



Dietary Fibre Intake and Bowel Habits After Bariatric Surgery: a Structured Literature Review

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Abstract

Background Bariatric patients regularly present with insufficient dietary fibre intake. Adequate dietary fibre is essential for gut function and laxation. This review aims to assess the effect of bariatric surgery on dietary fibre intake and bowel habits.

Methods This review was conducted using the methodology described by Kable et al. (Nurse Educ Today 8:878–886, 2012) for structured literature reviews.

Results Post-surgery, patients consume inadequate dietary fibre when compared to recommendations for healthy populations. Food intolerance to fibre-rich foods, food restriction and discomfort with eating are possible causes. Bowel habit changes are likely to be procedure-specific. Only one study has assessed both dietary fibre intake and bowel habits.

Conclusion Understanding changes in dietary fibre types and bowel habits will be useful to address future dietary interventions.

Keywords Bariatric surgery · Dietary fibre · Bowel habits · Constipation · Diarrhoea

Introduction

An important mechanism by which bariatric procedures reduce body weight is through reduction of food intake. Studies have identified suboptimal dietary intake after bariatric surgery, with less than recommended energy from carbohydrates and more than recommended energy from fats compared to comparative dietary guidelines [1–3]. Food intolerance to breads, cereals, rice, pasta, fruits and vegetables is thought to be a contributing factor to reduced carbohydrate and fibre-rich foods in this patient group [1, 4, 5].

Dietary fibre is considered to be the inedible part of the plant material that resists digestion and absorption in the small intestine, usually with complete or partial fermentation in the large intestine [6]. The National Health and Medical Research Council recommends that adults consume 25–30 g of dietary fibre per day [6].

Dietary fibre has a major role in the gastrointestinal tract. Where the particles are of sufficient size and coarseness,

insoluble fibre can have a significant laxative effect while soluble fibre can increase stool bulk by increasing biomass and fermentation by-products [7]. While disordered bowel habits have been identified in the morbidly obese population [8, 9], the effects of bariatric procedures on bowel habits has not been well defined [10, 11]. The aim of this paper is to systematically review the effect of bariatric surgery procedures on both dietary fibre intake and bowel habits. We hypothesize that bowel habits are associated with reduced fibre intake after bariatric surgery.

Methods

This review was conducted using a 12-step framework by Kable et al. [12]. The research questions were developed using the PICO format (see Table 1).

Search Strategy

To address the research question, studies were searched using the electronic databases ProQuest, Scopus, PubMed and CINAHL (Ebscohost). The search was conducted in September 2017 for the purpose of locating published research about the effect of bariatric surgery on dietary fibre intake and bowel habits.

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Table 1 Research questions developed from PICOs

What is the effect of bariatric surgery on dietary fibre intake in post-surgical obese adult patients compared to pre-surgery?
Population Obese adult individuals (BMI >30 kg/ m ² , male or female)
Intervention Bariatric surgery (RYGB, LAGB, SG)
Comparison Pre and post-surgery, any follow up time period
Outcomes Dietary fibre intake
What is the effect of bariatric surgery on bowel habits intake in post-surgical obese adult patients compared to pre-surgery?
Population Obese adult individuals (BMI >30 kg/ m ² , male or female)
Intervention Bariatric surgery (RYGB, AGB, SG)
Comparison Pre and post-surgery, any follow up time period
Outcomes Bowel habits

Limits Applied

Reference lists of articles retrieved were hand-searched to ensure no relevant studies were overlooked during the database searches. The search was limited to English language articles published during 2005–2017. When repeated searches of several databases yielded the same sources, the author was confident saturation had been achieved.

Inclusion and Exclusion Criterion

Papers were included if they were original research studies that reviewed the effect of bariatric surgery (RYGB, SG, LAGB) on dietary fibre intake and/or bowel habits in adult patients. Papers were excluded if they focused on pediatric, adolescent or pregnant patients, less than 3 months post-surgery, written in a language other than English, grey literature or alternative bariatric procedures. In addition, studies that focused on bowel habits and specific minerals or nutrients were excluded as they were previously published literature reviews and systematic reviews.

Search Terms

The search strategy was tailored using six search terms to search the article title and abstract within all data base searches. To ensure articles within the inclusion criterion were located, search terms and MeSH terms were tested prior to conducting the search in all engines.

Boolean operators were included in search terms: bariatric surgery, dietary fibre or dietary fibre, bowel habits, constipation, diarrhoea.

Search Process

The search engines were sequentially searched using search terms, and results are documented in Table 1. Articles that met the inclusion criteria were selected and are identified in Table 2 under the heading article ID. Results from the search

engines that did not identify any additional papers that met the inclusion criteria were excluded.

Retrieved Articles Assessed for Relevance

A two-step screening process was implemented to assess articles against the inclusion criteria. Step 1, titles and abstracts were scanned for their eligibility. Full text articles identified as eligible or unclear were retrieved. Step 2, full text articles were screened against the exclusion and eligibility criteria.

Summary of Included Articles

To avoid duplication in search results, articles that met the inclusion criteria were documented in a summary table (Table 3). A reference management system (Endnote) was used to enter each selected article, the search engine and search term used to locate each article. Articles found in subsequent searches were checked against articles in the summary table enabling duplicates to be excluded.

Number of Retrieved Articles

Selected database searches and removal of duplicates resulted in the retrieval of 13 papers. Grey literature was not included as part of the database search. Hand searching did not retrieve further articles that met the inclusion criteria. Figure 1 outlines the process of article retrieval and eligibility.

Review of Study Quality

Study strength was determined using the National Health and Medical Research Council (NHMRC) levels of evidence. Using a hierarchy of study design, the NHMRC levels of evidence use a graded approach (grade I (strongest) to IV (weakest), to provide a guide to the strength of evidence addressing the clinical question [13]. Each article was allocated a score based on the criterion.

Results

Most of the 13 studies retrieved were case series or cross-sectional studies looking primarily at the effect of bariatric surgery on either dietary intake (inclusive of dietary fibre) or bowel habits. The 13 articles included for review were split into two categories: dietary fibre (six articles, 46%) and bowel habits (seven articles, 54%). As one article covered both categories, it was included under bowel habits, however appraised in both sections.

Table 2 Search results: fibre and bowel habits after surgery

Search engine	Search (S) terms	No. of retrieved	No. met inclusion criteria	Table article ID
ProQuest	S1 bariatric surgery	18,613		
ProQuest	S2 dietary fibre or dietary fibre	34,912		
ProQuest	S3 bowel habits	3022		
ProQuest	S4 constipation	25,123		
ProQuest	S5 diarrhoea	121,531		
ProQuest	S6 S1 and S2	32	6	1, 2, 3, 4, 5, 6,
ProQuest	S7 S1 and S3	8	3	7
ProQuest	S8 S1 and S4	29	3	8, 9
ProQuest	S9 S1 and S8	104	1	10
Totals			10	10
Scopus	S1 bariatric surgery	10,731		
Scopus	S2 dietary fibre or dietary fibre	15,155		
Scopus	S3 bowel habits	1485		
Scopus	S4 constipation	28,322		
Scopus	S5 diarrhoea	80,315		
Scopus	S6 S1 and S2	53	1	11
Scopus	S7 S1 and S3	12	0	
Scopus	S8 S1 and S4	90	1	12
Scopus	S9 S1 and S8	172	1	13
Totals			3	
CINAHL	S1 bariatric surgery	3709		
CINAHL	S2 dietary fibre or dietary fibre	2784		
CINAHL	S3 bowel habits	205		
CINAHL	S4 constipation	4114		
CINAHL	S5 diarrhoea	9459		
CINAHL	S6 S1 and S2	3	0	
CINAHL	S7 S1 and S3	0	0	
CINAHL	S8 S1 and S4	6	0	
CINAHL	S9 S1 and S8	11	0	
Totals			0	
PubMed	S1 bariatric surgery	7436		
PubMed	S2 dietary fibre or dietary fibre	6025		
PubMed	S3 bowel habits	498		
PubMed	S4 constipation	8208		
PubMed	S5 diarrhoea	6790	0	
PubMed	S6 S1 and S2	11	0	
PubMed	S7 S1 and S3	1	0	
PubMed	S8 S1 and S4	6	0	
PubMed	S9 S1 and S8	5	0	
Totals			0	
Manual search reference list	No articles located that met inclusion criterion			

Studies were reported from 11 different countries, and encompassed Roux-en-Y gastric bypass (RYGB), laparoscopic adjustable gastric banding (LAGB) and sleeve gastrectomy, suggesting worldwide use of bariatric procedures in managing obesity.

Dietary Fibre Intake

All six studies in this category reported an association between bariatric surgery and reduced fibre intake. Of these, three reported data in patients prior to bariatric surgery [4, 10, 14] and two compared post-bariatric surgery patients with controls [4, 15]. The procedure type varied between studies, as did the timing of dietary assessment post-surgery ranging from 6 months to 5 years.

Dietary intake in each study was assessed using a validated Food Frequency Questionnaire (FFQ) or 24-h recall. Food Frequency Questionnaires categorize groups of people by their long-term intake of various nutrients for epidemiological studies while a 24-h recall is designed to estimate current nutrient intake [4]. A dietitian interview was also included in the methodology by both Johnson et al. [4] and Bavaresco et al. [14].

In two studies assessing pre-surgery fibre intake in obese adults, dietary fibre was found to be less than the recommended Adequate Intake ranging from 15.9–24.4 g/day per person [10, 14]. Similarly, fibre intake in the obese control group by Menegati et al. [15] was reported to average 24.4 g/day per person. The more rigorous study design by Johnson et al. [4], using a dietitian interview and control group, reported fibre intake at 29 g/day per person in both groups, comparable to

Table 3 Summary table of articles: dietary fibre intake and bowel habits after bariatric surgery

	Author (year) country	Study design	Sample size and sites	Comments/key findings	Quality appraisal/ include/ exclude
1	(Novais, Rasera, Leite, Marin, and De Oliveira, 2012) Brazil	Cross-sectional study assessing adequacy of food intake in women 2 years post-RYGB 24-h recall (2 days) during structured interview	141 gastric bypass women Single center	Fibre intake median 10.4 (1.6–23.3) g/day Reduced fibre due to low intake of non-starchy vegetables and fruits and contemporary dietary trends Bowel habits not assessed	IV Include
2	(McGrice and Porter, 2012) Australia	Multicenter cohort study to examine macronutrient intake in LAGB 1 year post-surgery FFQ	52 LAGB patients 3 centers	Reduced fibre intake on all participants: 14.0 (\pm 7.7) g/day Men, 14.2 (\pm 5.2) g/day Females: 13.7 (\pm 8.4) g/day Reduced CHO intake 41% of total energy (vs 45–60%) Bowel habits not assessed	IV Include
3	(Johnson et al. 2013) Norway	Prospective non-randomized clinical intervention trial comparing changes in dietary patterns 1 year post-RYGB to lifestyle intervention program FFQ interview with dietitian	139 patients RYGB (n = 76) Intervention (n = 63) Single center	Fibre intake reduced from 29 g/day pre-surgery to 22 g/day 1 year post-surgery Vegetable intake reduced 25%, potential cause of reduced fibre Bowel habits not assessed	III-2 Include
4	(Menegati et al. 2016) Brazil	Cross-sectional, case control study evaluating nutritional status, body composition and bone health of non-surgical women to post-RYGB (6–64 months post-op) Semi-quantitative FFQ	58 women RYGB (n = 25) Control (n = 33) Single center	Fibre intake 17.1 (12.4–21.9) g/day compared to the control 24.4 (19.4–29.4) g/day (P = 0.011) Low-fibre intake due to volume restriction and discomfort of eating from insufficient chewing. Bowel habits not assessed	III-3 Include
5	(Afshar et al. 2016) United Kingdom	Case series study to assess dietary intake and bowel habits before and after bariatric surgery (6.4 months) Validated Food Frequency Questionnaire (FFQ) and Bristol Stool Form Scale (BSFS)	26 patients RYGB (n = 19) SG (n = 5) Intra-gastric balloon (n = 2) Single center	Dietary fibre intake decreased from 24.4 (\pm 12.1) g/day pre-surgery to 17.5 (\pm 7.3) g/day post-surgery (p = 0.008) Frequency of bowel habits decreased from 8.6 (\pm 3.5) to 5.7 (\pm 3.5) motions/week (p = 0.001). Constipation increased 8 to 27% (p = 0.125), reduction in dietary fibre a suggested cause	IV Include
6	(Chou et al. 2017) Taiwan	Cross-sectional study investigating dietary intake and weight status after SG (5 years) FFQ and 24-h recall	40 SG patients Single center	Fibre intake 11.7 (\pm 6.5) g/day at 5 years Reasons for reduced fibre and bowel habits not assessed	IV Include
7	(Potoczna et al. 2008) Switzerland	Case series study investigating changes in bowel habits and flatulence on quality of life after bariatric surgery Specifically designed questionnaire	290 patients BPD (n = 103) RYGB (n = 126) LAGB (n = 61) Single center	40% increased constipation in LAGB (39.3% post-op vs 21.3% pre-op) due to reduced food and fibre intake RYGB—7-fold increase in number of loose stools or diarrhoea (46.1% vs 7.9% pre-surgery). Query due to acquired lactose intolerance Fibre intake not assessed	IV Include
8	(Sileri et al. 2012) Italy	Case series study evaluating faecal incontinence and constipation patterns in pre- and 6 months SG Wexner Constipation Score (WCS) and Faecal Incontinence Severity Index (FISI)	68 SG Single center	Faecal incontinence decreased, correlated to BMI reduction. WCS decreased from 3.7 (\pm 3) to 1.6 (\pm 3) post-op (p = 0.02). FISI score decreased 10 (\pm 8) to 1 (\pm 2) (p = 0.0001) Did not assess dietary fibre intake but refers to scarce fibre intake in obese population	IV Include
9	El Labban et al. (2015) Lebanon	Retrospective cross-sectional (pilot) study comparing effect of RYGB and SG surgeries on dietary intake, food preferences and GI symptoms 1 year post-surgery Food acceptability/preference/GI symptom questionnaire, FFQ, 3 \times 24-h recalls (Dietitian interview)	60 patients RYGB (n = 30) SG (n = 30) Sites: single center	Increase constipation SG (P < 0.05) Increased diarrhoea RYGB (P < 0.05) Dietary fibre not assessed; however, noted reduction in fibre-rich foods compared to RYGB	IV Include
10			193 patients	Constipation and diarrhoea defined	IV

Table 3 (continued)

Author (year) country	Study design	Sample size and sites	Comments/key findings	Quality appraisal/ include/ exclude
(Roberson, Gould and Wald, 2010) USA	Cross-sectional study evaluating effect of RYGB and LAGB on Fecal Incontinence (FI) Rome II diagnostic questions	RYGB (<i>n</i> = 160) LAGB (<i>n</i> = 33) Single center	Increased liquid stools after bariatric surgery, in particular RYGB with increased FI (48% women and 42% men had liquid FI, 21% women and 30% men had solid FI). No comment of constipation in LAGB Dietary fibre not assessed	Include
11 (Bavaresco et al. 2010) Brazil	Case series study assessing metabolic and nutritional profile of grade III obese patients 1 year post-RYGB 24-h recall with Dietitian	48 patients	Fibre intake at 1 year post-RYGB was 9.7 (\pm 7.0) g/day (<i>p</i> = 0.05) compared to preoperative 15.9 (\pm 10.7) g/day	IV Include
12 (Fysekidis et al. 2016) France	Cohort study examining effect of LAGB and SG on Functional Gastro Intestinal Disorders (FGID) compared to obese control Clinical questionnaire (Rome III criterion and Bristol Stool)	287 patients LAGB (<i>n</i> = 93) SG (<i>n</i> = 70) Control (<i>n</i> = 124) Single center	Constipation significantly increased with LAGB and SG compared to control (45.4% vs 28.2% (<i>p</i> = 0.003); no difference between surgeries Constipation likely due to reduced food intake and faecal volume, causing slower colonic transit Dietary fibre not assessed	III-2 Include
13 (Edholm et al. 2013) Sweden	Retrospective case series assessing RYGB results (11 years) Unspecified questionnaire	384 patients Single center	Diarrhoea weekly or more occurred in 22.8% of patients	IV Include

reference guidelines [6]. All three studies reported a statistically significant reduction in fibre after surgery regardless of surgery type or time since surgery.

At 1 year post-RYGB, Bavaresco et al. [14] reported an average of 9.7 g of fibre per day per person using a 24-h recall compared to Johnson et al. [4] who reported 22 g/day per person using a FFQ and dietitian interview. Using a FFQ Menegati et al. [15] and Afshar et al. [10] reported an average of 17.1 to 17.5 g of fibre per day at 6.4 months and 6 to 64 months, respectively. Novais et al. [5] reported an average intake of 10.4 g/day per person at 2 year post-RYGB. Both Menegati et al. [15] and Novais et al. [5] limited their studies to women only, potentially creating study bias.

The study by McGrice and Porter [3] was the only study to report on dietary fibre intake after LAGB. This study noted a small difference between males (14.2 g/day) and females (13.7 g/day) at 1 year post-surgery, which no other study compared. Inconsistency in data was identified in the two studies reporting dietary fibre intake after sleeve gastrectomy [10, 15]. Afshar et al. [10] averaged 17.5 g/day per person at 6 months post-surgery and had a small sample size of *n* = 5. Chou et al. [16] reported an average fibre intake of 11.7 g/day per person at 5 years post-sleeve gastrectomy, which is likely to be more reflective of long-term dietary patterns [15].

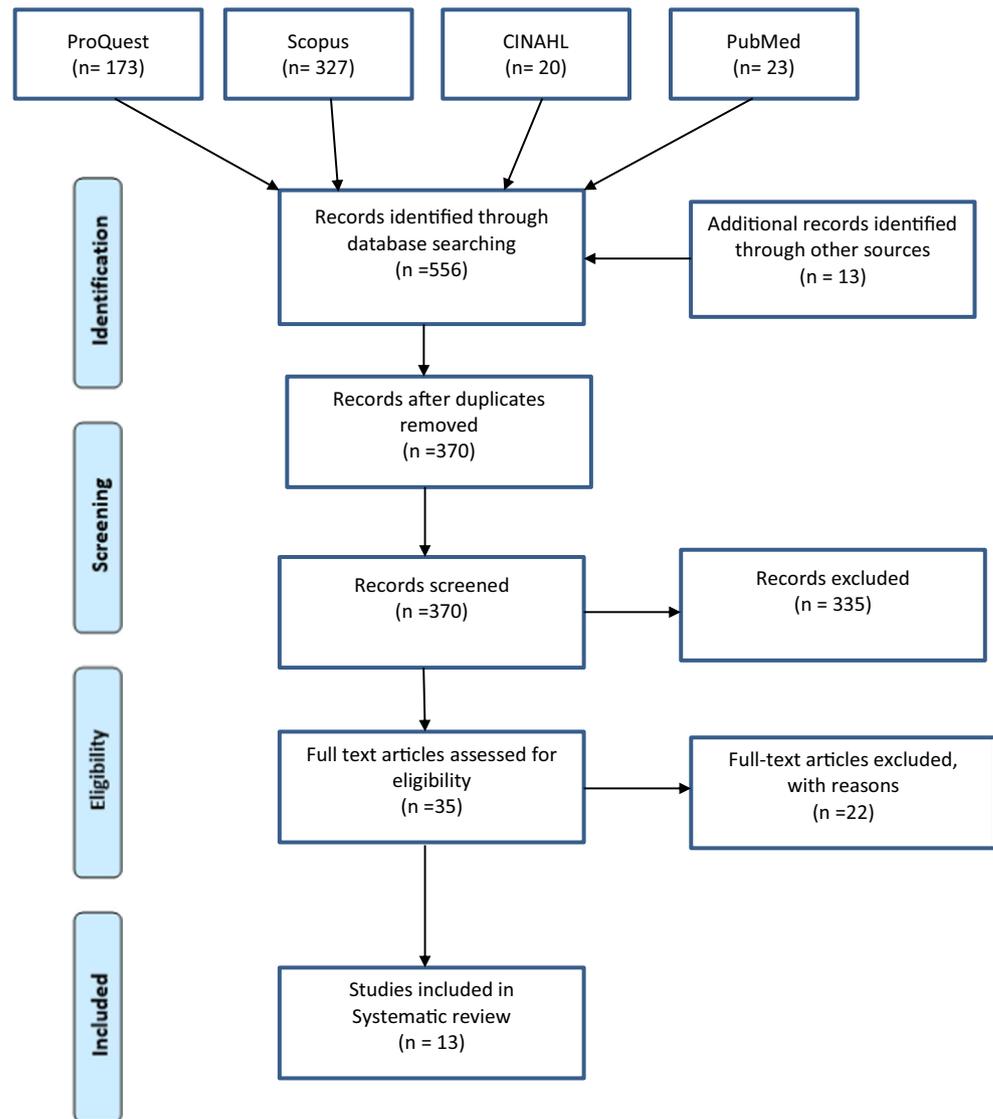
Bowel Habits After Surgery

Seven studies investigated the link between bariatric surgery and bowel habits. Constipation occurrence prior to surgery

was reported by Afshar et al. [10] as 8% and Potoczna et al. [11] as 21.3%. Potoczna et al. [11] was the only study to report on diarrhoea occurrence pre-surgery at 7.9%. Following surgery, diarrhoea was the most commonly reported change in bowel habits after RYGB, with three studies reporting 22.8 to 40% prevalence between 1 and 2 years post-surgery [1, 9, 11]. A fourth study by Edholm et al. [17] reported diarrhoea, occurring weekly or more in 22.8% of patients at 11 years post-RYGB. In contrast, Afshar et al. [10] reported a statistically significant reduction in bowel motions from 8.6 to 5.7 motions per week (*p* = 0.125) and an increase in constipation from 8 to 27% at 6 months post-RYGB. Each study used different instruments and methodology to evaluate bowel habit and did not include a control. Both Afshar et al. [10] and Potoczna et al. [11] compared bowel habit changes to pre-surgery patterns while El Labban et al. [1] and Edholm et al. [17] were limited by retrospective methodology [10, 11]. The use of validated questionnaires and definitions of both diarrhoea and constipation were strengths in the studies by both Roberson et al. [9] and Afshar et al. [10]; however, Roberson et al. [9] excluded males, thus creating study bias.

In a better designed study by Fysekidis et al. [18] using a control group, the rates of constipation reached statistical significance after both sleeve gastrectomy (8.9 months) and LAGB (15 months). Similarly, constipation 1 year post-sleeve gastrectomy reached statistical significance in the study by El Labban et al. [1]; however, the results were not supported by Sileri et al. [19] who reported a statistically significant reduction in Wexner Constipation Scores (*p* = 0.02). A 40% increase in

Fig. 1 PRISMA flow diagram of article retrieval



constipation at 5.7 years post-LAGB was reported by Potoczna et al. [11]; however, despite including LAGB in their study, Roberson et al. [9] did not report on constipation outcomes.

Discussion

Previous studies have identified suboptimal dietary intake after bariatric surgery, with less than recommended energy from carbohydrates and more than recommended energy from fats compared to comparative dietary guidelines [1–3]. A validated Food Frequency Questionnaire (FFQ) or 24-h recall were used within the reviewed studies to assess dietary intake. While different instruments were used to measure dietary intake, all studies found a reduction in dietary fibre intake following surgery despite surgery type or time from surgery. While each method has its strengths and weaknesses, the Food Frequency

Questionnaire has been shown to capture more realistic energy intake and distribution in obese individuals when compared to 24-h dietary recalls [20]. Dietary assessment methods based on recall are however susceptible to reporting bias due to both inaccurate recall and social desirability [18]. Of importance is the phenomenon of low energy reporting in any dietary assessment tool, particularly amongst obese subjects [4].

Based on the available data, bariatric surgery reduces dietary fibre intake regardless of surgery type or time from surgery. In the limited number of studies presented, dietary fibre intake was suboptimal compared to reference guidelines ranging from as low as 9.7 to 22 g/day per person. Fibre intake during the first year is expected to be lower than Adequate Intake, since this is the period that involves mechanical, and consequently dietary adaptations and reduction in total dietary intake. The adaptation process should however be complete 2 years after bariatric surgery with a stable habitual food

intake [5]. Studies after 2 years reported fibre intakes ranging from 10.4 to 11.7 g/day per person, remaining significantly lower than Adequate Intakes [5, 16].

Present dietary recommendations emphasize food groups rather than nutrients as food-based guidelines are thought to be easier for the general population to implement [4]. These guidelines emphasize a high intake of fruits, vegetables and whole grains and a limited intake of processed and energy-dense foods. Food intolerance to breads, cereals, rice, pasta, fruits and vegetables has been reported and suggested as potential contributing factors to reduced carbohydrate and fibre-rich foods after bariatric surgery [1, 4, 5]. Additionally, the restrictive part of the surgery reduces overall food intake [18]. Bariatric guidelines while recommending the inclusion of at least five daily serves of fresh fruit and vegetables provide no guidance in relation to Adequate Intakes of fibre in this patient cohort [21]. As reference values for dietary fibre intake are based on quantitative estimates of nutrient intake, they should be used with caution when estimating the nutritional needs of bariatric surgery patients [5].

Despite heterogeneity in study design and consistent findings of reduced dietary fibre, no studies reported contribution of food sources to fibre intake, types of fibre or use of fibre supplementation.

The effect of bariatric surgery on bowel habits is not well defined and appears to be procedure-specific. Overall, the number of studies available is limited using a range of validated and non-validated instruments and only two studies defined constipation or diarrhoea [9, 10]. Time from surgery to assess bowel habits ranged from 6 months to 11 years post-surgery; however, Potoczna et al. [11] concluded no significant adaptation occurring over time. No studies reported on physical activity or fluid intake in assessing changes to bowel habits following bariatric surgery.

Most of the studies reviewing the effect of RYGB on bowel habits report worsening diarrhoea potentially due to malabsorption or acquired lactose intolerance conversely increased constipation as reported by Afshar et al. [10]. In this study, a shorter limb of 124 cm was created compared to 250 cm by Potoczna et al. [11], resulting in reduced malabsorption. Differences in surgical techniques make the studies difficult to compare and could be a potential cause for the conflicting results.

Restrictive bariatric procedures such the LAGB and sleeve gastrectomy appear to worsen constipation; however, studies in these areas are limited and results for the sleeve gastrectomy are conflicting. Fibre is associated with accelerating gut transit; therefore, reduced fibre intake could be a cause of slower gut transit time after these surgeries. Mechanisms of altered bowel habits and cause have not been extensively studied.

Conclusion

In conclusion, the number of available studies on both dietary fibre intake and bowel habits are limited after bariatric procedures and most have focused on the RYGB. Diarrhoea is a common outcome experienced by this malabsorptive procedure. Increased risk of constipation is more likely to occur in the LAGB. In recent times, the sleeve gastrectomy has become more common yet studies related to dietary fibre intake and bowel habits are few [22]. Of the studies available, data suggests increased occurrence of constipation however is inconsistent.

Future prospective research after sleeve gastrectomy using validated instruments are required to gain a good understanding of dietary fibre intake, inclusive of fibre types and contributing food sources, to address potential adverse effects on bowel habits. In addition, further studies should take into account other variables impacting bowel habits inclusive of physical activity and hydration status. As dietary changes are limited in the first year after surgery from mechanical and dietary adaptations, further studies should be focused on habitual food intake, 1 year or more post-sleeve gastrectomy, to guide dietary interventions and their effect on bowel habits.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethics and Consent Statement All authors contributed to the paper conception, design, data collection, or data interpretation and/or analysis. All authors participated in the writing or critical review of the article and have approved the manuscript being submitted. This article is the original work of the submitting authors and is not considered for publication or been published elsewhere and does not breach any copyright to any other work.

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