title page and structured abstract in your paper.

- First long-term study of nutrient deficiency after bariatric surgery
- Demonstrates patterns in patient follow-up after bariatric surgery
- Highlights a major disparity in Nutrient screening and supplementation long-term after bariatric surgery

Table 1

Pre-operative Demographics for 2-year versus 10-year RYGB Patients

Variable	2-Year (n=107)	10-Year (n=172)	P-value
Age (years)	45.6 ± 11.9	43.2 ± 9.5	0.09
Sex (% female)	81.9	80.4	0.75
Race (% white)	88.79	91.6	0.39
Pre-operative BMI (kg/m ²)	51.5 ± 9.8	50.1 ± 8.1	0.38
Psychiatric History (%)	14.8	9.35	0.19
Gastroesophageal Reflux Disease (%)	30.8	31.0	0.98
Obstructive Sleep Apnea (%)	61.6	52.3	0.10
Degenerative Joint Disease (%)	58.9	58.7	0.98
Diabetes Mellitus (%)	68.2	61.3	0.25
Hypertension (%)	41.1	50.9	0.12

A p-value of $p < 0.05$ was denoted for statistical significance and was calculated using Chi² and Mann-Whitney U. RYGB = Roux-en-Y Gastric Bypass. BMI = Body Mass Index. Data are mean ± standard error of the mean or percentage.

Table 2

Nutrient Supplementation for 2-year versus 10-year RYGB Patients

Variable	2-Year	10-Year	P-value
Multivitamin (%)	70.3	58.9	0.05
Iron Supplement (%)	84.2	67.1	0.02
Folate Supplement (%)	14.2	4.5	0.01
Vitamin B-12 Supplement (%)	54.2	47.1	0.26
Vitamin D Supplement (%)	48.3	51.4	0.63
Calcium Supplement (%)	49.5	32.9	0.01
Time Since Last CBC (months)	12.2 ± 6.2	33.2 ± 10.9	<0.0001
Zinc Level (%)	8.2	9.3	0.43

Demonstrates nutrient supplementation, p-value of $p < 0.05$ was denoted for statistical significance and was calculated using χ^2 and Mann-Whitney U. CBC = Complete Blood Count. Data are mean ± standard error of the mean or percentage.

Table 3

Health Care Professional Follow Up and Weight loss for 2-year versus 10-year RYGB Patients

Variable	2-Year	10-Year	P-value
Time since last Surgeon Follow-Up (months)	13.3 ± 7.8	86.9 ± 39.9	<0.001
Time since last PCP Follow-Up (months)	3.1 ± 4.3	3.7 ± 3.4	0.21
Follow-Up BMI (kg/m ²)	33.1 ± 7.4	35.4 ± 8.6	0.03
% EBMI Reduction	70.4 ± 24.1	58.6 ± 34.1	<0.001

A p-value of $p < 0.05$ was denoted for statistical significance and was calculated using χ^2 and Mann-Whitney U. % EBMI = ((Pre-op BMI – 25) – (Interval BMI – 25))/(Pre-op BMI – 25). Data are mean ± standard error of the mean.

Table 4

Multivariate Logistic Regression for Multivitamin Use

Parameter	Odds Ratio [95% CI]	Wald Chi-Square	p-value
Last Surgeon Visit	0.973 [0.961,0.984]	20.9224	<0.0001
Last PCP Visit	1.055 [0.959,1.160]	1.2018	0.273
Interval Since Surgery	1.056 [0.919,1.213]	0.5743	0.4486
%EBMI	0.992 [0.983,1.002]	2.3608	0.1244
Obstructive Sleep Apnea	2.066 [0.760,5.612]	2.0381	0.1534
Cardiac Comorbidity	1.524 [0.540,4.296]	0.6506	0.4199
Degenerative Joint Disease	1.039 [0.550,1.960]	0.0127	0.9104
Diabetes Mellitus	0.607 [0.274,1.343]	1.4179	0.2338
GERD	1.907 [0.891,4.084]	2.7687	0.0961
Hypertension	1.341 [0.672,2.674]	0.6937	0.4049