REVIEW ARTICLE

ADHERENCE TO NUTRITIONAL SUPPLEMENTATION, FOLLOW-UP CARE, AND LOST TO FOLLOW-UP IN POST BARIATRIC SURGERY PATIENTS

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Background: With the global rise in obesity rates, bariatric surgery has emerged as an effective intervention for weight management and obesity-related comorbidities. Bariatric surgery offers transformative potential but demands lifelong adherence to multifaceted care, including nutritional supplementation and vigilant follow-up. Nutritional deficiencies affect 30% to 70% of patients, encompassing vital elements like vitamins (B12, D, folate), minerals (iron, zinc, calcium), and proteins, necessitating continuous monitoring to prevent complications. This comprehensive review explores the multifaceted challenges in post-bariatric surgery patient care, focusing on adherence to nutritional supplementation, follow-up care, and the prevalence of nutritional deficiencies. **Methods:** A systematic synthesis of relevant literature was conducted, encompassing studies examining post-operative care practices, adherence to prescribed multivitamin supplements (MVS), rates of follow-up, and nutritional deficiencies in bariatric surgery patients. Nine key studies were analyzed and synthesized to extract critical insights. **Results:** Findings revealed a complex landscape of post-bariatric surgery care, marked by both promise and pitfalls. Adherence to MVS regimens emerged as a significant challenge, influenced by factors such as forgetfulness, gastrointestinal side effects, cost concerns, and poor follow-up rate. Lost-to-follow-up rates varied across studies, raising concerns about the continuity of care. Nutritional deficiencies were prevalent, underscoring the importance of long-term monitoring. It highlights the need for tailored patient education, improved doctor-patient communication, and shared decision-making processes to enhance adherence and follow-up care. **Conclusion:** This review underscores the intricate nature of post-bariatric surgery patient care, emphasizing the critical role of adherence, follow-up, and nutritional monitoring. Disparities in care among different regions of the world with varying healthcare systems are acknowledged as a significant challenge; addressing these challenges necessitates a collaborative effort among healthcare providers, patients, and policymakers to optimize the long-term well-being of individuals who undergo bariatric surgery.

Keywords: Bariatric surgery; Nutritional deficiencies; Follow-up care; Lost to follow-up; Adherence

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INTRODUCTION

Obesity, a widespread and multifaceted chronic condition affecting individuals across the lifespan, represents a complex interplay of physiological, psychological, and societal factors. With the escalating global prevalence of obesity, it has emerged as a pressing public health challenge.[1] The consequences of obesity extend beyond physical health, encompassing compromised mental well-being, diminished quality of life, and elevated susceptibility to a spectrum of chronic diseases such as cardiovascular disorders, insulin resistance, and certain malignancies.[2] Despite extensive efforts to mitigate obesity through conventional lifestyle interventions, their efficacy remains limited, particularly in cases of severe or morbid obesity.[3] As a result, bariatric surgery has arisen as a transformative intervention, offering a promising avenue to reduce the adverse health consequences associated with obesity.[4]

Pivotal milestones punctuate the evolution of bariatric surgery as a viable treatment option. In 1994, Alan Wittgrove conducted the laparoscopic gastric bypass, ushering in a new era in obesity management.[4] This pioneering technique revolutionized surgical practices, facilitating minimally invasive procedures and expediting patient recovery. Subsequently, bariatric surgery's exponential growth has been remarkable, with a substantial surge in operations

performed worldwide.[5] The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) report of August 2022 underscores this growth, drawing on data from diverse registries and highlighting the significant contribution of bariatric surgery to healthcare.[6]

However, the transformative potential of bariatric surgery is counterbalanced by persistent challenges. Permanent alterations in gastrointestinal anatomy necessitate sustained adherence to multifaceted regimens, encompassing nutritional supplementation and vigilant follow-up care.[7,8] Notably, the management of nutritional deficiencies emerges as a critical concern within the realm of bariatric surgery. Research indicates that a considerable proportion of patients, ranging from 30–70%, encounter nutritional deficiencies post-surgery, underscoring the need for consistent monitoring and meticulous follow-up.[9] These deficiencies span a spectrum of essential elements, including vitamins (such as B12, D, and folate), minerals (iron, zinc, calcium), and proteins. Given the pivotal roles of these nutritional components in maintaining overall health, their deficits can culminate in a gamut of complications, ranging from anaemia and peripheral neuropathy to metabolic bone diseases and cardiomyopathy.[9]

In light of the evolving landscape of bariatric surgery, this systematic review seeks to address critical knowledge gaps surrounding the long-term efficacy of follow-up care, adherence to MVS, and lost to follow-up among post-operative bariatric surgery patients and their impact on long-term nutritional outcome and patient well-being. While the immediate post-operative phase has significant clinical attention, a notable lack of research exists pertaining to the dietary patterns, adherence behaviours, and nutritional outcomes of patients beyond this initial period.[10,11] Through a comprehensive synthesis of existing literature, this review aims to illuminate the trajectory of nutritional deficiencies, the implications of non-adherence, and the potential role of extended follow-up care in justifying these challenges over extended durations.

The review is structured to thoroughly analyze the effectiveness of follow-up care, addressing gaps in our comprehension of the enduring nutritional requirements of bariatric surgery patients. By closely examining the available evidence, this review aims to enhance our understanding of the evolving nature of dietary deficiencies and the pivotal role of adhering to follow-up care in preventing complications. This undertaking holds promise for informing clinical practices, enhancing patient education, and shaping policy recommendations to optimize long-term patient outcomes.

MATERIAL AND METHODS

Research Question and Protocol Development:

The primary objective of this systematic review is to assess the effectiveness of follow-up care, adherence to MVS, and lost to follow-up in patients who have undergone bariatric surgery. Secondary objectives include identifying gaps in the literature and exploring factors influencing the effectiveness of these protocols and strategies to overcome these challenges.

The systematic review protocol was developed following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and is available upon request.[12]

Search Strategy:

A comprehensive literature search was conducted in PubMed databases and Google Scholar. Following is the advanced search strategy.

("bariatric surgery"[Title/Abstract] OR "weight loss surgery"[Title/Abstract] OR "obesity surgery"[Title/Abstract] OR "gastric bypass surgery"[Title/Abstract] OR "sleeve gastrectomy"[Title/Abstract] OR "gastric banding"[Title/Abstract] OR "metabolic surgery"[Title/Abstract]) AND ("nutritional deficiencies"[Title/Abstract] OR "micronutrient deficiencies"[Title/Abstract] OR "vitamin deficiencies"[Title/Abstract] OR "mineral deficiencies"[Title/Abstract] OR "protein deficiencies"[Title/Abstract] OR "malnutrition"[Title/Abstract] OR "nutrient deficiencies"[Title/Abstract]) AND ("follow-up protocols"[Title/Abstract] OR "postoperative follow-up"[Title/Abstract] OR "long-term follow-up"[Title/Abstract] OR "monitoring protocols"[Title/Abstract] OR "surveillance protocols"[Title/Abstract] OR "postoperative care"[Title/Abstract] OR "monitoring strategies"[Title/Abstract] OR "nutritional monitoring"[Title/Abstract] OR "laboratory monitoring"[Title/Abstract] OR "biomarker monitoring"[Title/Abstract] OR "screening strategies"[Title/Abstract] OR "surveillance strategies"[Title/Abstract])

Inclusion and Exclusion Criteria:

The inclusion and exclusion criteria for this systematic review were carefully defined to ensure the relevance and appropriateness of the studies considered. Eligible studies were required to focus on adult bariatric surgery patients (aged 18 years and above) and specifically address the follow-up in different settings, long-term complications related to nutritional deficiencies and non-adherence to MVS. Only full-text articles published in the last six years were included to capture the most recent evidence.

To maintain a clear focus on follow-care of nutritional deficiencies in the context of bariatric surgery, studies that examined other co-morbidities or were related to pregnancy were excluded. Additionally, studies that did not provide full-text access or were not available in English were excluded to ensure the availability of complete and accessible information for the review.

Data Extraction:

Data extraction and review was conducted independently by two reviewers using a predefined data extraction form. In the case of disagreements, the researchers discussed the data for its relevance and design for eligibility criteria to reach an accord. A third researcher was counselled for objectivity if a decision could not be made.

Quality Assessment:

Following quality appraisal tools were used to check for bias. Only those articles were included that satisfied >70% of the criteria. Quality of the included papers is displayed in table 1.

Newcastle - Ottawa Quality assessment scale: Cohort study[13]

1. Representativeness of the exposed cohort
2. Selection of the non-exposed cohort
3. Ascertainment of exposure
4. Demonstration that outcome of interest was not present at start of study
5. Comparability of cohorts on the basis of the design or analysis
    - study controls for main factor (select the most important factor)
    - study controls for any additional factor (These criteria could be modified to indicate specific control for a second important factor)
6. Assessment of outcome
7. Was follow-up long enough for outcomes to occur
8. Adequacy of follow up of cohorts

JBI Critical Appraisal Checklist for analytical cross-sectional studies[14]

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

Cochrane Bias assessment tool for randomized control trials[15]

1. Was the allocation sequence random?
2. Was the allocation sequence concealed until participants were enrolled and assigned to interventions?
3. Did baseline differences between intervention groups suggest a problem with the randomization process?
4. Reaching risk-of-bias judgements for bias arising from the randomization process
5. remarks on judgements

Data Synthesis and Analysis:

Due to heterogeneity in study design and outcome measures, a qualitative synthesis of the findings was performed. Results were summarized narratively, highlighting key findings related to the effectiveness of follow-up protocols and monitoring strategies in managing nutritional deficiencies.

RESULTS

We identified 20,871 articles related to our topic. Afterward, 40 duplicates and 19000 papers were removed by automation tools because of ineligibility. 1755 papers were screened, 1651 papers were excluded by reviewing title and abstract and 58 excluded with further reading through the articles. Forty-six articles were retrieved and reviewed. We finalized 9 articles after using quality appraisal tools. Figure-1 exhibits the search strategy used to conduct this review in a PRISMA flowchart.[12]

Summary of the included articles is given in **table-2**. The majority of the included studies in this review consisted of observational designs (n=8). One notable exception was a prospective cohort study that formed part of a randomized controlled trial (RCT) involving specialized weight loss surgery supplements (WLS) (VITAAL I and VITAAL II) in conjunction with standard over-the-counter vitamins.[18] Additionally, one qualitative study featured participants recruited from community pharmacies and bariatric surgery facilities.[20]

All of the studies incorporated into this review were dedicated to the examination of post-operative follow-up care for bariatric patients, with a specific focus on addressing common nutritional deficiencies. Noteworthy trends regarding rates of loss to follow-up and non-adherence to prescribed supplements have been summarized in Table 3, revealing a progressive decline in patient engagement over successive years, coupled with reduced adherence to prescribed supplement regimens.

Collectively, the findings across all included studies underscore the critical necessity for vigilant follow-up care and meticulous patient monitoring to ensure optimal care and minimize complications

associated with nutritional deficiencies. A concise summary of the conclusions and results derived from these studies is presented in Table 4.

An Australian study, featured within this review, reported promising results characterized by the complete absence of nutritional deficiencies in patients undergoing a four-year follow-up regimen.[21] The factors contributing to this favorable outcome included the relatively low cost of supplements available to the study participants and a closely supervised follow-up program with proactive management of complications.

One study, which collated data from 3137 patients through local primary care physicians (PCPs), notably emphasized that individuals who undergo bariatric surgery often do not receive the recommended level of nutritional monitoring post-discharge from specialist care. This finding raises concerns about the adequacy of long-term nutritional support in this patient population.[23]

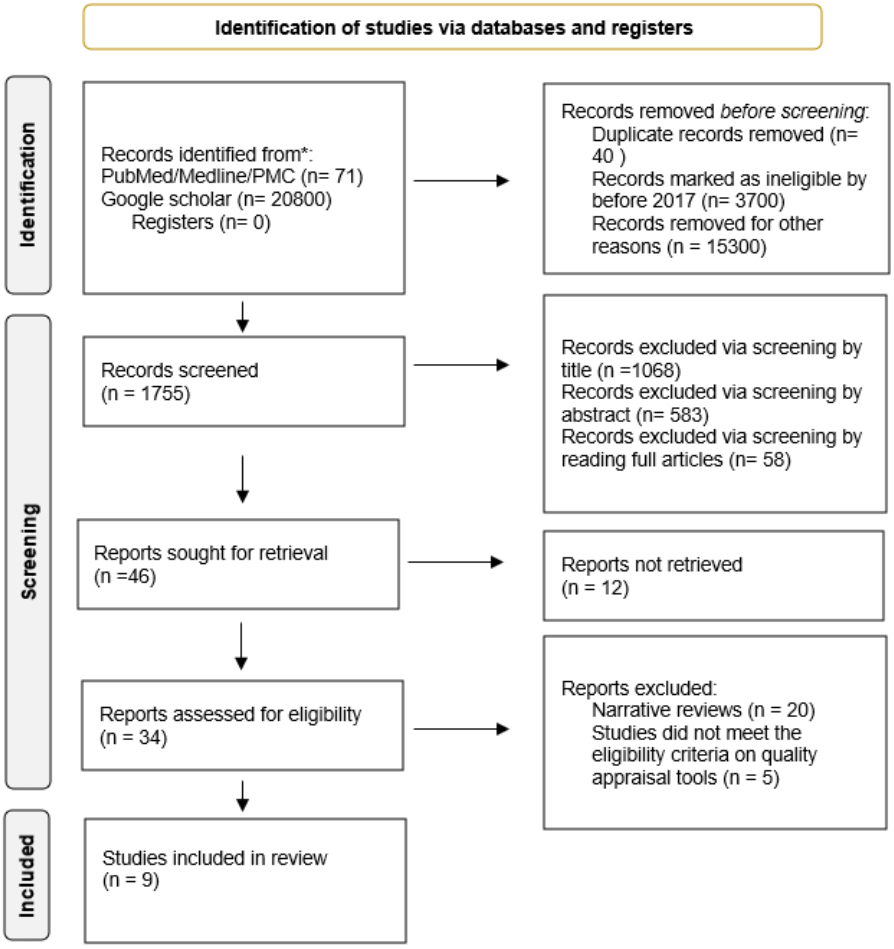

Figure-1: PRISMA Flowchart showing the selection and screening process of included studies[12]

Table-1: Quality appraisal tools

Author	Study type	Quality appraisal tool	1	2	3	4	5	6	7	8
J. Hunter Mehaffey *et al.* 2017[9]	Cross-sectional	Jbi Critical Checklist	yes	yes	yes	yes	-	-	yes	yes
Kristina Spetz *et al.* 2022[16]	Cohort study	Newcastle Ottawa Scale	Yes	-	Yes	Yes	Yes & yes	yes	Yes	yes
H. J. M. Smelt *et al.* 2021[17]	Cross-sectional	Jbi Critical Checklist	yes	Yes	yes	?	yes	yes	yes	yes
Laura Heusschen *et al.* 2022[18]	RCT	Cochrane Bias Tool	-	yes	-	Low risk of bias	Study was done under proper guidelines to minimize the risk of bias			
Tair Ben-Porat *et al.* 2017[19]	Cohort study	Newcastle Ottawa Scale	yes	no	no	yes	Yes & No	?	yes	yes
Yitka N. H. Graham *et al.* 2020[20]	Cross-sectional	Jbi Critical Checklist	yes	yes	yes	yes	-	-	yes	yes
Ravi Rao *et al.* 2023[21]	Cohort study	Newcastle Ottawa Scale	yes	-	yes	yes	-	yes	yes	yes
Kaleb Lourensz *et al.* 2022[22]	Cohort study	Newcastle Ottawa Scale	yes	-	yes	yes	Yes & yes	yes	yes	yes
Helen M Parretti *et al.* 2021[23]	Cohort study	Newcastle Ottawa Scale	yes	-	yes	yes	Yes & yes	yes	Yes	yes

Table-2: Summary of included studies.

Author	Purpose	Type of Study	Patients (N)	Age (Mean±SD)	Sex (% Male)	Mean BMI	Follow-up Duration	Supplements Prescribed (%)
J. Hunter Mehaffey *et al.* 2017[9]	this study compared nutrient supplementation as well as surgeon and PCPs follow-up between patients with short-term versus long-term follow-up	Retrospective Cohort	281 (10-year), 149 (2-year)	43.2±9.5 (10-year), 45.6±1.9 (2-year)	20% (10-year), Not Reported (2-year)	51.5±9.8	Up to 10 years	Over the counter multivitamins
Kristina Spetz *et al*. 2022[16]	to assess adherence to supplementation and predictors of low adherence	Prospective Cohort	263	41±11	21.7 %	40±5	2 years	Vit b12, calcium-vitamin D, iron
H. J. M. Smelt *et al.* 2021[17]	factors affect patient adherence to MVS intake after bariatric surgery	Cross-sectional	4614	41.6±10.8	20.3%	28.7±3	10 years	Specific Weight loss surgery supplements FitForMe®, Vitamine op recept, Flindall
Laura Heusschen *et al*. 2022[18]	compares micronutrient status using specialized MVS vs users of standard MVS and non-users of MVS	RCT	226	39.4±11.6	24%	30.4±10	3 years	specialized multivitamin supplement WLS Optimum; the VITAAL I and VITAAL II
Tair Ben-Porat *et al*. 2017[19]	To assess the prevalence of nutritional deficiencies and supplement consumption four years post-LSG	Prospective Cohort	192	42.8±11.2	32.5%	Not available	4 years	Supplements prescribed according to guidelines
Yitka N. H. Graham *et al.* 2020[20]	A potential role for community pharmacists in bariatric follow-up care is explored.	Cross-sectional. Qualitative method	bariatric surgical staff (n=9), community pharmacists (n = 16)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Ravi Rao *et al.* 2023[21]	nutritional outcomes in SADI-S patients using a nutritional supplement based on ASMBS guidelines	Prospective Cohort	196	44.9±6.7	30.6%	43.6±22.5	4 years	altered versions were formulated using the ASMBS nutritional 2016 guidelines
Kaleb Lourensz *et al.* 2022[22]	To evaluate the long-term outcomes of revisional malabsorptive bariatric surgery	prospective Cohort	102	49±9.2	13.7 %	41.3 (40.9–1.3)	Up to 17 years	Multivitamin, iron, vitamin B12, folic acid, calcium/vitamin D
Helen M Parretti *et al.* 2021[23]	To investigate whether nutritional and weight monitoring in primary care meets current clinical guidance, after patients are discharged from specialist bariatric care.	Retrospective Cohort	3137	48.4±10.3	20%	36.8 (8.8)	Up to 7.6 years	Multivitamin, iron, vitamin B12, folic acid, calcium/vitamin D

LGS = laparoscopic sleeves gastrectomy. ASMBS = American Society for Metabolic & Bariatric Surgery. SADL-S = single-anastomosis duodeno-ileal bypass with sleeve gastrectomy

Table-3: Loss to follow-up and non-adherence trend in included studies

Study	Lost to Follow-Up / Non-Adherence to MVS	Nutritional Deficiencies
J. Hunter Mehaffey *et al.* 2017[9]	Up to 39% of patients were lost to follow-up at 10 years, and up to 28% were lost at 2 years.	Not Reported
Kristina Spetz *et al.* 2022[16]	Non-adherence in the first year was reported at 11.9% and increased to 15% in the second-year post-surgery.	Individuals with low adherence to supplement regimens displayed significant deficiencies in vitamin B12, folate, vitamin D, and iron.
H. J. M. Smelt *et al.* 2021[17]	Inconsistent MVS use was reported by 15.4% of participants, and 7.4% did not use any MVS at all. Non-adherence in the first year was at 6.9% and increased to 13% by the fifth year of follow-up.	Not reported
Laura Heusschen *et al.* 2022[18]	15% of patients were lost to follow-up at 12 months, 22% at 24 months, and 38% at 36 months of follow-up.	Patients using specialized MVS had elevated levels of hemoglobin, folic acid, vitamin D, vitamin B12, and (corrected) calcium compared to those who did not use specialized MVS.
Tair Ben-Porat *et al*. 2017[19]	86% of patients were lost to follow-up at the 4-year mark, while 60% were lost at the 1-year post-surgery mark. Adherence to vitamins and minerals dropped significantly from 92.6% in the first year to 37% in the fourth post-operative year.	Notable deficiencies observed in individuals included vitamin D, vitamin B12, folate, and anemia.
Yitka N. H. Graham *et al.*[20]	Not applicable	Not applicable
Ravi Rao *et al.* 2023[21]	Lost to follow-up rates were as follows: 22.5% at 12 months, 26.8% at 24 months, 27.6% at 36 months, and 40.3% at 48 months.	Following surgery, mild to moderate vitamin deficiencies were observed in 14.2% of patients during the initial 18 months. However, by the 4-year mark, the cohort showed no nutritional deficiencies.
Kaleb Lourensz *et al.* 2022[22]	A total of 20.6% of patients were permanently lost to follow-up at a median of 5 years postoperatively.	Nutritional deficiencies were present in 82 (80.4%) patients, and 10 (9.8%) of these individuals experienced severe deficiencies necessitating periods of parenteral nutrition.
Helen M Parretti *et al.* 2021[23]	Only approximately 5% of patients receive recommended long-term follow-up reviews in primary care. Adherence rates were not reported.	The most prevalent deficiencies were low hemoglobin levels, ranging from 40.5% (sleeve gastrectomy) to 50.6% (gastric bypass and LAGB), and low ferritin levels, varying from 18.9% (LAGB) to 35.0% (gastric bypass and LAGB).
LAGB = laparoscopic adjustable gastric banding.		

Table-4: Summary of Results and Conclusions of included studies.

Study	Conclusion	Results	Remarks
J. Hunter Mehaffey *et al*. 2017[9]	Patients show a preference for PCPs follow-up, but there's a significant gap in malnutrition screening and nutrient supplementation post-surgery.	Short-term patients had higher nutrient supplementation but shorter time since last surgeon follow-up compared to long-term patients. (13.3±7.8 vs. 86.9±39.9 months, p<0.001)	Implementing multidisciplinary guidelines is crucial to managing this high-risk patient population and preventing malnutrition.
Kristina Spetz *et al*. 2022[16]	Significant disparities were observed in adherence to post-bariatric surgery supplementation regimens within the initial two-year period.	Factors such as younger age, the occurrence of side effects, pre-existing mental health issues, and lack of consistent medication use prior to surgery were linked to reduced adherence.	These findings underscore the necessity for customized follow-up approaches and the implementation of strategies to sustain long-term adherence.
H. J. M. Smelt *et al*. 2021[17]	Bariatric patients generally exhibit a unfavorable attitude towards the use of MVS. Consequently, it is crucial to furnish them with precise information concerning various methods for MVS intake and to acquire insights into individual patient preferences when recommending supplements.	Common reasons for non-adherence included forgetfulness (68.3%), gastrointestinal side effects (25.6%), unpleasant taste or smell (22.7%), cost concerns (13.5%), and perceived absence of vitamin deficiencies (20.9%). Dissatisfaction with MVS usage instructions was also noted (28.5%).	Improving adherence to MVS intake requires the shared decision-making practices. Furthermore, it emphasizes the need to enhance MVS formulations and explore potential reimbursement strategies to address the issue of non-adherence effectively.
Laura Heusschen *et al*. 2022[18]	While it's acknowledged that there isn't a one-size-fits-all MVS for all SG patients, the study found that WLS Optimum exhibited greater efficacy in maintaining normal serum concentrations compared to standard, over-the-counter supplements.	Specialized MVS users (Optimum 1.0 and 2.0) had higher levels of haemoglobin, folic acid, vitamin D, vitamin B12, and calcium compared to standard MVS users and non-users during follow-up.	Non-users of MVS showed the highest rates of micronutrient deficiencies and are likely to experience deteriorating nutritional status over the long term.
Tair Ben-Porat *et al.* 2017[19]	A significant prevalence of nutritional deficiencies is observed four years after LSG, coupled with poor adherence to nutritional supplementation.	At the four-year mark post-surgery, an 86% loss to follow-up was noted, and this figure stood at 60% at the one-year mark post-surgery. Additionally, adherence to vitamins and minerals dropped from 92.6% during the first year to a significant decrease of 37% by the fourth post-operative year.	Long-term nutritional follow-up and the maintenance of supplementation are essential for patients who have undergone LSG. Further studies are required to fully understand the clinical implications of these deficiencies.
Study	**Conclusion**	**Results**	**Remarks**

Yitka N. H. Graham *et al*. 2020[20]	Effective communication between bariatric units and community pharmacies is crucial to establish a well-defined and formalized support infrastructure. It is recommended that arrangements be made for compensating pharmacy specialists to ensure financial viability and sustainability of this support system.	Community pharmacists (n=16) expressed limited familiarity with bariatric surgery, making it challenging for them to consistently identify individuals who have undergone such procedures. However, they demonstrated an understanding of the absorption issues related to vitamins in bariatric patients.	There is clear potential to engage community pharmacists in the post-bariatric patient care pathway.
Ravi Rao *et al*. 2023[21]	Factors such as early and aggressive correction of nutritional deficiencies, regular laboratory monitoring, multidisciplinary team follow-ups, and adherence to the formulated nutritional supplement have contributed to favorable nutritional outcomes at the 4-year mark.	After surgery, mild to moderate vitamin deficiencies were observed in 14.2% of patients within the first 18 months. Remarkably, at the 4-year mark, the entire cohort showed no nutritional deficiencies.	Positive outcomes in this study linked to early and aggressive correction of pre and postoperative nutritional deficiencies, regular lab tests, and ongoing multidisciplinary follow-up. Low-cost supplements for the participants also supported good adherence.
Kaleb Lourensz *et al*. 2022[22]	Revisional malabsorptive bariatric surgery was found to be effective in inducing significant long-term weight loss and resolution of comorbidities. However, there were notable concerns regarding high rates of both temporary and permanent attrition from follow-up, which is particularly concerning given the high prevalence of nutritional deficiencies observed in the study.	The study reported a mean total weight loss of 22.7% (SD 13.4), 20.1% (SD 10.5), and 17.6% (SD 5.5) at 5, 10, and 15 years, respectively, since the revisional bariatric procedure. Additionally, nutritional deficiencies were identified in a significant portion of the patients, with 82 (80.4%) experiencing these deficiencies. Notably, 10 (9.8%) patients had severe deficiencies that necessitated periods of parenteral nutrition.	The data collected raises concerns about the long-term safety of malabsorptive bariatric procedures. This is primarily attributed to the challenges in ensuring patient compliance with MVS and the long-term follow-up requirements essential for managing nutritional deficiencies and related complications.
Helen M Parretti *et al*. 2021[23]	This study indicates that patients who undergo bariatric surgery often do not receive the recommended nutritional monitoring after being discharged from specialist care. It emphasizes the importance of supporting GPs and patients in engaging with follow-up care. Additionally, future research should aim to investigate the underlying reasons for these findings.	The median follow-up duration after surgery was approximately 5.7 years, with a range of 4.2 to 7.6 years across the studies. Notably, only a range of 45% to 59% of patients had their weight measured annually during the follow-up period. Moreover, the annual proportions of blood tests that are specific to bariatric surgery were consistently low across the studies.	These findings underscore the imperative need for improved engagement with follow-up care and PCPs in the post-bariatric surgery phase.
SG = Sleeve Gastrectomy. LGS = laparoscopic sleeves gastrectomy. GPs = general practitioners			

DISCUSSION

Background:

Obesity is a significant global health concern, characterized by excessive fat accumulation, often leading to adverse health outcomes. Both overweight (BMI ≥ 25.0 kg/m2) and obesity (BMI ≥ 30.0 kg/m2) are associated with increased all-cause mortality, with a notable 30% increase in mortality for every 5 kg/m2 increase in BMI above 25 kg/m2.[24] While lifestyle interventions can achieve modest weight loss of 2%-6%, the sustainability of these effects is limited, as nearly 90% of individuals tend to regain their initial weight within 1-5 years. Pharmaceutical treatments offer a weight loss of 5–15%, but these are typically considered adjuncts to lifestyle changes, with limited long-term effectiveness overall.[3]

Bariatric surgery, a well-established field for three decades, has yielded transformative effects on human physiology. It has proven to be instrumental in curing obesity-related comorbidities, reducing the risk of malignancies, and improving both the length and quality of life, previously considered unattainable by medical science. Bariatric surgical procedures are traditionally classified as restrictive, malabsorptive, or a combination of these approaches. Restrictive procedures involve reducing stomach size, thereby limiting energy intake and inducing satiety, while malabsorptive procedures bypass specific segments of the intestine, reducing nutrient absorption in the gastrointestinal tract.[24] However, these malabsorptive procedures, by altering the gastrointestinal physiology, can compromise the solubility and surface area for drug absorption, thereby influencing drug bioavailability. Furthermore, the reduction in functional gastrointestinal capacity after bariatric surgery may impact the bioavailability of MVS.[10]

The practice of bariatric surgery varies globally, with diverse surgical procedures and their associated outcomes and complications. Different regions have developed their guidelines for the detection and management of long-term complications following these procedures. Notably, the National

Institute for Health and Care Excellence (NICE) guidelines (last updated in 2016) provide comprehensive recommendations for bariatric surgery follow-up care.[25] They advocate for a minimum two-year follow-up care package within the bariatric service, encompassing nutritional intake monitoring (including protein and vitamins), comorbidity assessment, medication review, dietary and nutritional guidance, physical activity advice, personalized psychological support, and information on professionally-led or peer-support groups.[25] Following discharge from bariatric surgery services, it is essential to ensure that individuals are provided with at least annual assessments of their nutritional status and receive appropriate supplementation as needed, all within the framework of a collaborative care model for managing chronic diseases. During the initial two years post-surgery, it is anticipated that follow-up consultations will primarily involve interactions with either a dietitian or a bariatric physician. Typically, in the first year, patients are scheduled for three follow-up appointments, followed by annual follow-ups thereafter. Beyond this initial two-year period, follow-up consultations are likely to involve either a dietitian or a General Practitioner (GP) within a locally agreed-upon shared-care protocol.[25,26]

Different guidelines give different recommendations like the 2017 European Association for the Study of Obesity statement recommends 24-hour urine calcium testing as part of the follow-up protocol for patients who have undergone Roux-en-Y Gastric Bypass (RYGBP).[27] In contrast, the 2019 American guidelines do not advocate for this practice.[28] This raises a pertinent question: should 24-hour urine calcium testing be routinely included in post-RYGBP follow-up, or should it be omitted? Should we align with one set of guidelines over the other? What does the available evidence suggest in favour of or against these recommendations?[29]

Lost to Follow-Up: A Growing Concern:

The cornerstone of addressing complications and ensuring favourable surgical outcomes is vigilant post-operative follow-up and adherence to prescribed lifelong MVS. Alarming trends, as highlighted by the results of this systematic review, include a significant proportion of patients lost to follow-up and low adherence to supplements, which can result in severe, life-threatening complications and suboptimal surgical outcomes. Adherence to prescribed MVS among post-bariatric surgery patients emerges as a multifaceted challenge, influenced by several interrelated factors. H. J. M. Smelt *et al* provided data on non-adherence of MVS.[17] One of the foremost factors contributing to low adherence, as revealed in the studies is the propensity of patients to forget their daily supplement intake. This forgetfulness, reported by a substantial 68.3% of patients, reflects the demanding nature of post-bariatric surgery regimens, where patients are required to incorporate numerous medications and supplements into their daily routines. Gastrointestinal side effects, experienced by 25.6% of individuals, constitute another major barrier to adherence, often leading to discomfort and aversion to supplements. Similarly, the unpleasant taste or smell of supplements, cited by 22.7% of patients, creates an inherent aversion to their consistent usage. High costs associated with these supplements, an issue for 13.5% of patients, can further deter adherence, particularly in individuals with limited financial resources.[17,30] Interestingly, a significant portion (20.9%) of patients, despite being prescribed MVS, do not perceive themselves as having vitamin deficiencies, potentially diminishing their motivation to adhere to supplementation. Dissatisfaction with instructions on supplement usage, voiced by 28.5% of patients, reveals a critical communication gap between healthcare providers and patients, emphasizing the need for clearer and more patient-centric guidance.[17]

Variations in Follow-Up Care Worldwide:

The landscape of post-bariatric surgery care is not uniform across the globe, with marked disparities arising from differences in healthcare infrastructure, resources, and accessibility. It is imperative to recognize that the challenges in providing adequate follow-up care for post-operative bariatric patients are further exacerbated in regions with limited healthcare resources and lower literacy rates. In such areas, where medical systems may struggle to meet the demands of comprehensive, lifelong post-surgical care, the risks associated with inadequate follow-up are heightened. Patients in these regions may face substantial barriers to accessing necessary healthcare services, including regular monitoring, nutritional assessments, and prescribed supplements. Consequently, addressing the specific needs of bariatric patients in these underserved regions becomes an even more critical imperative. These challenges underscore the importance of tailoring post-surgical care protocols to the unique circumstances and healthcare ecosystems of different geographic areas, with a focus on ensuring that every patient, regardless of their location, can access the essential care required for the long-term success of bariatric surgery.

Role of Community Pharmacists and GPs:

Yitka N. H. Graham *et al* study introduces the concept of involving community pharmacists in counseling patients on MVS adherence.[20] Community pharmacies are often seen as easily accessible and convenient points of contact for healthcare advice. In England, for instance, 89% of the population lives within a 20-minute walk of their nearest pharmacy. However, the study also reveals that community pharmacists

generally have limited knowledge of bariatric surgery, which hampers their ability to identify individuals who have undergone such procedures. Furthermore, the specific role of community pharmacies in monitoring post-bariatric surgery care remains poorly defined. Pharmacists have long been recognized as valuable members of interprofessional teams for bariatric surgical patients, particularly in providing expertise on dosage forms and modifications to ensure the uninterrupted continuity of patient pharmacotherapy. Extending the reach of community pharmacies into post-surgical bariatric care is an avenue worth exploring to leverage their skills in advocating and sustaining long-term health and well-being for patients who initially struggle to adapt to the physiological changes brought about by bariatric surgery.

In study by Helen M Parretti *et al*, the follow-up of bariatric surgery patients by GPs post-discharge is often suboptimal.[23] These patients often do not receive the necessary specialized follow-up examinations and deficiency screenings essential for detecting complications associated with bariatric surgery. In reality, only a small fraction of patients undergo recommended long-term follow-up reviews within the primary care setting, which is a cause for concern.[23] This underscores the pressing need for enhanced engagement with follow-up care and collaboration with primary care providers, particularly in regions with resource constraints. The profound and permanent physiological alterations resulting from bariatric surgery necessitate ongoing vigilance, comprehensive patient education, and close monitoring.

Limitations of the Review:

It's important to acknowledge certain limitations in this comprehensive review of post-bariatric surgery patient care. Firstly, the included studies varied in design, ranging from observational to qualitative analyses, which could introduce heterogeneity in the findings. This diversity in study design may impact the generalizability of the results and the ability to draw uniform conclusions. Secondly, while these studies provided valuable insights into factors affecting adherence, lost to follow-up, and nutritional deficiencies, they were largely retrospective in nature. Prospective, long-term studies are needed to establish causal relationships and assess the effectiveness of interventions aimed at improving patient outcomes. Additionally, the geographical diversity of the included studies might limit the generalizability of findings to specific regions or healthcare systems. Furthermore, the studies themselves reported variations in patient demographics, surgical techniques, and follow-up protocols, making direct comparisons challenging. Finally, the majority of studies relied on self-reporting and electronic health records for data collection, which may introduce recall bias and limit the accuracy of adherence assessments. Despite these limitations, this synthesis of existing literature provides valuable insights and underscores the need for future research to address these gaps comprehensively.

Conclusion and Future Directions:

this comprehensive review underscores the intricate challenges in post-bariatric surgery follow-up care, MVS adherence, and the prevalence of nutritional deficiencies. It is evident that sustaining long-term adherence to supplementation regimens remains a substantial concern, with a multitude of factors contributing to non-compliance. Moreover, the issue of patients lost to follow-up, as highlighted by several studies, underscores the need for improved engagement with follow-up care, both within specialized bariatric units and in collaboration with primary care providers. Addressing these multifaceted challenges requires a comprehensive approach, encompassing patient education, improved communication among healthcare providers, shared decision-making processes, and exploring affordable supplement options. Future research endeavours should delve deeper into these strategies to optimize the post-bariatric surgery care pathway and enhance patient outcomes.

As the field of bariatric surgery continues to evolve, the insights gleaned from these studies should guide the development of patient-centered care protocols. Ensuring that patients receive the recommended nutritional monitoring and support post-specialist care discharge is paramount. Furthermore, preventing malnutrition in this high-risk population is essential. Collaborative efforts involving bariatric units, community pharmacies, primary care providers, and patients themselves will be instrumental in achieving these goals. By addressing the issues of adherence, lost-to-follow-up, and nutritional deficiencies comprehensively, we can work toward improving the long-term health and well-being of individuals who undergo bariatric surgery.

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