

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/322946457>

Low FODMAP diet in Egyptian patients with Crohn's disease in remission phase with functional gastrointestinal symptoms: Low FODMAP in Crohn's disease

Article · February 2018

DOI: 10.1002/jgh3.12037

CITATIONS

3

READS

122

5 authors, including:



Dalia Tayel

High Institute of Public Health

36 PUBLICATIONS 46 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



nutrition and food science [View project](#)



Original article [View project](#)

ORIGINAL ARTICLE

Low FODMAP diet in Egyptian patients with Crohn's disease in remission phase with functional gastrointestinal symptoms

Maha H Elhusseiny,^{*,†} Ali K Amine,[‡] Osama E Salem,[§] Dalia I Tayel[‡] and Eman A Elsayed[§]

^{*}Gastroenterology Unit, Faculty of Medicine, [†]Department of Nutrition, High Institute of Public Health, [§]Gastroenterology Unit, Faculty of Medicine, Alexandria University, Alexandria, Egypt and [‡]HCPC, UK

Key words

Crohn's disease, diet, FODMAP, gastrointestinal symptoms.

Accepted for publication 15 December 2017.

Correspondence

Dr Maha H Elhusseiny, Department of Gastroenterology, Alexandria Main University Hospital, Chamblion Street, el Azareeta, Alexandria Governorate, Alexandria 21514, Egypt. Email: dr-mahaelhusseiny@hotmail.com

Declaration of conflict of interest: None.

Author contribution: Maha H Elhusseiny, Ali K Amine, Osama E Salem, and Dalia I Tayel designed the study and formulated the research questions. Maha H Elhusseiny and Eman A Elsayed collected the dietary intake data, planned the meals, and collected all the information necessary on low FODMAP diet in small booklets that were available for all patients. Maha H Elhusseiny drafted the manuscript. All authors took part in a critical revision of the manuscript and approved the final version of the paper submitted for publication.

Funding support: Nutrition and Dietetic Department, High Institute of Public Health (HIPH)

Abstract

Background and Aim: Despite being in remission, functional gastrointestinal disease (FGID) in Crohn's disease (CD) patients can reduce their quality of life. The Egyptian daily diet contains a high amount of FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides, And Polyols). As the low FODMAP diet has been proven to be effective in irritable bowel syndrome worldwide, it was reasonable to take a step further and begin to study the effect of low FODMAP in Egyptian CD patients with FGID. The outcomes were assessed in terms of improvement in symptoms and hence the quality of life, and the factors that led to this improvement were also recorded.

Methods: In total, 100 CD patients with FGID in the remission stage who were already on a low-fiber diet (\pm lactose-free diet) were selected to follow the low FODMAP diet. A structured interview was performed after 3 months with a number of scored-scale questionnaires comparing symptoms before and after the diet and the impact on quality of life. Evaluation of the adherence, satisfaction, palatability, and affordability of the diet was performed. Different demographic data were also evaluated in correspondence with improvements in the quality of life.

Results: The mean score of FGID improvement was $38.45 \pm 21.56\%$. The quality of life was significantly improved; 90% of female patients *versus* 49.4% males had a better quality of life. The households (not working) as well as those with morning jobs (6 hours) reported an increase in quality of life. Although the Egyptian low FODMAP diet was expensive (in terms of gluten-free wheat), 67% were adherent to it (18.16 ± 6.85).

Conclusion: As a first step in Egypt, the low FODMAP diet was effective in improving the quality of life of CD patients with FGID.

Introduction

Crohn's disease (CD) is characterized by a transmural granulomatous inflammation that can affect any part of the gastrointestinal tract, most commonly the ileum, colon, or both. There may be unaffected bowel between areas of active disease (skip lesions).¹ In the Middle East and Egypt where inflammatory bowel disease (IBD), especially CD, is emerging, the distinction between IBD and chronic infective diseases may be problematic.² Symptoms are variable but often include diarrhea, which may be bloody; abdominal pain; and/or weight loss. Typically, there are periods of acute exacerbation combined with remissions. The definition of remission in CD is not straightforward as it includes clinical remission, endoscopic remission (mucosal healing), and laboratory investigations. Recently, more studies have been published

about functional gastrointestinal disease (FGID) symptoms in CD in remission.³ Furthermore, one study shows that about a third of quiescent CD patients will suffer from irritable bowel syndrome (IBS)-like symptoms.⁴ Because the low FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides, And Polyols) diet has now emerged as a key player in IBS treatment, it sounds logical to implement the same approach in these patients. Theoretically, the functional gut symptoms are due to luminal distension.⁵ Luminal distension causes symptoms of pain, bloating, and distension, as well as motility abnormalities. Thus, reducing the intake of dietary elements that can distend the intestine would be expected to improve FGID.

The FODMAP⁶ involves fructose, lactose, fructo- and galacto-oligosaccharides (fructans and galactans), and polyols (such as sorbitol, mannitol, xylitol, and maltitol), all of which

have three common functional properties (poorly absorbed in the small intestine, small and therefore osmotically active molecules, and rapidly fermented by bacteria). Restricting one FODMAP in isolation does not imply that there might not be other types of FODMAPs in the diet that would have the same effects on the bowel. The innovation in the FODMAP concept is that global restriction must have greater and more consistent effect than limited restriction. The Egyptian cuisine makes heavy use of legumes, vegetables, and fruits as Egypt's rich Nile valley and delta produce large, high-quality quantities of these crops, which contain high FODMAPs, particularly the fructose and fructans. In addition, bread, which is a major source of fructans, made from a simple recipe forms the backbone of Egyptian cuisine.⁷⁻⁹ Lactose is a disaccharide, naturally occurring in cheese, and is thought to have originated in Egypt. The manufacture of cheese is depicted in murals in Egyptian tombs from 2000 BC.⁹ The main everyday dishes in Egypt are Egyptian ful medames, mashed fava beans, and kushari, a mixture of lentils, rice, pasta, and other ingredients that are rich in FODMAPs.¹⁰ Consequently, there were many challenges in implementing the low FODMAP approach.

The aim of the present study, which was the first phase, is to determine the effect of the low FODMAP diet in CD patients in the remission stage with FGID symptoms for 3 months. The outcomes were evaluated in terms of the effect on the symptoms, the patients' adherence, satisfaction with the diet, and the quality of life. In addition, the patients' feedback, opinions and their demographic factors were assessed in relation to the improvement of their quality of life.

Methods

Subjects. The study included 100 CD patients in remission admitted to the Gastroenterology Unit of Alexandria Main University Hospital. We selected patients who had normal laboratory findings: C-reactive protein (CRP) (<3 mg/L), fecal calprotectin (<100 µg/g), Crohn's disease activity index (CDAI) below 150 points, and normal findings by the imaging study (computed tomography [CT] enterocolonography) and endoscopic reports. The patients who had active and/or complicated CD were excluded. Tables 1 and 2 show the distribution of patients according to different demographic data and their clinical condition. None had previous dietary education concerning their FGID. They were following a low-fiber diet ± lactose-free diet before the intervention. Approval of Ethics Committee of High Institute of Public Health, Alexandria University, was obtained. All patients were informed, and written consent was obtained from all participants after explaining the aim of the study.

Intervention step. In the first session (45–60 min),^{11,12} all patients were instructed on the diet in a one-on-one session. The session started by meeting and greeting the patient and assessing the overall clinical condition and medications of the patient. In addition, information was gathered on all nutrition-relevant data through 24-h recall history (to assess the general eating pattern and detect the contribution of high FODMAP diet in the patient's meals), and a short food frequency questionnaire was utilized to assess the serving size, frequency of consuming a high FODMAP diet and any aversions, or if the patient was already avoiding any of the high FODMAP diets (e.g. lactose-free diet).

Table 1 Distribution of the studied cases according to demographic data (*n* = 100)

	<i>n</i> = 100	%
Age		
<30	56	56.0
30–<40	34	34.0
40+	10	10.0
Mean ± SD	28.56 ± 7.0	
Gender		
Male	42	42.0
Female	58	58.0
Education		
Low (illiterate, read and write, and primary, preparatory)	25	25.0
Moderate secondary (general or vocational)	10	10.0
High (Tertiary)	65	65.0
Employment		
Household (Those who are not working)	26	26.0
Morning jobs (6 h)	30	30.0
Shift jobs (>6 h)	24	24.0
Student	20	20.0
Smoking		
No	80	80.0
Yes	20	20.0
Number of household (Those who are not working) (including the patient)		
1–3	36	36.0
4–5	40	40.0
>5	24	24.0

Afterward, the patient was educated about the physiological framework of the dietary approach. Then, specific dietary instructions, in addition to written individualized food lists and supporting instructions, were provided to the patients. Different communication skills were used to help the patients fit the right choices into their meals during the day. It was important to

Table 2 Distribution of the studied cases according to clinical data (*n* = 100)

	Number	%
Disease duration		
<5 years	30	30.0
5–10	55	55.0
≥ 10	15	15.0
Mean ± SD	5.90 ± 2.66	
Drugs		
Azathioprine	10	10.0
Immuran	75	75.0
Pentaza	42	42.0
Proton pump inhibitor	35	35.0
Vitamin D	10	10.0
Location		
Ileal	65	65.0
Colonic	5	5.0
Ileocolonic	25	25.0
Upper gastrointestinal disease	5	5.0

emphasize the suitable food alternatives and teach them to read food labels. We suggested different cooking tips for preparing easy and quick meals, taking into consideration all nutritional needs, food preferences, and budget limits. A sample menu for the week was given as an example (Table 3). Techniques for handling situations such as eating away from home were discussed. Some patients needed further consultation sessions either face to face, through the phone, or through emails.¹³

A structured confidential interview (30 min)^{11,12} was performed after 3 months using scored-scale questionnaires to assess the outcomes of the diet. The FODMAP adherence report scale (FARS) was completed by asking the patient five questions; each question has five possible answers (always, often, sometimes, rare, and never). The scoring was from 1 to 5 points, with a maximum score of 25 points.¹⁴ The satisfaction of the diet was measured by using the global symptom question, (Do you currently have satisfactory relief of your gut symptoms?),¹⁵ with five possible answers (always, often, sometimes, rare, and never). We evaluated the feedback of the patients concerning the cost, palatability, and the availability of the diet. The FGID symptoms pre- and post-low FODMAP diet were judged by using the gastrointestinal symptom rating scale (GSRS).¹⁶ The scale consists of 11 symptoms scored on a 4-point Likert scale. The quality of life pre- and post-FODMAP diet was evaluated by using the short inflammatory bowel disease questionnaire, SIBDQ score (responses scored on a 7-point Likert scale; 1 = worst function, 7 = best function. Global score ranges from 10 to 70).¹⁷ Different demographic data were evaluated in relation to the improvement of the quality of life (age, gender, employment, number of household, and smoking).

Statistical analysis of the data. Data were fed to the computer and were analyzed using the IBM SPSS software package version 20.0 (IBM Corp, Raymond, NY, USA). Qualitative data were described using number and percent. The Kolmogorov–Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum) and mean SD. The significance of the obtained results was judged at the 5% level. The chi-square test was used to compare categorical variables between different groups. Fisher's exact test or Monte-Carlo correction was used also for the correction of chi-square values when more than 20% of the cells had an expected count of less than 5. Student's *t*-test was used to compare normally distributed quantitative variables between the two studied groups. An *F*-test (ANOVA) was used to compare normally distributed quantitative variables between more than two groups. Paired *t*-test was used to compare normally distributed quantitative variables between two periods. Pearson coefficient was used to correlate between two normally distributed quantitative variables.

Results

According to the presented data, 86% of the patients found the diet *palatable*, 82% reported the availability of the diet (except gluten-free wheat), and 75% considered the diet affordable (except for gluten-free products). According to the FARS score, 67% were well adherent (mean score: 18.16 ± 6.85). In addition, 75% were satisfied with the diet. There was a significant overall reduction in the mean score of GSRS after the diet (9.72 ± 4.31) in comparison with that before the diet (15.78 ± 4.27) (Table 4).

Table 3 A suggested general low FODMAP sample menu, to be individualized according to the patients' requirements

Days	Breakfast	Lunch	Dinner	Snacks
Day 1	Eggs fried with tomato, parsley, salt, and pepper	Soup with carrots, potatoes, parsley, coriander, and chicken	Cake with corn flour and available fruits	Grilled corn Fruits with jam
Day 2	Small bowl of famous cheap Egyptian brands of porridge/rice cereals with milk or water with sugar and fruits (lactose-free milk if necessary)	Pizza from corn flour with allowed vegetables ± chicken Or Mahshi (stuffed cabbage with rice and vegetables without onions)	Corn flour bread with cheese and olives	Fruit salad with sugar Cucumber Chips Nuts Cakes from corn flour ± Ice cream Dark chocolate
Day 3	Vanilla cake with corn flour	Musqaea (aubergine, minced meat with herbs without onions or garlic) + rice Or Zucchini with potato bachelme	Corn flour bread with jam with the allowed fruits (strawberry)	
Day 4	Boiled eggs with herbs	Fried potatoes with grilled chicken	Large bowl of vegetables (no onions) with feta cheese/tuna	
Day 5	Cheese (feta) with tomato and olive oil plus cucumber	Cooked potatoes with tomato and chicken/different vegetables + rice	Mashed potatoes with herbs and parsley	
Day 6	Egg omelet with cheddar cheese, salt, and pepper	Spinach-cooked rice and green herbs + rice	Allowed fruits in cream or jam	
Day 7	Orange cake with corn flour	Large bowl of salad with tuna (no onions)	Eggs boiled with salt and pepper	

FODMAP, Fermentable Oligosaccharides, Disaccharides, Monosaccharides, And Polyols.

Table 4 Comparison of studied cases according to GSRS pre- and post-low FODMAP diet (n = 100)

GSRS	Pretreatment Mean ± SD	Post-treatment Mean ± SD	t	P
Abdominal pain	1.65 ± 0.87	0.83 ± 0.82	7.683 [†]	<0.001 [†]
Bloating	1.47 ± 0.73	0.83 ± 0.60	7.664 [†]	<0.001 [†]
Flatulence	1.46 ± 0.69	0.86 ± 0.64	7.978 [†]	<0.001 [†]
Belching	1.65 ± 0.82	0.91 ± 0.82	7.975 [†]	<0.001 [†]
Borborygmi	1.54 ± 0.77	0.83 ± 0.73	7.869 [†]	<0.001 [†]
Fecal urgency	1.55 ± 0.81	0.80 ± 0.70	8.409 [†]	<0.001 [†]
Incomplete evacuation	1.54 ± 0.83	0.85 ± 0.77	7.518 [†]	<0.001 [†]
Nausea	1.0 ± 0.90	0.97 ± 0.85	0.291	0.771
Heartburn	1.08 ± 0.80	0.95 ± 0.74	1.237	0.219
Acid regurgitation	1.12 ± 0.92	1.20 ± 1.06	0.083	0.934
Lethargy	1.63 ± 0.75	0.69 ± 0.61	10.480 [†]	<0.001 [†]
Total score of GSRS	15.78 ± 4.27	9.72 ± 4.31	15.239 [†]	<0.001 [†]

[†]Statistically significant at P ≤ 0.05.

FODMAP, Fermentable Oligosaccharides, Disaccharides, Monosaccharides, And Polyols; GSRS, gastrointestinal symptom rating scale; t, P, t and P values for paired t-test.

Furthermore, colonic symptoms such as abdominal pain, bloating, flatulence, belching, borborygmi, fecal urgency, and incomplete evacuation, in addition to lethargy, were significantly reduced after the diet (P < 0.001). Consequently, the mean score of the percentage of improvement of the functional symptoms was calculated: (postdiet score – prediet score)/prediet score × 100 (38.45 ± 21.56) (Fig. 1).

Interestingly, there was a significant improvement in every aspect of the SIBDQ questionnaire (P < 0.001). Moreover, the percent score for quality of life was calculated: (average score – 1)/6 × 100 (Fig. 2). In addition, there was a positive

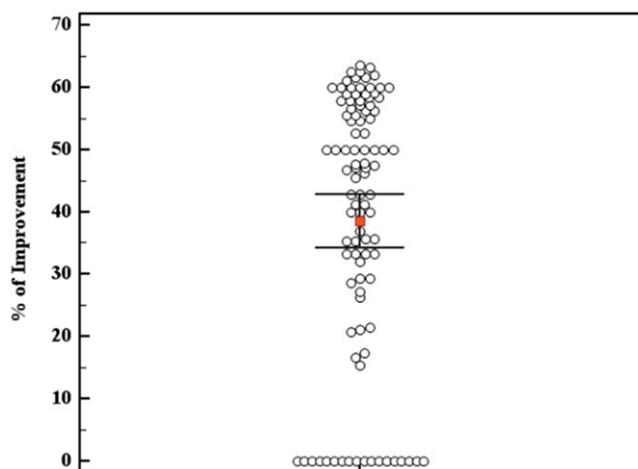


Figure 1 Dot plot shows descriptive analysis of studied cases according to the percentage of improvement of the functional gastrointestinal disease symptoms. The minimum–maximum score (0.0–63.64) with mean value ± SD (38.45 ± 21.56). Postdiet score – Prediet score/ prediet score × 100.

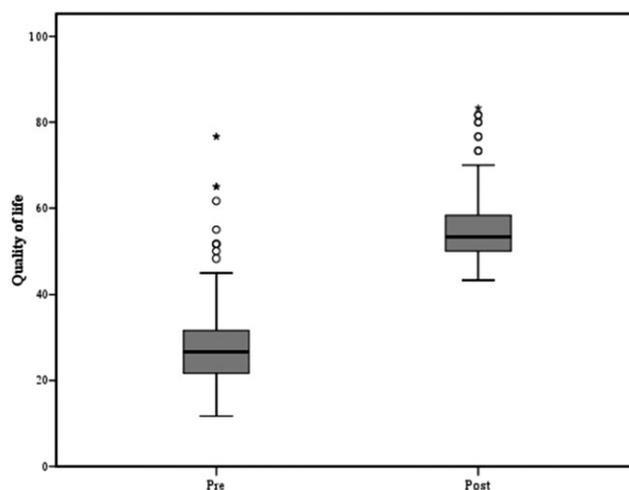


Figure 2 Box and whisker diagram showing the distribution of the studied cases according to the percent total score of the SIBDQ (short inflammatory bowel disease questionnaire). The percent score was calculated: (average score – 1)/6 × 100. The results were statistically significant at P ≤ 0.05.

significant correlation between adherence and the quality of life after the diet (r = 0.435, P < 0.001) (Fig. 3). We documented a true correlation between the percentage of improvement of the symptoms of the patients and the impact of the diet on their quality of life (r = 0.396, P < 0.001). As for the demographic data and the quality of life, 19 of 21 (90.5%) female patients recorded improvement in the quality of life after following the diet. Moreover, 17 of 21 (81%) with high (tertiary) education, 16 of 21 (76.2%) of the household (not working), and 19% of those with only 6 working hours recorded better quality of life than those with longer shift hours. The number of the household also had an impact on the quality of life as 76.2% who lived with one to two members recorded better quality versus the 4.8% who lived with more than four members. There was no significant

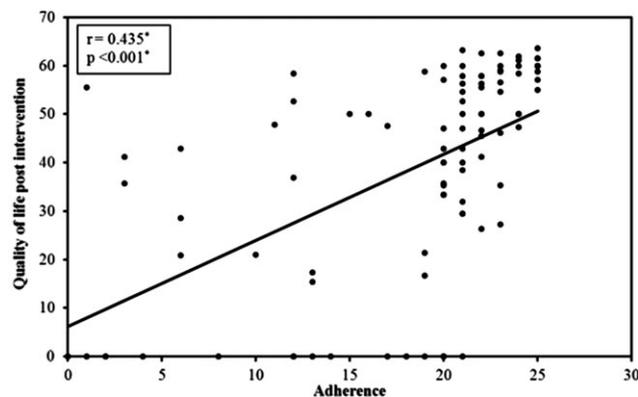


Figure 3 Correlation between adherence and quality of life after following the low FODMAP (Fermentable Oligosaccharides, Disaccharides, Monosaccharides, And Polyols) diet for 3 months. Pearson coefficient was used to correlate between the both variables. r: Pearson coefficient *: Statistically significant at p ≤ 0.05

relationship between the age of the patients and being a smoker and the quality of life.

Discussion

Although there were several challenges, specifically with the nature of the Egyptian diet, a significant number of patients were adherent to the low FODMAP diet for 3 months. Our result was supported by a number of studies that reported the adherence to the diet with no problems mainly due to the vast improvement of the symptoms.^{18–20} Different factors that would be expected to empower the patients to comply with the diet were assessed; 86% of the patients found the diet palatable. A significant number also found the diet affordable. However, not all the food items were accessible, especially the wheat-free (gluten-free) bread. It was noticed that patients had chosen to buy rice, corn, and potato flour rather than the gluten-free wheat as they were more available and cheaper. There was an agreement with several local shops covering the main areas in Alexandria to bake cheap products with corn or rice flour. Accordingly, it was found that three-quarters of the patients were strikingly satisfied. Our finding was also evidenced by studies which found that patients were fairly satisfied, even those who underwent group education and not one-on-one sessions.^{18,21}

In the present study, overall, significant improvement occurred after following the diet ($t = 15.239$, $P < 0.001$). Furthermore, abdominal pain, bloating, flatulence, belching, borborygmi, and incomplete evacuation and fecal urgency were expressively reduced after the diet. Likely,²² there were data illustrating a significant reduction in the severity of abdominal pain (OR: 1.81, 95% CI: 1.13–2.88; $I(2) = 0.00$, $P = 0.56$), bloating (OR: 1.75, 95% CI: 1.07–2.87; $I(2) = 0.00$, $P = 0.45$), and overall symptoms of FGID in patients who followed a low FODMAP diet. Other recorded data found¹⁹ that bloating, abdominal pain, and flatulence were the symptoms that showed the greatest improvement after 4 weeks of following the low FODMAP diet in IBS patients. Unpredictably, one study²³ did not find a clear difference in their comparative trials between the response to a low FODMAP diet in IBS with constipation and IBS with diarrhea.

It is not surprising then that the quality of life of the patients was recorded to be considerably better after following the diet for 3 months. One study²² reported significant improvement in the quality of life in patients with FGID who consumed a low FODMAP diet even if there was no improvement in the functional symptoms, as reported by some.²⁴

In the current study, we tried to summarize the factors that contributed to the success of the diet in terms of improving the quality of life. There was a positive significant correlation between the percentage of improvement, the adherence to the diet, and the quality of life after the diet. We found that being female, with a higher education level, household, or working in jobs with less than 6 h only and living with a small number of people in the same place are all factors that were associated with the improvement of quality of life after following the diet for 3 months. Our preliminary reasons are that these factors lead to a better understanding of the challenges of the nature of the diet in Egypt (which depends mainly on high FODMAP items as beans and bread). Unfortunately, according to our data, no one who

worked in long-shifts jobs (>6 h) demonstrated improvement in their quality of life. Supporting our data, it was reported that a higher education level and being employed for no more than 35 h per week were associated with the success of the diet as there is time to seek out the food required.²⁵

Acknowledgments

This work was supported by the Nutrition and Dietetic Department, High Institute of Public Health (HIPH). We thank all the patients who participated in this study as well as Alexandria University Hospital for giving us the chance to conduct such a study.

References

- 1 Ha F, Khalil H. Crohn's disease: a clinical update. *Therap. Adv. Gastroenterol.* 2015; **8**: 352–9.
- 2 Almadi MA, Ghosh S, Aljebreen AM. Differentiating intestinal tuberculosis from Crohn's disease: a diagnostic challenge. *Am. J. Gastroenterol.* 2009; **104**: 1003–12.
- 3 Sands BE, Ooi CJ. A survey of methodological variation in the Crohn's disease activity index. *Inflamm. Bowel Dis.* 2005; **11**: 133–8.
- 4 Jonefjäll B, Strid H, Ohman L, Svedlund J, Bergstedt A, Simren M. Characterization of IBS-like symptoms in patients with ulcerative colitis in clinical remission. *Neurogastroenterol. Motil.* 2013; **25**: 756–e578.
- 5 Salvioli B, Serra J, Azpiroz F, Malagelada JR. Impaired small bowel gas propulsion in patients with bloating during intestinal lipid infusion. *Am. J. Gastroenterol.* 2006; **101**: 1853–7.
- 6 Gibson PR, Shepherd SJ. Personal view: food for thought—western lifestyle and susceptibility to Crohn's disease. The FODMAP hypothesis. *Aliment. Pharmacol. Ther.* 2005; **21**: 1399–409.
- 7 Muir JG, Shepherd SJ, Rosella O, Rose R, Barrett JS, Gibson PR. Fructan and free fructose content of common Australian vegetables and fruit. *J. Agric. Food Chem.* 2007; **55**: 6619–27.
- 8 Wehr H, Cowan JM. *Dictionary of Modern Written Arabic*. Urbana, IL: Spoken Language Services, Inc, 1994.
- 9 Nilsson U, Dahlqvist A. Cereal fructosans: part 2 – characterisation and structure of wheat fructosans. *Food Chem.* 1986; **22**: 95–106.
- 10 Kraig B, Sen CT. *Street food around the world: an encyclopedia of food and culture*. Santa Barbara, California: ABC-CLIO, 2013.
- 11 Huamán JW, Felip A, Guedea E, Jansana M, Videla S, Saperas E. The diet low in fermentable carbohydrates short chain and polyols improves symptoms in patients with functional gastrointestinal disorders in Spain. *Gastroenterol. Hepatol.* 2015; **38**: 113–22.
- 12 Pedersen N, Ankersen DV, Felding M *et al.* Low FODMAP diet reduces irritable bowel symptoms and improves quality of life in patients with inflammatory bowel disease in a randomized controlled trial. *Gastroenterology.* 2014; **146** (Suppl. 1): S-587.
- 13 Irvine EJ, Feagan B, Rochon J *et al.* Quality of life: a valid and reliable measure of therapeutic efficacy in the treatment of inflammatory bowel disease. *Gastroenterology.* 2012; **106**: 287–96.
- 14 Byrne M, Walsh J, Murphy AW. Secondary prevention of coronary heart disease: patient beliefs and health-related behaviour. *J. Psychosom. Res.* 2005; **58**: 403–15.
- 15 Irvine EJ, Whitehead WE, Chey WD *et al.* Design of treatment trials for functional gastrointestinal disorders. *Gastroenterology.* 2006; **130**: 1538–51.
- 16 Svedlund J, Sjodin I, Dotevall G. GRSR—a clinical rating scale for gastrointestinal symptoms in patients with irritable bowel syndrome and peptic ulcer disease. *Dig. Dis. Sci.* 1988; **33**: 129–34.

- 17 Irvine EJ, Zhou Q, Thompson AK. The short inflammatory bowel disease questionnaire: a quality of life instrument for community physicians managing inflammatory bowel disease. *Am. J. Gastroenterology*. 1996; **91**: 1571–8.
- 18 Maagaard L, Ankersen DV, Végh Z *et al.* Follow-up of patients with functional bowel symptoms treated with a low FODMAP diet. *World J. Gastroenterol*. 2016; **22**: 4009–19.
- 19 Böhn L, Störsrud 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**: 1399–407.
- 20 de Roest RH, Dobbs BR, Chapman BA *et al.* The low FODMAP diet improves gastrointestinal symptoms in patients with irritable bowel syndrome: a prospective study. *Int. J. Clin. Pract.* 2013; **67**: 895–903.
- 21 Whigham L, Joyce T, Harper G *et al.* Clinical effectiveness and economic costs of group versus one-to-one education for short-chain fermentable carbohydrate restriction (low FODMAP diet) in the management of irritable bowel syndrome. *J. Hum. Nutr. Diet.* 2015; **28**: 687–96.
- 22 Marsh A, Eslick EM, Eslick GD. Does a diet low in FODMAPs reduce symptoms associated with functional gastrointestinal disorders? A comprehensive systematic review and meta-analysis. *Eur. J. Nutr.* 2016; **55**: 897–906.
- 23 Staudacher HM, Whelan K, Irving PM, Lomer MC. Comparison of symptom response following advice for a diet low in fermentable carbohydrates (FODMAPs) versus standard dietary advice in patients with irritable bowel syndrome. *J. Hum. Nutr. Diet.* 2011; **24**: 487–95.
- 24 Ostgaard H, Hausken T, Gundersen D, El-Salhy M. Diet and effects of diet management on quality of life and symptoms in patients with irritable bowel syndrome. *Mol. Med. Rep.* 2012; **5**: 1382–90.
- 25 Geary RB, Irving PM, Barrett JS, Nathan DM, Shepherd SJ, Gibson PR. Reduction of dietary poorly absorbed short-chain carbohydrates (FODMAPs) improves abdominal symptoms in patients with inflammatory bowel disease—a pilot study. *J. Crohns Colitis*. 2009; **3**: 8–14.