Efficacy of low FODMAP diet in adult irritable bowel syndrome

ABSTRACT

Background: Irritable bowel syndrome is a sapping functional gastrointestinal disorder that disturbs the lives of 5%-10% of otherwise healthy individuals leads to frequent dietary changes, generate more costs, and increase doctor visits.There are still no effective treatments however, the low fermentable oligosaccharides, disaccharides, monosaccharides and polyols was introduced

Aim: Study the effect of low-FODMAP-diet restriction phase in irritable bowel syndrome symptoms management

Patients and methods: This was prospective observational study following a sample of consented patients visiting the Gastro-Intestinal and Liver diseases specialized outpatient clinics of Baghdad Teaching Hospital diagnosed with irritable bowel syndrome according to Rome IV criteria. Participants were interviewed and their symptoms were checked pre and post diet. All data were kept anonymous. Categorical data were presented in numbers, and percentage, The Wilcoxon signed-rank test was applied to compare any improvement in symptoms before and after application of diet. In all statistical associations, a P value less or equal 0.05 was considered significant.

Results: the average age of participants was 38.12years, more than half of the sample were females (62%).The commonest irritable bowel syndrome type reported was constipation (46%), followed by mixed (28%). Abdominal pain, bloating and flatulence were the main three reported symptom's; 49 (98%) each. All symptoms showed a significant improvement post-diet. Outof the 50 interviewed-participants, 37 (74%) had a total general improvement. No significant association was found between demographical variables on general improvement of IBS symptoms.

Conclusions and recommendations:the study highlighted the implication of low-FODMAP restriction phase which successfully decreased the severity of all symptoms among a sample of IBS diagnosed patients. Further study might focus follow patients through the reintroduction and personalization phases of low-FODMAP diet.

Keywords: low FODMAP diet; Irritable bowel syndrome; restriction phase; symptoms management; abdominal pain

Introduction

Irritable bowel syndrome (IBS) is one of the commonest complains in the gastrointestinal outpatient, with a worldwide prevalence of 40%[1].IBS disturbs the lives of 5%-10% of otherwise healthy individuals at any one point in time and, in most people, runs a relapsing and remitting course[2].In Western nations, the IBS is more predominate among females; yet, this isn't the case toward the east. In Asia, IBS is thought to be under-diagnosed [3].Recent Iraqi

study reported a prevalence of 7.9% with 52% being of mixed type, Women had a higher prevalence than men (4.90 versus 3.00) [4].

IBS is a sapping functional gastrointestinal disorder that leads to frequent dietary changes, generate more costs, and increase doctor visits; around 35.7% of IBS patients visits health facilities more than 5 times per year [5].IBS comes with a wide range of symptoms including abdominal pain, bloating and abdominal distention and altered bowel movements, with a predominance of diarrhea, constipation, or an interchange of these signs, which cannot be explained by a structural or biochemical abnormality [6].

Although acute enteric infection was described as a risk factor[7], yet IBS was identified in people with psychological comorbidity and in women than in the rest of the general population[2].
IBS pathophysiology of IBS is still

concealed yet trial have attributed it to an error of communication between the gut and the brain, leading to motility disturbances, visceral hypersensitivity, and altered CNS processing. Genetic associations, changes in gastrointestinal microbiota, mucosal lesions, and immune function have been also implicated[2, 3].

IBS diagnosis is mostly related to symptoms with minimum investigations used, unless alarm symptoms such as weight loss or rectal bleeding are present, or there is a family history of inflammatory bowel disease or coeliac disease [2].

Similarly, for treatment of IBS, it standardly targets the predominant symptom experienced by the patient and marks the pathophysiology, for instance accelerated transit or visceral hypersensitivity. There are still no effective disease-modifying treatments [8];however, rising suggestion supports the modification in diet as researchers introduced the low fermentable oligosaccharides, disaccharides, monosaccharides and polyols shortly known as FODMAP diet, and reported a reduction in the global IBS symptoms [9].

FODMAPs are present in many commonly consumed foods (such as stone fruits and legumes), lactose-containing foods, and artificial sweeteners. As these chemical substances are poorly absorbed, they may induce osmotic effects and distension in the intestine, leading to colonic sensitivity[10]. A low-FODMAP diet also decrease the proportion of bacteria in the intestine [11], and though this diet is gaining reputation, as the National Institute of Health and Care Excellence of the United Kingdom recommended the use of low FODMAPs diet for patients with IBS [12], but not without complaint. There are some safety concerns centered around the diet initial elimination phase leading to compromise of nutritional and psychological health, others regarding inappropriate application of the diet. In addition to apprehensions concerningdamage of the microbiota, and the lack of up-to-date randomized trialsinvestigating the effectiveness of low FODMAP diet in elevating the symptoms[11,13,14].

The low-FODMAP diet consists of three phases, restriction, which typically last for four to six weeks, followed by a re-introduction, and personalizing the diet according to the participant needs. [15] The study aims to illustrate the effectiveness of low-FODMAP diet during the restriction phase on IBS symptoms management.

Patients and Methods

This was a prospective observational study included all eligible patients who were visiting the Gastro-Intestinal and Liver diseases specialized outpatient clinics of Baghdad Teaching Hospital during the time of the study from first of March till the end of August 2023, and were diagnosed with IBS according to Rome IV criteria by specialized gastroenterologists. Patients were recruited, their history and diagnosis were reviewed.

Inclusion criteria:

Age <45 years, diagnosed with IBS, and with no IBS- alarm symptoms (anemia, blood in the stool, unexplained weight loss, fever, diarrhea, appearance of new symptoms), had normal complete blood count (CBC), normalThyroid Stimulating Hormone Test, and normal antitissuetranglutaminaseantibody test.

Exclusion criteria:

- If younger than 45 years and had IBS-alarm symptoms, unless they have a normal colonoscopy.
- If 45 years and older,with or without IBS- alarm symptoms, unless they have a normal colonoscopy.
- Those with inflammatory bowel diseases (Crohn's disease, ulcerative colitis), celiac disease, and thyroid diseases were not included in the study

The eligible participants were surveyed, their demographic and contact details were saved after obtaining verbal and written consents and explaining the aim of the study and the low-FODMAP diet treatment. Participants were interviewed and their symptoms were checked (Abdominal pain, Abdominal bloating/ distention, Flatulence, Belching, Gurgling, Urgency to open bowel, Incomplete evacuation, Nausea, Heart burn, Acid regurgitation, Lethargy) before enrolling, each symptom had four-scale responses (none, mild, moderate, and severe). Participants were followed up weekly through phone calls and recalled after 4 weeks, when a similar symptom-check was done.

All data were kept anonymous, no divulge of information had ever occurred. Categorical data were presented in numbers, and percentage, The Wilcoxon signed-rank test was applied to compare symptomsbetween pre and post FODMAP diet restriction. In all statistical associations, a P value less or equal 0.05 was considered significant.

Results

The average age of participants was 38.12±10.4 years, more than half of the sample were females 31 (62%), living in urban settings 43(86%), secondary education 12 (24%), employed 30(60%). Table (1) depicts the demographical variables of the studied sample.

Table (1) Demographical variables of the studied sample.

Variables		Frequency	Percentage
Age in years	20-29	10	20.0
	30-39	25	50.0
	40-49	9	18.0

	≥50	6	12.0
Gender	Male	19	38.0
	Female	31	62.0
Residency	Urban	43	86.0
	Rural	7	14.0
Education	Illiterate	9	18.0
	primary	6	12.0
	secondary	12	24.0
	high school	6	12.0
	college or institute	17	34.0
Employment	notworking, housewife	20	40.0
	employed/working	30	60.0
Marital status	Not married	18	36.0
	Married	32	64.0
smoking	No	40	80.0
	Yes	10	20.0
Alcohol	No	49	98.0
	Yes	1	2.0
Monthly income	No or not enough	24	48.0
	Enough	26	52.0
BMI	Normal <25	8	16.0
	Overweight 25-29	23	46.0
	Obese >=30	19	38.0
Total		50	100.0

More than half of the sample had IBS for 1 year or more 26(52%), while the remaining 24(48%) were diagnosed in less than a year.

Figure (1) shows the commonest IBS type reported was constipation (C-IBS), it was stated among 23 (46%) participants, followed by the mixed type (M-IBS) in 14(28%), unclassified 9(18%) and only 4 (8%) participants had the diarrhea type (D-IBS).

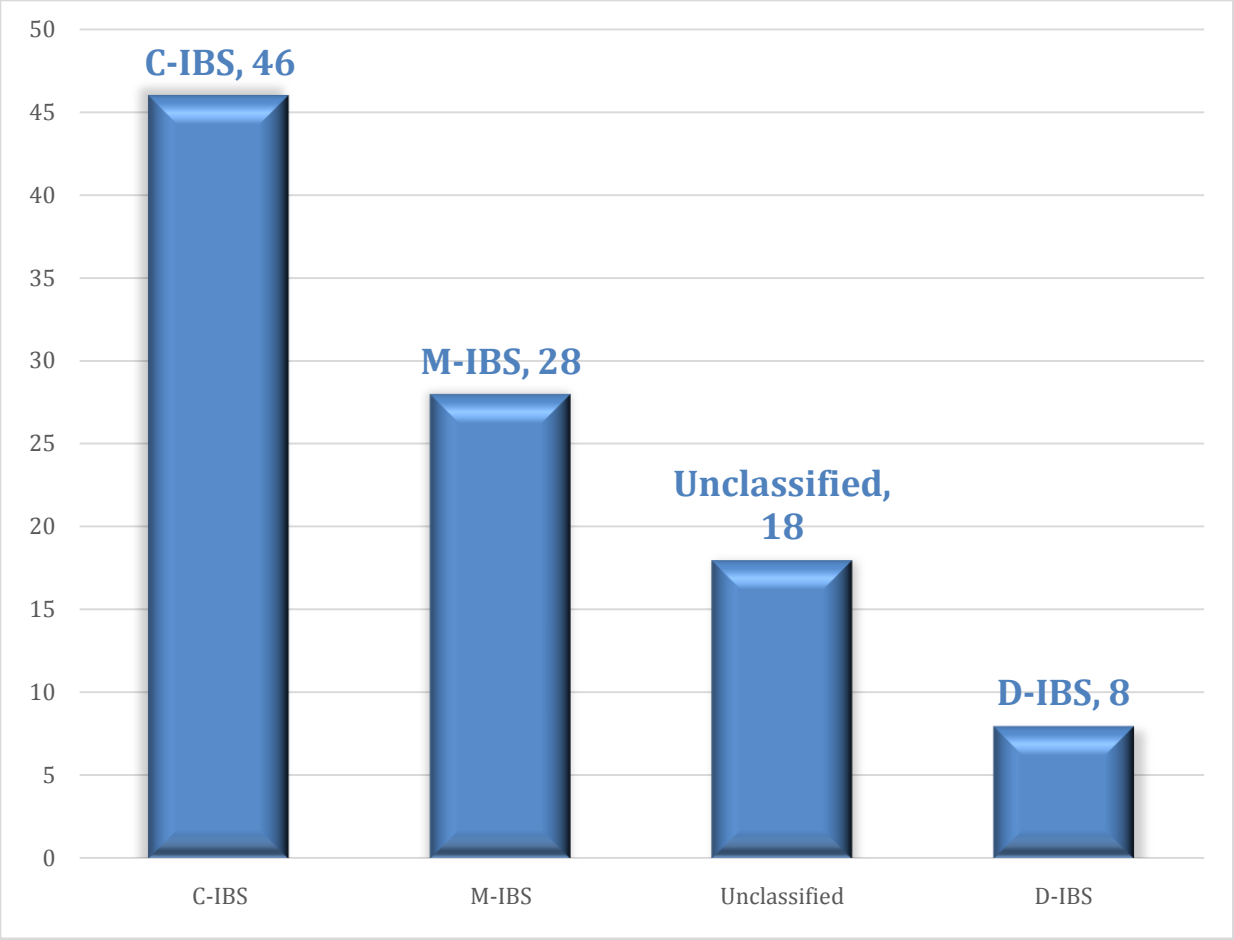

Figure (1). Types of IBS among the studied sample.

Abdominal pain, bloating and flatulence were the main three reported symptom's; 49 (98%) each, followed by incomplete evacuation 48(96%), lethargy was reported among 47(94%), belching 44(88%), Gurgling 44(88%), while nausea was reported in 35 (70%), heart burn was seen among 33 (66%), acid regurgitation was positive among 32(64%), and urgency to open bowel was stated among 30 (60%) participants.

All symptoms showed a significant improvement post diet. Table (2) shows the progress of symptoms pre and post low-FODMAP diet. Abdominal pain was severe in 38 (76%) of cases before starting the diet, the percent decrease to 18% post-diet.

Bloating was reported pre diet among 2(4%), 11(22%), and 36(72%) participants, as mild, moderate and severe respectively. Post diet, 20 (40%), 7(14%), and only 5 (10%) reported mild, moderate, and sever bloating respectively.

Flatulence was described as a severe symptom among 27(54%) of the participants. post FODMAP, the percentage declined to only 4 (8%) participants.

Belching symptom showed a significant improvement post-diet from 14(28%) reporting severe belching to only 3 participants (6%).

Gurgling was claimed by 6(12%), 18(36%), and 20(40%) of participants as mild, moderate, and severe symptom pre-initiation of low-FODMAP regime. Positive progresses were noted post-diet as 8(16%), 4(8%) and 3(6%) had reported the symptom as mild, moderate and severe respectively.

The urgency feeling to use bathroom was significantly improved post-diet, as around 18 participants were relieved from the symptom.

Sense of incomplete bowel evacuation was stated by 6(12%),9(18%), and 33(66%) participants as mild, moderate and severe symptom. Post dieting 9(18%), 7(14%), and 8 (16%) participants reported same symptom

Nausea showed a significant improvement with dieting, 9(18%) of participants reported severe nausea, post dieting only one participant (2%) reported having severe nausea

Heartburn was seen among 9(18%), 16(32%) and 8(16%) participants as mild, moderate and severe symptom, post-diet 39(78%) participants were free from heart burn and only 8(16%), and 3(6%) reported mild and moderate symptoms respectively

Acid regurgitation was significantly improved with low-FODMAP diet, pre-diet 7 participants (14%) had severe symptom, post dieting the percentage dropped to zero.

Lethargy was declared by 4(8%), 30 (60%) and 13 (26%) as mild, moderate and severe lethargy before initiating the FODMAP diet. Significant improvement was seen post dieting as 6(12%), 6(12%) and only 4 (8%) participants reported mild, moderate and severe lethargy.

Table (2) Distribution of reported symptoms pre and post low-FODMAP diet

Symptoms	FODMAP	Severity n (%)				P value
		No	**Mild**	**Moderate**	**Severe**	
Abdominal pain	Pre	1(2)	2(4)	9(18)	38(76)	Z=-5.492
	Post	16(32)	20(40)	5(10)	9(18)	<0.001
Bloating	Pre	1(2)	2(4)	11(22)	36(72)	Z=-5.667
	Post	18(36)	20(40)	7(14)	5(10)	<0.001
Flatulence	Pre	1(2)	2(4)	20(40)	27(54)	Z=-5.682
	Post	24(48)	16(32)	6(12)	4(8)	<0.001
Belching	Pre	6(12)	6(12)	24(48)	14(28)	Z=-5.190
	Post	35(70)	6(12)	6(12)	3(6)	<0.001
Gurgling	Pre	6(12)	6(12)	18(36)	20(40)	Z=-5.523
	Post	35(70)	8(16)	4(8)	3(6)	<0.001
Urgency	Pre	20(40)	6(12)	9(18)	15(30)	Z=-4.432
	Post	38(76)	8(16)	3(6)	1(2)	<0.001

Incomplete evacuation	Pre	2(4)	6(12)	9(18)	33(66)	Z=-5.245
	Post	26(52)	9(18)	7(14)	8(16)	<0.001
Nausea	Pre	15(30)	11(22)	15(30)	9(18)	Z=-4.411
	Post	34(68)	13(26)	2(4)	1(2)	<0.001
Heart burn	Pre	17(34)	9(18)	16(32)	8(16)	Z=-4.733
	Post	39(78)	8(16)	3(6)	0	<0.001
Acid	Pre	18(36)	8(16)	17(34)	7(14)	Z=-4.419
	Post	38(76)	6(12)	6(12)	0	<0.001
Lethargy	Pre	3(6)	4(8)	30(60)	13(26)	Z=-5.285
	Post	34(68)	6(12)	6(12)	4(8)	<0.001

Outof the 50 interviewed-participants, 37 (74%) had a total general improvement. Table (3) illustrates no significant influence of demographical variables on general improvement of IBS symptoms.

Table (3). Distribution of participants by demographical variables, according to general improvement post-FODMAP diet.

Variables		General improvement		P value
		No	Yes	
Age (in years)	20-29	3(21.4%)	11(78.6%)	0.846
	30-39	7(31.8%)	15(68.2%)	
	40-49	2(25%)	6(75%)	
	≥50	1(16.7%)	5(83.3%)	
Gender	Male	4(21.1%)	15(78.9%)	0.742
	Female	9(29%)	22(71%)	
Residency	Urban	11(25.6%)	32(74.4%)	0.867
	Rural	2(28.6%)	5(71.4%)	
BMI	Normal <25	2(25.0%)	6(75.0%)	0.997
	Overweight 25-29	6(26.1%)	17(73.9%)	
	Obese ≥30	5(26.3%)	14(73.7%)	
Education	Illiterate	4(44.4%)	5(55.6%)	0.595
	Primary	1(16.7%)	5(83.3%)	
	Secondary	2(16.7%)	10(83.3%)	
	High school	1(16.7%)	5(83.3%)	
	College	5(29.4%)	12(70.6%)	
Marital status	Not married	5(27.8%)	13(72.2%)	0.830
	Married	8(25.0%)	24(75.0%)	
Smoking	No	10(25.0%)	30(75.0%)	0.747
	Yes	3(30.0%)	7(70.0%)	
Alcohol	No	13(26.5%)	36(73.5%)	1.000
	Yes	0	1(100%)	
Income	No or not enough	8(33.3%)	16(66.7%)	0.339

	Enough	5(19.2%)	21(80.8%)	
IBS type	Diarrhea	0	4(100.0%)	0.369
	Constipation	6(26.1%)	17(73.9%)	
	Mixed	3(21.4%)	11(78.6%)	
	Unclassified	4(44.4%)	5(55.6%)	

Discussion

The average age of participants was 38.12 years, which agrees with Muhsin S et al 2023 in ThiQar-Iraq [16] ,and Farsi F et al 2022 where the average age was 38.8 and 38.41 years respectively [17].

More than half of the sample were females (62%)agreeing with results reported by Amin HS et al,Farsi F et al,Alharbi MH et al, and AlButaysh OF et al, wherefemale participants were more likely to be affected by IBS than males[18-20].The current finding isalso in agreement withthat described by Oka P et al meta-analysis, where the prevalence of IBS was higher in women than in men [21],while a study by Latif A et alin Pakistan showed that males (53.7%) were more than females (42.3%) [22] and Aljammaz KI et al in Saudi Arabia, where males were predominant than females was (54% vs 46%)[23],this can be related to the tendency of genders to seek health;women empowerment encourage visits the health care facility. In our sample majority were females from urban settings, with around 60% of participant were employed.

The most common type of IBS was C-IBS (46%), followed byM-IBS (28%). While D-IBS was reported only among 8%, this agrees with a recent Iraqi study by Al Attar Z 2020, where most patients had constipation (40.3%) [24] Yet, the commonest type reported by Black CJ et alstudywas D-IBS41.3%and C-IBS was only diagnosed among 11.5% of the sample[25].

Other studies by Oka P et al, and Alharbi MH et aldescribed the mixed IBS as the prevalent type(33.8%-53%)[19, 21], Such difference can be related to other confounders liketype of diet consumed, behavioral and environmental factors, and to Rome Criteria applied.Type of IBS dictates the symptoms, abdominal pain, bloating and flatulence were the commonest reported symptoms which agrees with findings reported by Latif A et al 2020, and Pop LL et al [22, 26],where abdominal pain and bloating were the most bothering symptoms respectively. While Black CJ et al, reported abdominal bloating and unspecified functional bowel discord (23.4%-23.8%). [25].

Interestingly all symptoms showed a significant improvement post-diet, which is in alignment with findings reported byDimidi E et al 2023 [27]also agreeing with Chey WD et al 2022 and Bellini M et al. The low-FODMAP diet is probably the most evidence-based diet intervention for IBS. [15, 28]The result is also in alignment with findings published by Black CJ systematic review where low FODMAP diet ranked first vs habitual diet in relieving IBS symptoms. [29]Yet a study by Pourmand H et al reported that adherence to the low FODMAP diet was significantly associated with low intakes of macro- and micro-nutrients as well as all food groups and didn't lower IBS symptoms[30].

Out of the 50 interviewed-participants, 37 (74%) had general improvement. Which agrees with the response rate in the literature to a low FODMAP diet ranged between 50-76% [13], Yet

higher than that reported in a study by Dimidi E et al 2023, where the response rate ranged from 45% to 55% [27].This can be related to sample follow up period and procedure. As low-FODMAP diet need to be applied in suitable conditions with proper education, preferably by a health professional trained in its delivery.

No significant association was seen between demographic variables (age, gender, marital status, education, occupation, BMI, residency, income..etc), and general improvement in IBS symptoms after low-FODMAP diet. Which is in alignment with results reported by Rej A et al where no significant difference in the gender of patients was noted [13],and goes with findings stated by Latif A et al 2022, and Alharbi MH et al 2022, where there was no significant effect of variables such as age, gender, residency, smoking, marital status, education, employment, and economic status on IBS[19,22].

Yet, studies by Amin Hs et al in Saudi Arabia- Riyadh,and Ismael A etal in Iraq Kirkuk [4], showed a significant association with low income, unemployment [18]. This might be related to a level of psychological upset that leads to IBS. It had been reported that insomnia [31], anxiety, depression, and low physical activity are statistically significant variables with symptomatic IBS. [23].

Conclusions and Recommendations

The study highlighted the implication of low-FODMAP restriction phase which successfully decreased the severity of all symptoms among a sample of IBS diagnosed patients.

Increasing the knowledge not only about IBS, but also about the modalities of therapy availablethat help coping with the condition. Encourage a consultation with a nutritional specialist once diagnosis was made.

Further study might focus follow patients through the reintroduction and personalization phases of low-FODMAP diet.

References

1. Sperber AD, Bangdiwala SI, Drossman DA, et al. Worldwide prevalence and burden of functional gastrointestinal disorders, results of Rome foundation global study. Gastroenterology.2021;160:99–114.e3.
2. Ford AC, Sperber AD, Corsetti M, Camilleri M. Irritable bowel syndrome. Lancet. 2020 Nov 21;396(10263):1675-1688.
3. Tang HY, Jiang AJ, Wang XY, Wang H, Guan YY, Li F, Shen GM. Uncovering the pathophysiology of irritable bowel syndrome by exploring the gut-brain axis: a narrative review. Ann Transl Med. 2021 Jul;9(14):1187.
4. Ismael A, Ali W, Yawoz M. The Irritable Bowel Syndrome Prevalence of Amidst Iraqi Inhabitance In Kirkuk Via Utilizing Of Rome IV Gauge. Kirkuk Journal of Medical Sciences .2022;10(2):1-17

5. Schwille-Kiuntke J, Rüdlin SL, Junne F, Enck P, Brenk-Franz K, Zipfel S, Rieger MA. Illness perception and health care use in individuals with irritable bowel syndrome: results from an online survey. BMC Fam Pract. 2021;22(1):154.
6. Sebastián Domingo JJ. Irritable bowel syndrome. Med Clin (Barc).2022 Jan 21;158(2):76-81. English, Spanish.
7. Wadi W, Rathi M, Molan A. The possible link between intestinal parasites and irritable bowel syndrome (IBS) in Diyala Province, Iraq.Annals of Parasitology. 2021;67(3):505–513
8. Camilleri M. Management Options for Irritable Bowel Syndrome. Mayo Clin Proc. 2018 Dec;93(12):1858-1872.
9. Killian LA, Muir JG, Barrett JS, Burd NA, Lee SY. High Fermentable Oligosaccharides, Disaccharides, Monosaccharides, and Polyols (FODMAP) Consumption Among Endurance Athletes and Relationship to Gastrointestinal Symptoms. Front Nutr. 2021 Apr 20;8:637160.
10. Major G, Pritchard S, Murray K, et al. Colon hypersensitivity to distension, rather than excessive gas production, produces carbohydrate-related symptoms in individuals with irritable bowel syndrome. *Gastroenterology* 2017;152(1):124–133.
11. Halmos EP, Christophersen CT, Bird AR, Shepherd SJ, Gibson PR, Muir JG. Diets that differ in their FODMAP content alter the colonic luminal microenvironment. *Gut* 2015;64(1):93–100
12. Diagnosis and management of irritable bowel syndrome in adults in primary care: summary of NICE guidance, 2015. *Br Med J*. 2015;350(Mar. 3):h1216
13. Rej A, Avery A, Ford AC, Holdoway A, Kurien M, McKenzie Y, Thompson J, Trott N, Whelan K, Williams M, Sanders DS. Clinical application of dietary therapies in irritable bowel syndrome. J Gastrointestin Liver Dis. 2018 Sep;27(3):307-316.
14. Bohn L, Storsrud S, Liljebo T, et al. Diet low in FODMAPs reduces symptoms of irritable bowel syndrome as well as traditional dietary advice: A randomized controlled trial. *Gastroenterology* 2015;149(6):1399–1407
15. Chey WD, Hashash JG, Manning L, Chang L. AGA Clinical Practice Update on the Role of Diet in Irritable Bowel Syndrome: Expert Review. Gastroenterology. 2022 May;162(6):1737-1745.e5.
16. Muhsin S, Abass A, Hassan M. Assessment of Quality of life in irritable bowel syndrome patients and detecting the factors that are associated with QoL in Thi-Qar-Iraq.Journal of Population Therapeutics & Clinical Pharmacology.2023;30(5):e267–e272
17. Farsi F, Zonooz SR, Ebrahimi Z, Jebraili H, Morvaridi M, Azimi T, et al. The Incidence of Post-infectious Irritable Bowel Syndrome, Anxiety, and Depression in Iranian Patients with Coronavirus Disease 2019 Pandemic: A Cross-Sectional Study. Turk J Gastroenterol. 2022;33(12):1033-1042
18. Amin HS, Irfan F, Karim SI, Almeshari SM, Aldosari KA, Alzahrani AM, etal. The prevalence of irritable bowel syndrome among Saudi population in Riyadh by use of Rome IV criteria and self-reported dietary restriction. Saudi J Gastroenterol. 2021;27(6):383-390
19. Alharbi MH, Alhazmi AH, Ujaimi MH, Alsarei M, Alafifi MM, Baalaraj FS, Shatla M. The Prevalence of Irritable Bowel Syndrome and Its Relation to Psychiatric Disorders Among Citizens of Makkah Region, Saudi Arabia. Cureus. 2022 Dec 19;14(12):e32705.

20. AlButaysh OF, AlQuraini AA, Almukhaitah AA, Alahmdi YM, Alharbi FS. Epidemiology of irritable bowel syndrome and its associated factors in Saudi undergraduate students. Saudi J Gastroenterol. 2020;26(2):89-93
21. Oka P, Parr H, Barberio B, Black CJ, Savarino EV, Ford AC. Global prevalence of irritable bowel syndrome according to Rome III or IV criteria: a systematic review and meta-analysis. Lancet Gastroenterol Hepatol. 2020 Oct;5(10):908-917.
22. Latif A, Aziz Memon F, Asad M. Irritable Bowel Syndrome in a Population of a Developing Country: Prevalence and Association. Cureus. 2020 May 14;12(5):e8112
23. Aljammaz KI, Alrashed AA, Alzwaid AA. Irritable bowel syndrome: Epidemiology and risk factors in the adult Saudi population of the central region. Niger J Clin Pract. 2020;23(10):1414-1418
24. Al Attar Z. Irritable Bowel Syndrome: The Most Common Presentation, Severity Ranking and Therapeutic Regimens among Patients Attending Outpatient. Al-kindy College Medical Journal 2020;16(1):10-17
25. Black CJ, Yiannakou Y, Houghton LA, Ford AC. Epidemiological, Clinical, and Psychological Characteristics of Individuals with Self-reported Irritable Bowel Syndrome Based on the Rome IV vs Rome III Criteria. Clin Gastroenterol Hepatol. 2020 Feb;18(2):392-398.e2.
26. Pop LL, Mureşan IA, Dumitraşcu DL. How much bloating in the irritable bowel syndrome? Rom J Intern Med. 2018 Dec 1;56(4):221-226.
27. Dimidi E, Belogianni K, Whelan K, Lomer MCE. Gut Symptoms during FODMAP Restriction and Symptom Response to Food Challenges during FODMAP Reintroduction: A Real-World Evaluation in 21,462 Participants Using a Mobile Application. Nutrients. 2023 Jun 9;15(12):2683.
28. Bellini M, Tonarelli S, Nagy AG, Pancetti A, Costa F, Ricchiuti A, de Bortoli N, Mosca M, Marchi S, Rossi A. Low FODMAP Diet: Evidence, Doubts, and Hopes. Nutrients.2020;12(1):148.
29. Black CJ, Staudacher HM, Ford AC. Efficacy of a low FODMAP diet in irritable bowel syndrome: systematic review and network meta-analysis. Gut. 2022;71(6):1117-1126.
30. Pourmand H, Keshteli AH, Saneei P, Daghaghzadeh H, Esmaillzadeh A, Adibi P. Adherence to a Low FODMAP Diet in Relation to Symptoms of Irritable Bowel Syndrome in Iranian Adults. Dig Dis Sci. 2018 May;63(5):1261-1269.
31. Yazbeck G, Malaeb D, Shaaban H, Sarray El Dine A, Hallit S, Hallit R. Irritable bowel syndrome (IBS) among Lebanese adults: unidentified IBS and associated factors. BMC Public Health. 2023 Aug 22;23(1):1589.