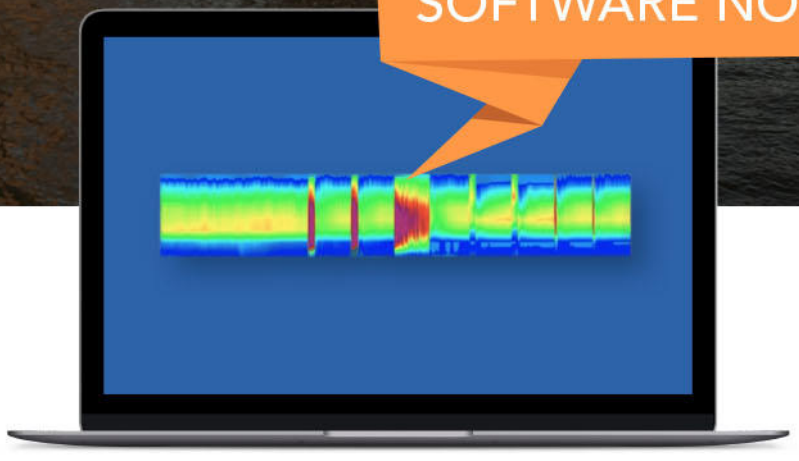
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ORIGINAL ARTICLE

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Implementation of the low FODMAP diet in functional gastrointestinal symptoms: A real-world experience

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Abstract

Background: The low FODMAP (fermentable oligo-, di-, monosaccharides, and polyols) diet reduces functional gastrointestinal symptoms (FGID) when implemented by dietitian-delivered education in clinical trials, but it is unknown how well the diet is followed in routine clinical care and if differences exist when implemented by physician or dietitian. This study aimed to evaluate the real-world experience of patients recommended the diet.

Methods: This case-series interviewed FGID patients attending a gastroenterology clinic with previous recommendation to trial the low FODMAP diet, examining who recommended the diet and what their percentage improvement was. To evaluate implementation of the diet's 3 phases, questions were constructed based on current literature and clinical guidelines regarding length of initial restriction and food knowledge (Phase-1), number of foods re-challenged (Phase-2) and food re-introduction as tolerated (Phase-3). The comprehensive nutrition assessment questionnaire provided daily FODMAP intake. Data were analyzed using chi-squared tests.

Key Results: In 80 patients (21 male), the diet was recommended by the gastroenterologist in 53%, general practitioner 22%, dietitian 9% and other 15%. 30% saw a dietitian for guidance. 55% reported a ≥50% symptom improvement. The diet was followed appropriately during Phase-1 by 78% (with vs without a dietitian, 96% vs 71%; $P = .02$), Phase-2 by 48% (70% vs 39%; $P = .02$) and Phase-3 by 40% (65% vs 29%; $P < .01$). A FODMAP intake of <12 g/d (considered therapeutic) was achieved by 44% (72% vs 31%; $P < .01$).

Conclusions & inferences: Symptom improvement was reported in half of patients, but many did not reach the therapeutic FODMAP intake target, especially without dietitian education. Compliance was poor in Phase-2 and Phase-3 but improved with dietitian guidance.

KEYWORDS

carbohydrates, dietary therapy, FODMAPs, functional bowel disorders

Abbreviations: CNAQ, Comprehensive nutrition assessment questionnaire; FGID, Functional gastrointestinal disorder; FODMAP, Fermentable oligo-, di-, monosaccharides, and polyols; IBD, Inflammatory bowel disease; IBS, Irritable bowel syndrome; IBS-SSS, IBS severity scoring system; QOL, Quality of life; RDA, Recommended dietary allowance.

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1 | INTRODUCTION

Gastrointestinal conditions including irritable bowel syndrome (IBS) and inflammatory bowel diseases (IBD) contribute to worsening of quality of life (QOL) and cause significant economic burden.[1] While symptoms of abdominal pain and bloating are hallmark features of IBS,[2] they also occur in 35%-45% of patients with IBD in remission.[3] Guidelines recommend dietary modification as primary and secondary therapies for symptom management,[4,5] with both clinicians and patients favoring diet above other treatment modalities.[6] The low FODMAP (fermentable, oligo-, di-, monosaccharides, and polyols) diet is supported by high-quality evidence with meta-analyses recommending its use in both IBS[7,8] and IBD.[9] The diet is a 3-phase diet, with an initial 2-6 week restriction (Phase 1), followed by re-challenges to assess individual tolerance (Phase 2) and long-term individualized maintenance phase (Phase 3).[10]

Although evidence for efficacy exists for the low FODMAP diet, success has largely been shown using provided meals or dietitian-delivered education. Studies using dietitian-taught therapies have provided 10-60 minutes education often with dietitian contact pre- and postintervention and/or weekly phone contact.[11-13] The provision of personalized dietary counseling by an expert dietitian is believed to be positively associated with compliance and success of the diet,[10,14,15] as well as providing key support for patients to undertake and interpret re-challenges to ensure nutritional adequacy.[16] Concern has been raised for the use of non-dietitian led dietary implementation due to potential risks such as reduced nutritional adequacy and lack of long-term management.[17] Two studies have investigated nurse-led low FODMAP dietary intervention, with improved symptom response seen in one study[18] but not the other.[19] It is thought that non-personalized diet sheets, books or online information is insufficient and often out-of-date due to the rapidly evolving nature of the diet.[14,15] Additionally, evaluation of three low FODMAP food lists showed discordance, with a >50% lack of overlap,[20] and the FODMAP content of packaged foods was unable to be readily deciphered by food labeling.[21]

Despite evidence for dietitian-delivered therapy, in reality many patients undertake the diet with minimal supervision, either after the diet is recommended by the physician with the use of non-personalized diet sheets or the patient self-implements the diet. Little is known about how patients implement the diet outside of clinical trials. A small study of eight patients receiving written advice from their doctor reported patients found diet sheets overly simplistic with lack of personalization resulting in reduced utility.[22] In a survey of USA gastroenterologists, 75% reported that they recommend diet therapies to at least half of their IBS patients, with the low FODMAP diet recommended most frequently.[6] Educational handouts were used by 81%, while only 21% reported that they usually refer their patients to a dietitian.[6] Lack of access to knowledgeable dietitians and poor understanding of their role in implementing therapy may be factors influencing referral to dietitians. The aim of this study was to evaluate the real-world experience of patients who attended a gastroenterology clinic who had either been recommended a low FODMAP diet by a healthcare professional or reported self-implementation of the diet. We hypothesize that those who see a dietitian for guidance are able to more appropriately follow the 3 phases of the diet.

Key Points

- The low FODMAP diet is efficacious in reducing functional gastrointestinal symptoms when implemented by dietitian-delivered education in clinical trials, but it is unknown how well the diet is followed in routine clinical care.
- Half of patients report a symptom improvement but compliance is poor in Phase-2 (re-challenge) and Phase-3 (long-term) but improved with dietitian guidance.
- This real-world experience informs clinical practice, encouraging referral to a dietitian for implementation of dietary therapies, particularly the low FODMAP diet.

2 | MATERIALS AND METHODS

2.1 | Study design

This study was a case-series of patient experiences after recommendation and/or use of the low FODMAP diet. A chart review was conducted of patient files of those attending gastroenterology clinic appointments from January to October 2018 at Hotel Dieu Hospital in Kingston, Ontario, Canada, to identify eligible patients. Referrals to the clinic primarily were received from general practitioners. Eligible patients were not limited to specific gastrointestinal conditions but must have either had either a previous recommendation to trial the low FODMAP diet (by their gastroenterologist, general practitioner, other healthcare professional, or elsewhere eg, family or friend) or self-reported use of the diet for management of functional symptoms. Patients with organic diseases such as celiac disease or inflammatory bowel disease were eligible, and the presence of functional symptoms was determined by the treating gastroenterologist during their clinical assessment. Ineligible patients were those who had not been recommended the low FODMAP diet, or those who had not previously tried the diet, or those who did not know what a low FODMAP diet was when approached by the research staff. Patients deemed eligible were approached by research staff either at (in-person) or after their clinic appointment (via phone) and informed consent obtained. Ethics approval was received from the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (approval number #6022294).

2.2 | Evaluation of patient experience

Participants were interviewed for 20-30 minutes by the research dietitian either at their clinic appointment, within a research clinic

room with a small number of interviews conducted over the phone. All interviews were conducted by the same person (Caroline Tuck, postdoctoral Research Fellow, PhD dietitian with expertise in gastroenterology nutrition). Interviews were conducted alone, or in the presence of a family member with the participants' permission. The full set of interview questions is available in the Table S1. Patients were aware that the study aimed to understand patient experiences following recommendation of the low FODMAP diet. Briefly, participants were questioned regarding who recommended the diet; how long ago the recommendation was made; if they saw a dietitian; what other therapies they have used in the past; their key symptoms at the time of dietary recommendation and at the time of interview; how strictly they followed the diet after it was recommended; how long they followed the diet for; what their dietary adherence was at the time of the interview; if they could list examples of low and high FODMAP foods; if they were told to re-challenge FODMAPs; and how many foods they re-challenged. An additional 10-item questionnaire using a 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree) was developed to evaluate participants perceptions about the education provided on the low FODMAP diet, their understanding of the long-term use of the diet, and whether they felt the diet had improved their health.

2.3 | Evaluation of patient implementation of the diet

Implementation of each phase was recorded as appropriate or not, depending on the following unvalidated criteria:

1. Phase 1, FODMAP restriction: patients had to (a) demonstrate a good food knowledge (ie, be able to provide at least 3 correct examples of low and high FODMAP foods on questions 15 and 16 of Table S1, with 100% correct foods listed), and (b) have tried the diet for at least 2 weeks, and (c) report to have used the diet at least 50% of the time.
2. Phase 2, the re-challenge phase: patients must have re-challenged at least 2 foods. If they re-challenged by meals (containing multiple high FODMAP foods) rather than specific foods then this was determined to be not appropriate. Re-challenge was evaluated using questions 17 and 18 shown in Table S1 and asked patients if they re-challenged, and if so, to provide details on what foods or FODMAP subgroups they re-challenged, if they tolerated the foods and if they re-introduced them back into the diet.
3. Phase 3, the long-term maintenance phase: patients needed to be able to report re-introduction of foods as tolerated.

For Phases 2 and 3, patients were excluded if they were recently recommended the diet and hence not yet up to the next phase, or they did not appropriately undertake the previous phase. Additionally, if no symptom improvement was noted at Phase 1 and hence the patient returned to their usual diet as would be appropriate clinical practice, then they were excluded from Phase 2 and Phase 3.

2.4 | Gastrointestinal symptoms

During the interview, to mimic that of clinical questioning, participants were asked to rate how much better they felt their symptoms were when using the low FODMAP diet giving a number out of 100 (ie, a percentage), with 0 being no change in symptoms and 100 being complete symptom resolution. If the individual was no longer following the diet, patients were asked to answer this retrospectively, that is when they tried the diet, what was their symptom improvement. Patients were also asked to provide a number out of 100 as to any worsening of symptoms when using the low FODMAP diet. In addition, the IBS severity scoring system (IBS-SSS) was conducted evaluating their symptoms over the past 10 days as previously described.[23]

2.5 | Dietary intake

The Monash University Comprehensive Nutrition Assessment Questionnaire (CNAQ) was used to evaluate dietary intake. This 297-item semi-quantitative food frequency questionnaire is a validated tool assessing dietary intake of a wide range of nutrients including energy, macronutrient, fiber, and FODMAP content.[24] A daily total FODMAP intake of 12 g was used as a therapeutic target based on levels achieved in previous clinical studies,[11,25] but this cutoff has not been validated. No target for individual FODMAP subgroups was set. As not all patients were following the diet at the time of assessment, CNAQ data were assessed as a combined group; as those recommended the diet within the past 6 months; and those reporting current use of the diet at least 50% of the time.

2.6 | Food-related quality of life and dietary acceptability

Dietary acceptability and food-related QOL were evaluated using two questionnaires adapted from O'Keefe et al[26] and Grunert et al.[27] Both questionnaires used a 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree) with disagree and strongly disagreed grouped in the results, as well as agree and strongly agree. The 13-item dietary acceptability questionnaire examined the effect of diet on eating environment, cost and ease of shopping and cooking, and travel. A seven-item questionnaire was used to evaluate food-related QOL.

2.7 | Statistical analysis

Data were analyzed using IBM SPSS Statistics version 23 (SPSS Inc) and GraphPad Prism version 7.02 (Graph Pad Software). A formal power calculation was not conducted. Categorical data were analyzed using the Pearson chi-squared test or the Fisher's exact test as appropriate. Unpaired *t* tests or Mann-Whitney *U* tests were performed to compare between groups as appropriate. A P value ≤ .05 was used to determine significance.

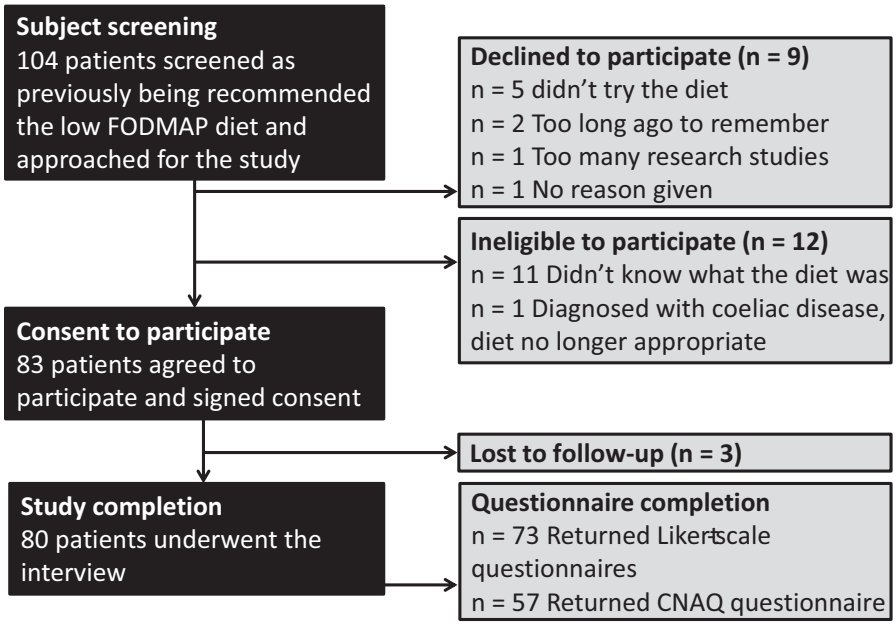


FIGURE 1 Patient recruitment flowchart

3 | RESULTS

The recruitment flowchart is displayed in Figure 1. Of the 104 patients screened to have been recommended the low FODMAP diet at prior visits to the gastroenterology clinic, 80 patients agreed to participate. The baseline demographics are displayed in Table 1. The most common diagnosis was IBS, and the subject group was female predominant. The diet was recommended by the gastroenterologist in 53%, general practitioner in 22%, dietitian in 9%, and other in 15%. From the 104 patients screened to be eligible, 21 (20%) patients either never tried the diet or did not know what the diet was when approached about the study, providing an 80% uptake of the low FODMAP diet therapy in this cohort.

Of the 80 patients who enrolled, information provided was most often an education handout in written form (n = 58 (73%)). Additionally, 23 (29%) reported they were offered a referral to a dietitian, others were provided a website (n = 15 (19%)), or in some cases patients reported being told verbally that the low FODMAP diet may assist without any additional information provided (n = 5 (6%)). Following the dietary recommendation, 67 (84%) sought further information from the internet, 16 (20%) asked their general practitioner for more information and 18 (23%) used a smartphone application. Twenty-four patients (30%) saw a dietitian for low FODMAP dietary guidance for a mean of 2.5 ± 1.4 visits (29% had 1 visit, 21% had 2 visits, 33% had 3 visits, 17% had 5 visits). When asked if dietary therapy was their preferred form of treatment, 59 (74%) said 'yes', 15 patients (19%) said 'no', and 6 patients (8%) were 'unsure'.

3.1 | Dietary intake

At the time of interview, total FODMAP intake was highly variable across all patients, with 25/57 (44%) achieving a FODMAP intake of 12 g or less, a level considered to be therapeutic (72% who saw a dietitian vs 31% who did not; $P < .01$, Pearson chi-squared test). When analyzing those who were recently recommended the diet (within the past 6 months), the significance between those who did and did not see a dietitian was maintained ($P = .04$). When analyzing those who reported they were currently using the diet at least 50% of the time, 79% who saw a dietitian achieved the ≤12 g therapeutic target, compared to 39% who did not see a dietitian (n = 37, $P = .02$, Figure 2), and total FODMAP intake was lower in those who saw a dietitian compared to those who did not (n = 35, $P = .04$, Mann-Whitney U test).

Assessing intake by each FODMAP subgroup, those who saw a dietitian had a statistically lower intake of polyols compared to those who did not ($P = .04$, Mann-Whitney U test, Table 2) and there was a trend toward lower excess fructose intake ($P = .08$). None of the other FODMAP subgroups, macronutrients, or micronutrients of interest were statistically different between those who did and did not see a dietitian (Table 2). No differences in micronutrient intake were noted when analyzing those who were recently recommended the diet compared to those who had previously been recommended the diet. There was no correlation between FODMAP intake and reported symptom change.

3.2 | Adherence to the 3 phases of the low FODMAP diet

The diet was followed appropriately during Phase 1 by 63/80 (78%, Figure 3), but this was reduced by 30% for Phase 2 and by a further 8% for Phase 3, resulting in only 40% who appropriately followed all 3 phases of the diet. Those who saw a dietitian were more likely to follow each of the 3 phases appropriately (odds ratio Phase 1:9.2 (95% CI 1.5-100.7; Phase 2:3.6 (1.1-11.5); Phase 3:4.6 (1.6-13.6); $P < .05$), Pearson chi-squared test, Figure 3). Forty-five (56%) patients followed Phase 1 of the diet for an appropriate length of time (2-12 weeks). However, six patients (8%) who did not see a dietitian

TABLE 1 Participant characteristics

	Total	Saw a dietitian	Did not see a dietitian
n (%)	80 (100%)	24 (30%)	56 (70%)
Sex (m:f)	21:59	4:20	17:39
Age, y (median (range))	48 (18-81)	48 (20-72)	48 (18-81)
BMI (median (range))	27 (18-47)	25 (18-43)	27 (18-47)
Diagnosis			
IBS	58 (73)	21 (88)	37 (66)
Functional bloating	3 (4)	0 (0)	3 (5)
Functional diarrhea	2 (3)	1 (4)	1 (2)
Ulcerative colitis	1 (1)	0 (0)	1 (2)
Crohn's	9 (11)	1 (4)	8 (14)
IBD unspecified	1 (1)	0 (0)	1 (2)
Celiac	1 (1)	1 (4)	0 (0)
Other	5 (6)	0 (0)	5 (9)
Who recommended the diet			
Gastroenterologist	43 (54)	10 (42)	33 (59)
General practitioner	18 (23)	6 (25)	12 (21)
Dietitian	7 (9)	7 (29)	0 (0)
Nurse	3 (4)	0 (0)	3 (5)
Family or friend	2 (3)	1 (4)	1 (2)
Self	4 (5)	0 (0)	4 (7)
Other	3 (4)	0 (0)	3 (5)
Length of time since diet recommendation			
<6 mo	27 (34)	10 (42)	17 (30)
>6 mo	53 (66)	14 (58)	39 (70)
Number of months (median (range))	10 (1-60)	10 (1-48)	10 (2-60)
Diet stage at time of interview			
Phase 1 (following for <6 mo)	5 (6)	2 (8)	3 (5)
Phase 1 (following for >6 mo)	18 (23)	3 (13)	15 (27)
Phase 2	5 (6)	2 (8)	3 (5)
Phase 3	22 (28)	10 (42)	12 (21)
Returned to habitual diet as no symptom improvement	20 (25)	4 (17)	16 (29)
No longer following the diet	10 (13)	3 (13)	7 (13)
Presence of gastrointestinal symptoms[a]			
Abdominal pain	72 (90)	22 (92)	50 (89)
Bloating	53 (66)	17 (71)	36 (64)
Diarrhea	53 (66)	18 (75)	35 (63)
Constipation	30 (38)	10 (42)	20 (36)
Gas	32 (40)	13 (54)	19 (34)
Nausea	8 (10)	2 (8)	6 (11)
Heartburn	4 (5)	1 (4)	3 (5)

(Continues)

TABLE 1 (Continued)

	Total	Saw a dietitian	Did not see a dietitian
Reflux	10 (13)	2 (8)	8 (14)
Presence of non-gastrointestinal symptoms			
Tiredness	12 (15)	4 (17)	8 (14)
Headaches	24 (30)	11 (46)	13 (23)
Migraines	8 (10)	0 (0)	8 (14)
Asthma	4 (5)	1 (4)	3 (5)
Eczema	7 (9)	1 (4)	6 (11)
Urticaria	9 (11)	4 (17)	5 (9)
Rhinitis	11 (14)	5 (21)	6 (11)

Note: Data displayed as n (%) unless otherwise indicated.
[a]Percentage of patients reporting presence of each symptom at the time of low FODMAP diet recommendation.

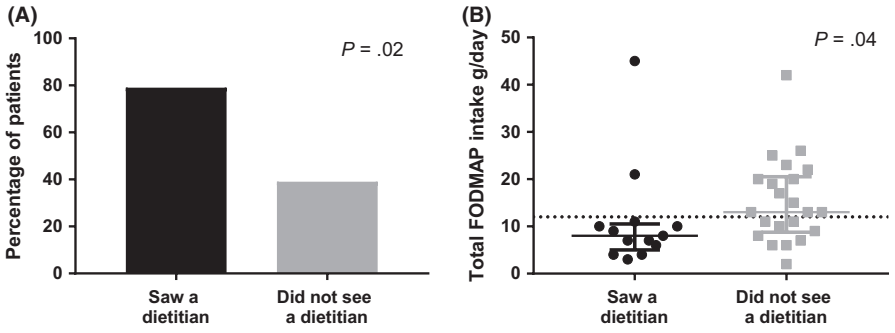


FIGURE 2 Total daily FODMAP intake according to the comprehensive nutrition assessment questionnaire of those patients who reported current use of the diet ≥50% of the time. A, Seventy-nine percent of patients who saw a dietitian met the therapeutic target of ≤12 g total FODMAP intake per day, compared to 39% who did not see a dietitian (n = 37, *P* = .02, Pearson chi-squared test). B, There was a lower total FODMAP intake in those who saw a dietitian compared to those who did not (n = 35, *P* = .04, Mann-Whitney *U* test, one outlier in each group was excluded due to values >2SD from mean)

followed the diet for <2 weeks, and 29 (36%, 8 that did see a dietitian and 21 that did not see a dietitian) patients followed the diet for longer than is recommended (>3 months). Thirty-five (44%) patients reported being told to re-challenge their tolerance to high FODMAP foods, 14 (18%) by their dietitian, 14 (18%) by their gastroenterologist, 2 (3%) by their general practitioner, and 5 (6%) found out through their own reading.

Overall, 37 patients (51%) agreed that the low FODMAP diet had improved their health (Table 3). Patients who saw a dietitian were more likely to agree to the statements 'I understood the dietary instructions provided' (*P* = .04) and 'I felt I had sufficient knowledge to follow the dietary recommendations' (*P* = .03) than those who did not see a dietitian, although significance was lost after adjustment for multiple comparisons using false discovery rate.

3.3 | Patient-reported effect on symptoms

Overall, 31% of patients reported a <25% improvement in their symptoms i.e. did not respond to the diet (17% who saw a dietitian vs 38% who did not see a dietitian). Those who reported that diet was their preferred form of treatment were more likely to report symptom improvement (*P* = .05, Mann-Whitney *U* test Figure 4). Fifty-five percent of patients reported the diet provided a ≥50% improvement in their symptoms. However, performing an intention-to-treat analysis (including those patients who did not agree to participate due to not trying the diet after recommendation or due to not knowing what the diet was after recommendation) reduced the response rate to 46% (52/96).

The reported percentage improvement was not statistically different between those who did and did not see a dietitian (median (IQR), 50 (26-80) vs 45 (1-77), *P* = .20, Mann-Whitney *U* Test). Comparing those who had functional gastrointestinal symptoms only vs those who had organic disease (IBD or celiac disease) with functional symptoms, there was no difference in reported percent symptom improvement (functional symptoms only 50 (15-80) vs organic disease with functional symptoms 69 (5-80), *P* = .51). When comparing reported symptom improvement by phase of the diet the patient was in at the time of the study (Table 1), there were no differences with the exception of those patients who were no longer on the diet due to lack of symptom improvement who reported less percent symptom improvement (0 (0-13)) compared to those in Phase 1 (following for >6 months, 65 (40-80), *P* < .01), Phase 2

TABLE 2 Daily nutrient intake according to comprehensive nutrition assessment questionnaire (median ± IQR)

	Total (n = 57)	Saw a dietitian (n = 18)	Did not see a dietitian (n = 39)	$P^{\dagger}$
Energy (kcal)	7725 (5887-10024)	7674 (6041-11707)	7787 (5849-9718)	.84
Carbohydrates	187 (149-297)	186 (143-334)	187 (151-277)	.90
Sugars	98 (65-145)	97 (56-151)	98 (68-137)	.79
Starch	93 (64-131)	94 (59-164)	90 (67-118)	.45
Protein	82 (63-113)	104 (51-125)	81 (65-101)	.60
Fat	78 (55-97)	78 (57-102)	78 (54-96)	.64
Fiber	27 (21-37)	27 (18-35)	27 (22-37)	.71
Resistant starch	4 (2-5)	4 (2-5)	4 (2-5)	.62
Total FODMAP	13.8 (8.2-25)	9 (6-24)	19 (11-25)	.04*
Excess fructose	2 (1-5)	2 (1-3)	3 (1-6)	.08
Polyols	2 (1-4)	2 (1-2)	3 (1-5)	.04*
Lactose	3 (1-12)	2 (0-14)	3 (1-12)	.54
Fructans	3 (2-4)	2 (2-3)	3 (2-4)	.52
GOS	1 (1-1)	1 (1-1)	1 (1-1)	.80
Micronutrients of interest				
Calcium (mg)	893 (652-1194)	884 (461-1428)	893 (695-1049)	.89
Folate (mg)	298 (242-408)	322 (225-439)	295 (242-389)	.97
Iron (mg)	11 (9-16)	13 (8-17)	11 (9-16)	.83
Niacin (mg)	20 (15-26)	22 (15-27)	19 (14-25)	.65
Riboflavin (mg)	2 (1-3)	2 (1-3)	2 (2-2)	.46
Thiamin (mg)	1 (1-2)	1 (1-2)	1 (1-2)	.67
Zinc (mg)	12 (9-15)	13 (8-16)	11 (9-14)	.98

Note: Values expressed as grams per day unless otherwise stated. FODMAP denotes fermentable oligo-, di-, monosaccharides, and polyols. GOS denotes galacto-oligosaccharides.

†Statistical analysis conducted between those who did and did not see a dietitian using Mann-Whitney *U* Tests.

*Denotes statistical significance between those who saw a dietitian vs those who did not see a dietitian.

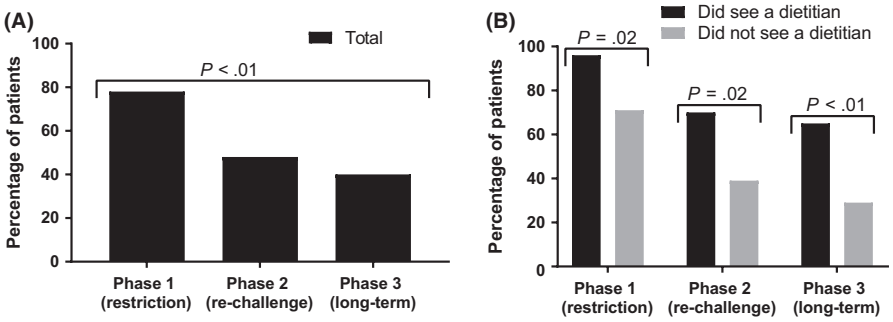


FIGURE 3 Percentage of patients appropriately following the 3 phases of the low FODMAP diet. A, While most patients were able to follow Phase 1 of the diet appropriately, significantly less followed Phase 2 and Phase 3 appropriately ($P < .01$, Pearson chi-squared test). B, Patients who saw a dietitian were more likely to follow each of the 3 phases of the low FODMAP diet appropriately ($P < .05$)

(80 (64-85), $P < .01$), and Phase 3 (75 (60-91), $P < .01$). Sixty-two percent reported they continued the diet to some extent (ie, for ≥3 months or re-introduced to tolerance) suggesting perceived symptom improvement. According to the IBS-SSS, at the time of the study there was no significant difference between those who saw a dietitian vs those who did not (mean ± SD, 275 ± 90 vs 231 ± 117, $P = .11$, unpaired *t* test).

3.4 | Reported use of other dietary and non-dietary therapies

The vast majority of patients (92%) reported using other forms of therapy other than diet for management of their symptoms (Figure 5). Fifty-two percent (42/80) reported simultaneous use of other dietary manipulations during their trial of the low FODMAP

TABLE 3 Diet perception, food-related quality of life, and dietary acceptability questionnaires (n = 73)

	Total, n (%)			Saw a dietitian, n (%)			Did not see a dietitian, n (%)			
	Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree	P†
Diet perception questionnaire										
1. I understood the dietary instructions provided	7 (10)	8 (11)	58 (79)	0 (0)	0 (0)	23 (100)	7 (14)	8 (16)	35 (70)	.04*
2. I felt confused about the dietary recommendations	19 (26)	12 (16)	42 (58)	3 (13)	6 (26)	14 (61)	16 (32)	6 (12)	28 (56)	.24
3. I feel I had sufficient knowledge to follow the dietary recommendations	24 (33)	9 (12)	40 (55)	2 (9)	3 (13)	18 (78)	22 (44)	6 (12)	22 (44)	.03*
4. I have remained on the low FODMAP diet strictly	13 (18)	15 (21)	45 (62)	4 (17)	4 (17)	15 (65)	9 (18)	11 (22)	30 (60)	.68
5. I was taught to re-challenge foods to test my tolerance	34 (47)	8 (11)	31 (42)	6 (26)	2 (9)	15 (65)	28 (56)	6 (12)	16 (32)	.09
6. I understood how to use the diet in the long term	26 (36)	14 (19)	33 (45)	9 (39)	3 (13)	11 (48)	17 (34)	11 (22)	38 (76)	.88
7. I understand what the term FODMAP means and why they are relevant to my symptoms	8 (11)	10 (14)	55 (75)	1 (4)	3 (13)	19 (83)	7 (14)	7 (14)	36 (72)	.75
8. I wish I had been given more instruction on how to follow the diet	36 (49)	12 (16)	25 (34)	10 (43)	4 (17)	9 (39)	26 (52)	8 (16)	16 (32)	.26
9. Dietary treatment was my preferred treatment option	12 (16)	10 (14)	51 (70)	3 (13)	4 (17)	16 (70)	9 (18)	6 (12)	35 (70)	.77
10. The low FODMAP diet has improved my health	20 (27)	16 (22)	37 (51)	6 (26)	5 (22)	12 (52)	14 (28)	11 (22)	25 (50)	.88
Food-related quality of life										
1. Food and meals are positive elements of my life	15 (21)	10 (14)	48 (66)	7 (30)	3 (13)	13 (57)	7 (14)	7 (14)	35 (70)	.62
2. When I think of my next meal, I only see problems, obstacles and disappointments	22 (31)	17 (23)	34 (47)	7 (30)	7 (30)	9 (39)	10 (20)	10 (20)	25 (50)	.88
3. I am generally pleased with my food	15 (21)	17 (23)	41 (56)	6 (26)	6 (26)	11 (48)	7 (14)	11 (22)	30 (60)	.52
4. Food and meals give me satisfaction in my daily life	16 (22)	13 (18)	44 (60)	6 (26)	3 (13)	14 (61)	8 (16)	10 (20)	30 (60)	.51
5. My life in relation to food and meals is close to my ideal	33 (46)	20 (27)	20 (27)	13 (57)	6 (26)	4 (17)	16 (32)	14 (28)	16 (32)	.20
6. I wish my meals were a much more pleasant part of my life	36 (49)	17 (23)	20 (27)	12 (52)	8 (35)	3 (13)	19 (38)	9 (18)	17 (34)	.10

(Continues)

TABLE 3 (Continued)

	Total, n (%)			Saw a dietitian, n (%)			Did not see a dietitian, n (%)			
	Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree	$P^{\dagger}$
7. With regard to food, the conditions of my life are excellent	32 (44)	19 (26)	22 (30)	9 (39)	9 (39)	5 (22)	18 (36)	10 (20)	17 (34)	.46
Dietary acceptability										
1. I find it easy to buy suitable foods for my current diet at my normal supermarkets or shops	19 (26)	11 (15)	43 (59)	7 (30)	4 (17)	12 (52)	9 (18)	7 (14)	31 (62)	.57
2. I am able to buy foods suitable for my current diet at my normal supermarkets or shops	9 (13)	13 (18)	51 (70)	3 (13)	4 (17)	16 (70)	5 (10)	9 (18)	35 (70)	.72
3. I use specialty shops to buy food for my current diet	27 (37)	11 (15)	35 (48)	12 (52)	6 (26)	5 (22)	11 (22)	5 (10)	30 (60)	.05*
4. It takes extra time to shop for my current diet	33 (45)	13 (18)	27 (37)	15 (65)	3 (13)	5 (22)	15 (30)	10 (20)	22 (44)	.08
5. It takes extra time to cook for my current diet	30 (42)	14 (19)	29 (40)	14 (61)	2 (9)	7 (30)	14 (28)	12 (24)	22 (44)	.08
6. I find food labeling is adequate to allow me to confidently choose suitable foods	20 (28)	17 (23)	36 (49)	5 (22)	6 (26)	12 (52)	11 (22)	11 (22)	24 (48)	.95
7. The cost of my current diet is more expensive	34 (47)	16 (22)	23 (32)	16 (70)	4 (17)	3 (13)	14 (28)	12 (24)	20 (40)	.01*
8. Does eating out at restaurants make it more difficult for you to follow your current diet?	58 (79)	8 (11)	7 (10)	22 (96)	1 (4)	0 (0)	20 (40)	7 (14)	7 (14)	.10
9. Does eating out at friends/families make it more difficult for you to follow your current diet?	57 (79)	6 (8)	10 (14)	19 (83)	3 (13)	1 (4)	23 (46)	3 (6)	9 (18)	.17
10. Does travel make it more difficult for you to follow your current diet?	56 (77)	7 (10)	10 (14)	22 (96)	1 (4)	0 (0)	17 (34)	6 (12)	10 (20)	.05*
11. Overall, I find my current diet tasty and enjoyable	15 (21)	20 (27)	38 (52)	5 (22)	8 (35)	10 (43)	9 (18)	12 (24)	28 (56)	.82
12. I can incorporate my current diet easily into my life	25 (34)	16 (22)	32 (44)	11 (48)	6 (26)	6 (26)	13 (26)	10 (20)	26 (52)	.25
13. My current dietary needs have created stress with my family/friends	21 (29)	13 (18)	39 (53)	9 (39)	5 (22)	9 (39)	10 (20)	8 (16)	30 (60)	.36

Note: FODMAP denotes fermentable oligo-, di-, monosaccharides, and polyols.

†Statistical analysis conducted between those who did and did not see a dietitian using Pearson chi-squared tests.

*Denotes statistical significance between those who saw a dietitian vs those who did not see a dietitian.

diet (Figure 5). Additionally, most patients (87%) also reported using other dietary therapies at a different time to trialing the low FODMAP diet.

3.5 | Food-related quality of life and dietary acceptability

Several differences were observed between those who did and did not see a dietitian from the food-related QOL and dietary acceptability questionnaires, although significance was lost following adjustment for multiple comparisons using false discovery rate (Table 3); those who did not see a dietitian were more likely to agree or strongly agree that they use specialty shops to buy food for their current diet (P = .05), that their diet is more expensive (P = .01), and that travel makes it more difficult to follow their current diet (P = .05).

4 | DISCUSSION

Use of diet as therapy in gastrointestinal disorders has gained popularity among patients and physicians. When using pharmacotherapy, medications are given at a specific dose shown to be therapeutic. Similarly, dietary therapies should be given in an evidence-based manner. Efficacy of the low FODMAP diet has been shown with dietitian guidance, thought to be important for appropriate implementation and compliance.[10] The current study was not intended or designed to examine the efficacy of the diet, rather it was a real-world evaluation of the use of the diet in a typical clinical setting. Aims were primarily to understand what patients do when given a recommendation of the low FODMAP diet. Key findings include that most patients report dietary therapy to be their preferred treatment modality and that most feel at least some symptom benefit following the low FODMAP dietary recommendation. While only one-third of patients consulted a dietitian for guidance, seeing a dietitian assisted patients to achieve the therapeutic target for FODMAP intake, and improved ability to appropriately follow the diet's 3 phases. This study shows that while the low FODMAP diet is an important therapeutic option, many patients are not adequately equipped to follow the dietary regimen.

This study provides important insight into the use of the 3 phases of the low FODMAP diet in a clinical setting. While 78% of patients are able to appropriately follow Phase 1 of the diet, significantly less are able to appropriately follow Phase 2 (48%) and even fewer for Phase 3 (40%), although these rates are much improved when patients consult a dietitian. Additionally, over one-third of patients followed the restricted diet for longer than recommended, which is important considering concern of detrimental effects on the microbiota profile and nutritional adequacy.[28] It has been shown that patients who are educated by a dietitian feel that written information and dietitian consultation are the most important factors associated with efficacy and adherence.[29] O'Keefe et al[26] showed that 82% continue an adapted low FODMAP diet that is Phase 3, following two visits with a dietitian, compared to 65% who saw a dietitian in the current study. Differences between studies may be due to the number of dietitian visits, as in the current study almost one-third of patients saw a dietitian for only one visit.

Symptoms chronicity is highlighted in this cohort as 92% percent had used another form of therapy to help manage symptoms and 87% had tried another dietary therapy. In 513 IBS patients, most used multiple treatments with nearly half reporting a willingness to 'try anything' to manage their symptoms, although dietary changes were not evaluated.[30] Of concern in the current study is that over half the patients reported using concurrent dietary strategies, that is 'diet-stacking', potentially resulting in an over-restricted diet and making it difficult to identify which strategy the individual is responding to.

Attention has been drawn to potential detrimental effects on nutrient status of the low FODMAP diet, although studies to date have suggested nutrient intake is largely maintained during Phase 1.[28] In concordance here, mean intakes of most nutrients reached the recommended dietary allowance (RDA) with the exception of calcium and folate. However, without data before the diet was instituted it is difficult to ascertain if low intakes were a result of the dietary intervention, reassuringly intakes were not different depending on education mode. In contrast, FODMAP intake was altered by dietitian input, with those who saw a dietitian more likely to reduce their FODMAP intake to therapeutic levels, possibly affecting likelihood of achieving symptom response. However, this was not reflected in our results, possibly due to small subject numbers. Alternatively, it may be the change in FODMAP intake compared to usual diet that is the key driver of symptom response, which was not able to be measured in this retrospective study.

Although controversial, dietary therapies have been proposed to reduce non-gastrointestinal symptoms, such as fatigue with a gluten-free diet[31] and eczema with a low chemical diet.[32] To date, minimal evaluation of these symptom has been conducted in clinical trials of the low FODMAP diet, although it has been suggested to reduce fatigue.[33] Non-gastrointestinal symptoms were commonly reported in this cohort, which frequently coexist with gastrointestinal symptoms[34] and warrants further investigation.

There are several limitations to consider. Firstly, the classification of patients as appropriately following the 3 phases of the low FODMAP diet was made using unvalidated measures without daily food or symptom questionnaires. The classification for each phase was based on current recommendations for best clinical practice for use of the diet.[10,14,16] However, the classifications were somewhat lenient; for example, patients only had to report re-challenge of at least 2 foods to be classified as appropriate, and hence results may have overestimated the number of patients appropriately following the 3 phases of the diet. With regard to the food frequency questionnaire, it is commonly known that underreporting occurs when using food frequency questionnaires, with estimates ranging from 24%-33%,[35] and while the questionnaire has been validated in Australia, it has not been validated in Canada, although it has been used in the UK[26] and New Zealand.[25] Due to a lack of clinical

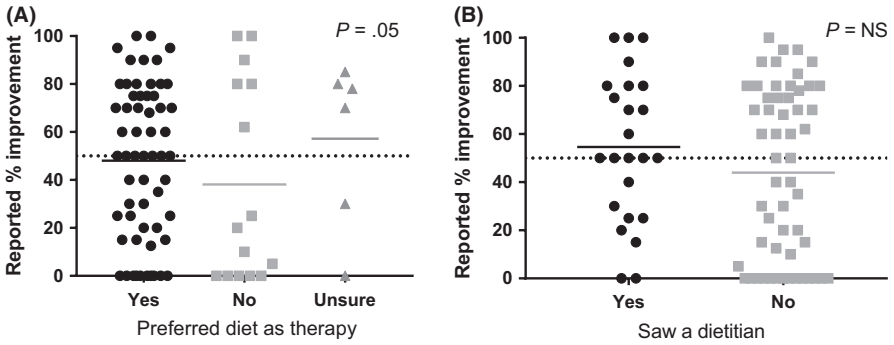
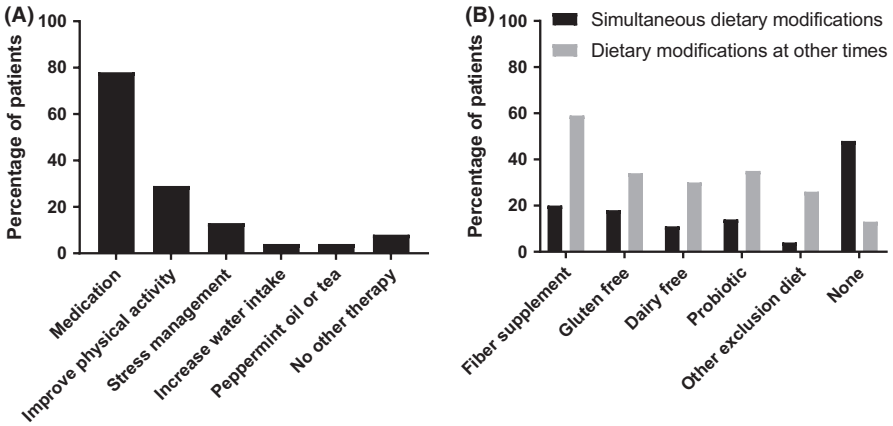


FIGURE 4 Reported percentage symptom improvement. A, Those who preferred diet as therapy were more likely to report symptom improvement compared to those who did not (P = .05, Mann-Whitney U test). B, The diet was reported to provide a ≥50% improvement in symptoms in 67% who saw a dietitian and 50% of those who did not see a dietitian, although there was no statistical significance between the two groups (P = .17)

FIGURE 5 Reported use of other non-dietary (A) and dietary (B) therapies to assist in managing symptoms



data on validated therapeutic FODMAP intake target levels, the therapeutic target of <12 g daily total FODMAP intake was chosen based on levels achieved in dietary education trials.[11,25] Changes in dietary FODMAP intake (ie, pre- and post–intervention) would likely provide a more useful measure, but due to the retrospective nature of this study this type of data was not able to be collected. Secondly, data were collected retrospectively and, in some cases, a considerable amount of time had passed since the diet was first recommended, hence recall bias may have occurred. While this is a limitation to patient perception of symptom improvement, the primary aim of the study was to evaluate how patients proceed when given the dietary recommendation. By collecting data retrospectively, there was a reduction in bias of patients altering their behavior due to study enrollment. Thirdly, although many patients were unaware, data collection was undertaken by a dietitian, which may have influenced responses. Fourthly, multiple selection biases may have occurred. Patients were recruited from gastroenterology specialist clinics and hence likely had more severe symptoms[36] which may have influenced their motivation to follow the dietary recommendations and/or symptom response. As data collection was retrospective, patients who had symptomatic improvement with the diet may not have returned to clinic and hence would not have been captured. Patients who had more success with the diet may have been more likely to agree to participate. Fifthly, other factors such as socioeconomic status, and education status were not assessed in this study which may have influenced which patients saw a dietitian resulting in other reasons for differentiation between the two groups. Finally, this single-center study may not be applicable to other populations.

The findings of the current study should inform clinical practice. Dietary therapy was the preferred treatment for many patients and those who preferred diet were more likely to respond, suggesting that in those patients who are not interested in diet therapies other treatment options may be more efficacious. In line with the 50%-80% response rate seen in efficacy trials,[28] 55% of patients who tried the diet reported improvement regardless of education mode. However, consideration should be given to the 20% of patients who failed to implement the diet at all. Without dietitian guidance, patients are twice as likely to be non-responders to the diet (<25% symptom improvement), and patients' ability to follow the 3 phases of the diet is diminished, highlighting the role of the dietitian. Patients with IBS would benefit from more support from healthcare professionals for medical and dietary management,[30,37] a gap that could be filled by a dietitian who has more time allotted per patient than physicians. In areas where access to knowledgeable dietitians is limited, group dietitian therapy should be considered[38] and funding for improved dietitian access should be sought. A dietitian-first gastroenterology clinic

was trialed in low-risk patients and found to reduce wait times[39] and may reduce 'diet-stacking' due to earlier provision of dietary advice. Clinicians should also be aware of the high use of concurrent therapies and how this may influence perception of symptom improvement. Patients should re-challenge high FODMAP foods within an appropriate length of time to avoid long-term use of the diet. Future studies should evaluate if improved ability to follow the 3 phases of the diet results in long-term benefits for symptom control, microbiota profile and nutrient profile.

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CONFLICT OF INTEREST

CT, DR, SV have no conflicts of interests to declare. JM declares that the Department of Gastroenterology financially benefits from the sales of a digital application and booklets on the low FODMAP diet.

AUTHOR CONTRIBUTIONS

CT and SV designed the research. CT, DR, SV conducted the research. JM provided accesses to the dietary analysis software. CT analyzed the data. CT, DR, SV wrote the manuscript. CT had primary responsibility for the final content. All authors read and approved the final manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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