# The impact of low-FODMAP diet on symptom relief in patients with irritable bowel syndrome

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**Running title:** Low-FODMAP diet and irritable bowel syndrome

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## ABSTRACT

**Background and Objectives:** Irritable bowel syndrome (IBS) stands as a prevalent functional gastrointestinal condition known for causing persistent abdominal pain, changes in bowel patterns, and diminished quality of life. The low fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAP) diet has emerged as a potential approach to managing IBS through dietary adjustments. To explore how the low FODMAP diet affects symptom relief, nutritional well-being, and overall quality of life in IBS patients when compared to those adhering to a standard diet. **Methods and Study Design:** A retrospective cohort study was conducted, including patients with IBS categorized into a regular diet group and a low FODMAP diet group. Dietary intake, daily nutrient intake, IBS symptom severity, adverse events, and quality of life were assessed. **Results:** The low FODMAP diet group demonstrated significantly lower intake of fermentable carbohydrates, including total dietary fiber, fructose, lactose, sorbitol, and total carbohydrates, compared to the regular diet group. Additionally, the low FODMAP diet group exhibited favorable nutritional profiles, reflecting higher intake and utilization of essential nutrients such as vitamin C, iron, calcium, vitamin D, and omega-3 fatty acids. Moreover, significant improvements in symptom severity, adverse event profiles, and quality-of-life scores were observed in the low FODMAP diet group compared to the regular diet group. **Conclusions:** The Low-FODMAP Diet significantly alters nutrient intake in IBS patients, which may contribute to the observed symptom relief.


**Key Words: low-FODMAP diet, symptom, relief, irritable bowel syndrome, nutrients**

## INTRODUCTION

Irritable bowel syndrome (IBS) is a common gastrointestinal condition marked by persistent abdominal pain, discomfort, and alterations in bowel patterns, affecting a significant segment of the global populace.[1, 2] The condition is multifaceted and involves various factors, including changes in gut motility, heightened visceral sensitivity, dysfunction in the gut-brain axis, and immune system activation, contributing to its complex pathophysiology.[3, 4] The management of IBS often requires a multidisciplinary approach, with dietary modifications increasingly recognized as playing a significant role in alleviating symptoms and improving patients' quality of life. One dietary approach that has garnered interest for its potential to alleviate symptoms in individuals with IBS is the low fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAP) diet, among various dietary

strategies.[5, 6] Dietary interventions form an integral part of IBS management, aiming to address the diverse range of symptoms experienced by affected individuals. The low FODMAP diet (LFD), specifically designed to reduce the intake of fermentable carbohydrates, has emerged as a promising dietary management strategy for individuals with IBS.[7, 8] In the small intestine, FODMAPs were inefficiently absorbed and were easily fermented by the bacteria in the large intestine, resulting in heightened gas production, bloating, and abdominal discomfort.[9, 10] Thus, the restriction of FODMAPs in the diet aims to minimize these symptom triggers and potentially alleviate the burden of gastrointestinal symptoms in affected individuals.

In the pursuit of enhancing the evidence base for dietary interventions in IBS, the impact of the LFD on symptom relief, daily nutrient intake, and quality of life has been a subject of increasing research interest.[11] The concept of modifying dietary intake to manage IBS symptoms was underpinned by the intricate interplay between food components, gut microbiota, and gastrointestinal function. Understanding the role of dietary factors, particularly the LFD, in mitigating the symptom burden and enhancing the overall well-being of individuals with IBS was crucial for optimizing the comprehensive care of affected patients.[12] This study aims to investigate the impact of the LFD on symptom relief, nutrient intake, and quality of life in patients with IBS, compared to those following a regular diet.

## MATERIALS AND METHODS

### *Study design and participants*

This study was a retrospective cohort study that included patients with IBS from January 2023 to June 2023, categorized into two groups based on their dietary patterns: a regular diet (RD) group and an LFD group. In order to be eligible for inclusion in this study, patients had to meet the following criteria13: a diagnosis of IBS, aged between 18 and 65 years, with complete medical records, normal mental and cognitive function, and the ability to undergo four weeks of follow-up. Patients who were deemed ineligible for the study were those who exhibited severe cardiovascular, hepatic, neurological, or psychiatric diseases. Furthermore, participants were excluded if they had other gastrointestinal diseases, diabetes, food allergies, or intolerances. Furthermore, patients following a specific diet, including vegetarian, vegan, gluten-free, low FODMAP, or low-carbohydrate high-fat diet, were also excluded. Individuals who had undergone gastrointestinal surgery, with the exception of appendectomy or cholecystectomy, and those who had used antibiotics within one month prior to the start of the study were also excluded. Furthermore, pregnant or lactating females, as well as patients who

had previously consulted a dietitian for IBS management or were currently undergoing other IBS therapies, were excluded from participation. Finally, individuals who had taken pharmacologic agents to modify their symptoms, such as laxatives or antidiarrheal agents, were also excluded.

***Dietary intervention***

Patients in the RD group maintained their usual dietary habits without any specific dietary interventions or restrictions, including no active restriction of high FODMAP foods. This was confirmed through self-reported food journals collected during a 7-day baseline period, reviewed by a research dietitian for completeness. The 7-day food record is a standard, validated tool for assessing dietary intake and compliance, as demonstrated in prior low FODMAP diet studies.[14,15] They were given thorough guidance on how to document their food and beverage consumption, including specific details on brand, type, estimated portion sizes using packaging information, household measurements, or standardized images of food. To ensure the precision of the dietary intake data, a single research dietitian meticulously reviewed all food records for completeness. Moreover, during initial visit, patients in LFD group were received counseling from one of two experienced dietitians in addition to written materials. Those in the LFD group were advised to limit their intake of specific carbohydrates such as fructans (found in wheat, onion, garlic), galacto-oligosaccharides (found in pulses), lactose (found in milk), fructose in excess of glucose (found in honey), and polyols (found in apples, pears). They were also instructed to replace these items with suitable low FODMAP alternatives. Throughout the 4-week intervention, all patients were contacted weekly to monitor any adverse effects and address any concerns regarding their assigned diet. Finally, during the last week of the intervention, patients completed a 7-day food record which was then submitted at their final trial visit. Data regarding dietary consumption was gathered at the initial phase, referred to as the "Regular Diet", and during the concluding week of the 4-week intervention. This was achieved through the utilization of a 7-day food diary along with household measures and food photographs to aid in estimating portion sizes. The information from these food diaries was then inputted into dietary analysis software (specifically, Diet Plan, Version 6 P3 Forestfield Software, Horsham, UK) for thorough analysis. Nutrient intake was determined using the Composition of Foods Integrated Dataset (CoFID).

***Data collection***

General information including age, gender, BMI, duration of IBS, IBS symptom severity scores, IBS subtype, educational level, employment status, and marital status was collected and compiled from the medical records system. IBS patients were further categorized as constipation-predominant (IBS-C), diarrhea-predominant (IBS-D), or mixed diarrhea and constipation (IBS-M). Daily nutrient intake was assessed through dietary intake data (e.g., vitamin C, iron, calcium, vitamin D, and omega-3 fatty acids) derived from 7-day food records analyzed using dietary analysis software. Gastrointestinal symptoms during the study period, including abdominal pain score, bloating score, weekly flatulence frequency, stool consistency, and overall IBS score were recorded. The IBS Symptom Severity Scale (IBS-SSS) was used to evaluate the severity of symptoms related to irritable bowel syndrome including five elements. These components encompass the assessment of abdominal discomfort, frequency of abdominal pain episodes, level of bloating discomfort, satisfaction with bowel habits and behaviors, as well as the influence of gastrointestinal symptoms on daily life. Each item has a maximum score of 100, resulting in a total score of 500. Scores between 75-175 indicate mild severity, 176-300 indicate moderate severity, and scores exceeding 300 indicate severe severity. Higher scores correspond to more severe IBS symptoms. The reliability of this questionnaire was reported to be 0.953.[16] Adverse events during the trial period, such as nausea, headache, diarrhea, constipation, and flatulence, were documented. Quality of life scores at the conclusion of the study, including somatization, emotion management, role performance, cognitive function, and return to social activities, were also assessed. The study employed the Short Form 36 (SF-36) to assess individuals' quality of life. The extensive scale encompasses various domains such as physical functioning, mental health, social well-being, and overall health status. It includes assessments on physical functioning, limitations arising from physical health issues, emotional constraints, energy levels, emotional well-being, social interaction, pain evaluations, and overall health perceptions. Respondents rated each question on a five-point scale, from "excellent" to "poor." Each question is scored from 0 to 100, with higher scores indicating a lesser impact of the related issue. The scale demonstrated a reported reliability of 0.90.[17]

***Statistical methods***

Data analysis for the study utilized the SPSS 29.0 statistical software (SPSS Inc, Chicago, IL, USA). Categorical variables were represented as [n (%)] and chi-square test was used. Assessment of normal distribution for continuous variables was conducted using the Shapiro-

Wilk test. The reporting of results for normally distributed continuous variables took the form of mean ± standard deviation (SD), and the corrected variance t-test was applied. Statistical significance was set at a two-tailed $p < 0.05$. A post-hoc power analysis was performed based on the observed difference in overall IBS-SSS scores ($\alpha = 0.05$), indicating > 80% power to detect significant differences with the current sample size.

## RESULTS

### *Baseline characteristics*

A total of 134 were included in the current study (Figure 1). The initial characteristics of the research subjects can be found in Table 1. Within the study, 65 participants were part of the RD Group, while the LFD Group consisted of 69 individuals. These groups displayed similarity across various parameters such as age, gender distribution, body mass index, IBS duration, IBS-SSS, IBS subtype distribution, level of education, employment status, and marital status. Importantly, no statistically significant variances were noted between the two groups ($p > 0.05$). These findings suggest that at baseline, the participants in the two dietary intervention groups were well-matched, supporting the comparability of the groups at the outset of the study.

### *Daily FODMAP intake*

The LFD Group demonstrated significantly lower intake of total dietary fiber ($p < 0.001$), fructose ($p< 0.001$), lactose ($p < 0.001$), sorbitol ($p < 0.001$), and total carbohydrates ($p < 0.001$). The RD group showed higher intake of fermentable carbohydrates (e.g., fructose, lactose), consistent with the absence of FODMAP restrictions (Figure 2). These findings emphasize the distinct dietary patterns between the two groups, highlighting the effectiveness of the LFD in altering specific nutrient intake in patients with IBS.

### *Daily nutrient intake*

The nutritional analysis indicated significant differences in the vitamin C intake ($p = 0.002$), iron intake ($p = 0.011$), calcium intake ($p = 0.005$), vitamin D levels ($p = 0.002$), and omega-3 fatty acid intake ($p = 0.004$) between the RD Group and the LFD Group (Figure 3). These results suggest that the LFD significantly influences the daily nutrient intake of patients with IBS, potentially contributing to the observed symptom relief.

***IBS-SSS***

The analysis of the IBS-SSS revealed statistically significant differences between the RD Group and the LFD Group in all parameters, including abdominal discomfort ($p$ = 0.006), abdominal discomfort episodes per day ($p$ = 0.002), abdominal distension discomfort ($p$ = 0.004), satisfaction with bowel movements ($p$ = 0.002), daily life impact ($p$ = 0.006), and overall IBS-SSS ($p$ = 0.002) (Figure 4). These findings indicate that the LFD significantly improved symptom severity and overall quality of life for patients with IBS when compared to the RD Group.

***Adverse events***

The comparison of adverse events between the RD Group and the LFD Group revealed statistically significant differences in the occurrence of nausea ($p$ = 0.046), headache ($p$ = 0.030), diarrhea ($p$ = 0.016), constipation ($p$ = 0.046), and flatulence ($p$ = 0.026), respectively (Table 2). These results highlight a significantly lower incidence of adverse events in the LFD Group compared to the RD Group, indicating the favorable tolerability of the LFD in patients with IBS.

***Quality of life score***

The comparison of quality-of-life scores between the RD Group and the LFD Group revealed statistically significant differences in somatization ($p$ = 0.001), emotion management ($p$ = 0.003), role play ($p$ = 0.003), cognitive function ($p$ = 0.002). There was also a statistically significant difference in the return to social function ($p$ = 0.013) between the two groups (Table 3). These findings suggest that the LFD positively impacted the quality of life in patients with IBS, as evidenced by improvements in various domains of quality-of-life scores when compared to the RD Group.

## DISCUSSION

IBS, a common functional gastrointestinal issue, is characterized by enduring abdominal discomfort, pain, and alterations in bowel habits.[18, 19] The physiology of irritable bowel syndrome (IBS) is intricate, involving alterations in gut movement, heightened sensitivity in the abdomen, disruptions in the communication between the gut and the brain, and activation of the immune system. Management of IBS often requires a multidisciplinary approach, with dietary modifications playing a significant role in alleviating symptoms and improving patients' quality of life.[20, 21] In this research, our objective was to explore how a LFD affects

symptom relief, nutrient intake, and quality of life among IBS patients in contrast to individuals adhering to a standard diet. Dietary intake analysis revealed significant differences in nutrient intake between the RD group as well as the LFD group. Patients under the LFD demonstrated significantly lower intake of total dietary fiber, fructose, lactose, sorbitol, and total carbohydrates compared to those adhering to a regular diet. Such distinctive dietary patterns highlight the effectiveness of the LFD in altering specific nutrient intake in patients with IBS. These findings were consistent with previous research demonstrating the potential of LFD in reducing fermentable substrates that can contribute to gas production, bloating, and abdominal discomfort in individuals with IBS.[22, 23] The LFD targets specific dietary components that were known to exacerbate gastrointestinal symptoms in individuals with IBS. FODMAP are a group of carbohydrates that are not effectively absorbed in the small intestine. These carbohydrates undergo fermentation by gut bacteria in the large intestine, resulting in elevated gas production and symptoms such as bloating and abdominal discomfort.[24, 25]

Furthermore, the observed differences in nutrient intake reflect the body's nutritional state as influenced by the low FODMAP diet (LFD). We observed significant differences in vitamin D, calcium, vitamin C, iron, and omega-3 fatty acid intake between the RD group and the LFD group. The LFD group exhibited favorable nutritional profiles, including higher intake of essential nutrients such as vitamin C, calcium, omega-3 fatty acids, vitamin D, and iron. These nutritional improvements were of clinical significance, as individuals with IBS may be at risk of inadequate nutrient intake due to dietary restrictions, malabsorption, and gastrointestinal symptoms.[26] The observed enhancement of daily nutrient intake with the LFD reinforces its potential role in addressing dietary deficiencies associated with IBS and promoting overall health in affected individuals. The analysis of the IBS-SSS demonstrated significant improvements in abdominal discomfort, abdominal discomfort episodes per day, abdominal distension discomfort, satisfaction with bowel movements, daily life impact, and overall IBS-SSS in the LFD group compared to the RD group. These findings underscore the clinical relevance of the LFD in ameliorating IBS symptoms and enhancing overall well-being. The observed reductions in symptom severity align with the premise of the LFD, which aims to minimize the consumption of poorly absorbed, fermentable carbohydrates that can exacerbate gastrointestinal symptoms in individuals with IBS. The significant improvements in symptom severity further support the beneficial effects of the LFD as a dietary management strategy for individuals with IBS. Adverse events analysis revealed a significantly lower incidence of nausea, headache, diarrhea, constipation, and flatulence in the

LFD group compared to the RD group. These findings indicate the favorable tolerability of the LFD in patients with IBS, reflecting its potential for mitigating adverse gastrointestinal symptoms commonly experienced by affected individuals. The lower occurrence of adverse events with the LFD was of paramount importance in clinical practice, as it signifies the potential for improved gastrointestinal tolerability and enhanced treatment adherence in patients with IBS undergoing dietary management.[27-29] Moreover, the quality of life scores analysis demonstrated significant improvements in somatization, emotion management, role play, cognitive function, and return to social function in the LFD group compared to the RD group. These findings highlight the multifaceted benefits of the LFD beyond symptom relief, encompassing improvements in various domains of quality-of-life scores. The observed enhancements in quality of life reflect the holistic impact of the LFD on psychological well-being, social functioning, and emotional health in individuals with IBS, emphasizing its potential to address the multidimensional impact of the condition on patients' lives. The amelioration of symptoms such as abdominal discomfort, bloating, and altered bowel habits can alleviate the physical and psychological burden experienced by patients, leading to enhanced emotional well-being, social functioning, and cognitive adaptability. Furthermore, the restoration of adequate nutrient intake and the resultant improvements in metabolic and physiological functions can support systemic health and vitality, reinforcing the overall impact of the LFD on quality of life domains beyond symptom relief.[30-32]

Overall, the findings from this study provide compelling evidence for the favorable impact of the LFD on symptom relief, nutrient intake, and quality of life in patients with IBS. The demonstrated improvements in nutrient intake, symptom severity, adverse event profiles, and quality-of-life scores endorse the clinical significance of the LFD as a promising dietary management approach for individuals with IBS. However, it was important to acknowledge the limitations of this study. Firstly, the retrospective cohort study design employed in this investigation necessitates consideration of potential selection bias and the inability to establish causality. While efforts were made to control for confounding variables, the inherent limitations of retrospective analyses should be taken into account when interpreting the results. The 4-week intervention period may not entirely capture the long-term impact and sustainability of the LFD on symptom relief, nutrient intake, and quality of life in IBS patients. While the 7-day record from the final week effectively captured short-term compliance, it may not reflect long-term adherence, warranting further investigation. Future studies implementing longer follow-up periods were warranted to elucidate the extended efficacy and safety of the LFD. Moreover, the small sample size and demographic

homogeneity warrant cautious generalization of the findings to broader populations of individuals with IBS. Additionally, while our study demonstrates changes in nutrient intake, direct assessment of daily nutrient intake via biomarkers (e.g., serum vitamin D or iron levels) was not conducted. Future studies should incorporate such measures to fully elucidate the LFD's impact on daily nutrient intake. In light of these limitations, it was imperative to conduct further long-term, prospective randomized controlled trials involving larger, diverse cohorts to validate the enduring benefits and safety profile of the LFD as a dietary management strategy for individuals with IBS.

***Conclusion***

In summary, this study offers important insights into the potential advantages of implementing the LFD to tackle the various difficulties linked with IBS. The LFD significantly alters nutrient intake in IBS patients, which may contribute to the observed symptom relief. Future research endeavors should focus on elucidating the long-term effects, mechanistic underpinnings, and individualized application of the LFD to optimize its clinical utility and enhance the comprehensive care of individuals with IBS.

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**CONFLICT OF INTEREST AND FUNDING DISCLOSURE**

The authors have no conflicts of interest to declare.

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**Table 1.** Baseline characteristics

| Parameter | RD group (n=65) | LFD group (n=69) | $t/\chi^2$ | *p* |
|---|---|---|---|---|
| Age (years) | 39.3 ± 5.21 | 40.1 ± 4.95 | 0.893† | 0.374 |
| Gender | | | | |
| Male [n (%)] | 31 (47.7%) | 36 (52.2%) | 0.120‡ | 0.730 |
| Female [n (%)] | 34 (52.3%) | 33 (47.8%) | | |
| BMI ($kg/m^2$) | 22.7 ± 2.95 | 23.2 ± 3.21 | 0.844† | 0.400 |
| Duration of IBS (months) | 3.21 ± 1.47 | 3.54 ± 1.21 | 1.43† | 0.156 |
| IBS-SSS Score | 295 ± 6.21 | 294 ± 6.15 | 0.774† | 0.440 |
| IBS Subtype (%) | | | | |
| IBS-D | 20 (30.8%) | 19 (27.5%) | 0.649‡ | 0.723 |
| IBS-C | 23 (35.4%) | 22 (31.9%) | | |
| IBS-M | 22 (33.9%) | 28 (40.6%) | | |
| Educational Level | | | | |
| High School | 13 (20.0%) | 12 (17.4%) | 0.360‡ | 0.835 |
| College | 26 (40.0%) | 31 (44.9%) | | |
| Graduate School | 26 (40.0%) | 26 (37.7%) | | |
| Employment Status | | | | |
| Employed | 39 (60.0%) | 38 (55.1%) | 0.464‡ | 0.793 |
| Unemployed | 13 (20.0%) | 17 (24.6%) | | |
| Student | 13 (20.0%) | 14 (20.3%) | | |
| Marital Status | | | | |
| Married | 45 (69.2%) | 47 (68.1%) | 0.067‡ | 0.967 |
| Single | 13 (20.0%) | 15 (21.7%) | | |
| Divorced | 7 (10.8%) | 7 (10.1%) | | |

RD, regular diet; LFD, low FODMAP diet; BMI, body mass index; IBS, Irritable bowel syndrome; IBS-SSS, IBS Symptom Severity Scale; IBS-C; constipation-predominant; IBS-D, diarrhea-predominant; IBS-M, mixed diarrhea and constipation.
†t-test
‡chi-square test.

**Table 2.** Adverse events

| Parameter | RD group (n=65) | LFD group (n=69) | $\chi^2$ | *p* |
|---|---|---|---|---|
| Nausea (%) | 9 (13.9%) | 2 (2.9%) | 3.97‡ | 0.046 |
| Headache (%) | 8 (12.3%) | 1 (1.45%) | 4.69‡ | 0.030 |
| Diarrhea (%) | 9 (13.9%) | 1 (1.45%) | 5.76‡ | 0.016 |
| Constipation (%) | 9 (13.9%) | 2 (2.9%) | 3.97‡ | 0.046 |
| Flatulence (%) | 10 (15.4%) | 2 (2.9%) | 4.96‡ | 0.026 |

RD, regular diet; LFD, low FODMAP diet
‡chi-square test

**Table 3.** Quality of life

| Parameter | RD group (n=65) | LFD group (n=69) | t | *p* |
|---|---|---|---|---|
| Somatization | 76.0 ± 10.02 | 81.7 ± 9.98 | 3.29† | 0.001 |
| Emotion management | 76.1 ± 9.78 | 81.1 ± 9.26 | 3.03† | 0.003 |
| Role play | 77.3 ± 10.23 | 82.4 ± 9.21 | 3.06† | 0.003 |
| Cognitive function | 77.5 ± 9.11 | 82.7 ± 9.82 | 3.19† | 0.002 |
| Return to social function | 77.7 ± 9.78 | 82.1 ± 10.23 | 2.51† | 0.013 |

RD, regular diet; LFD, low FODMAP diet
†t-test

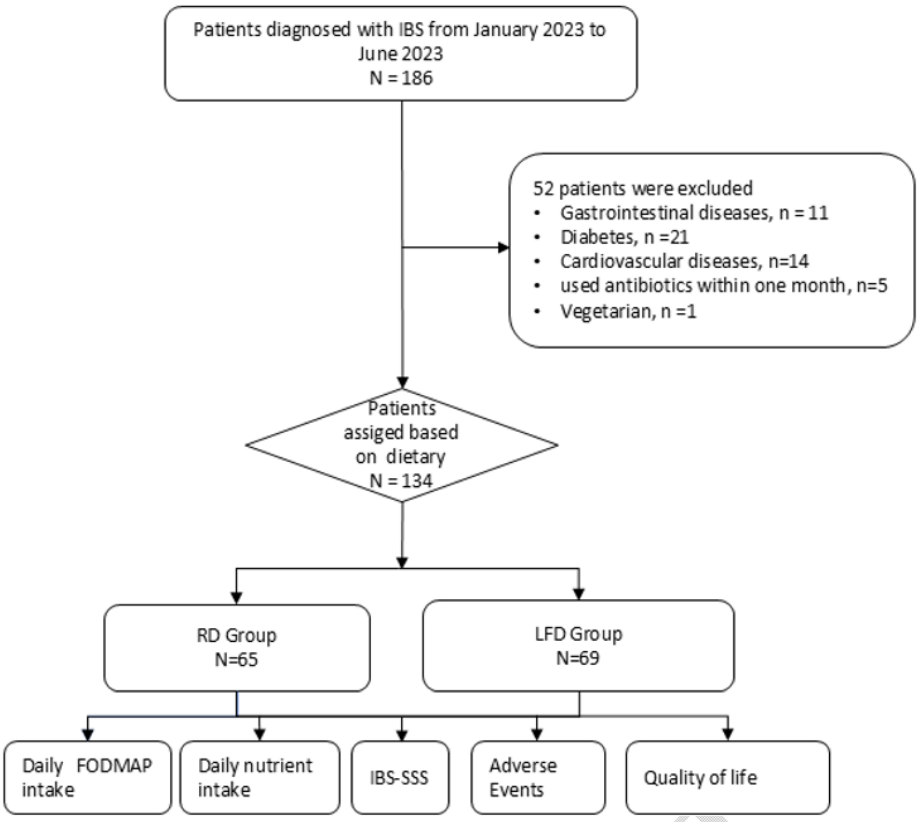


**Figure 1.** Patient selection flowchart.

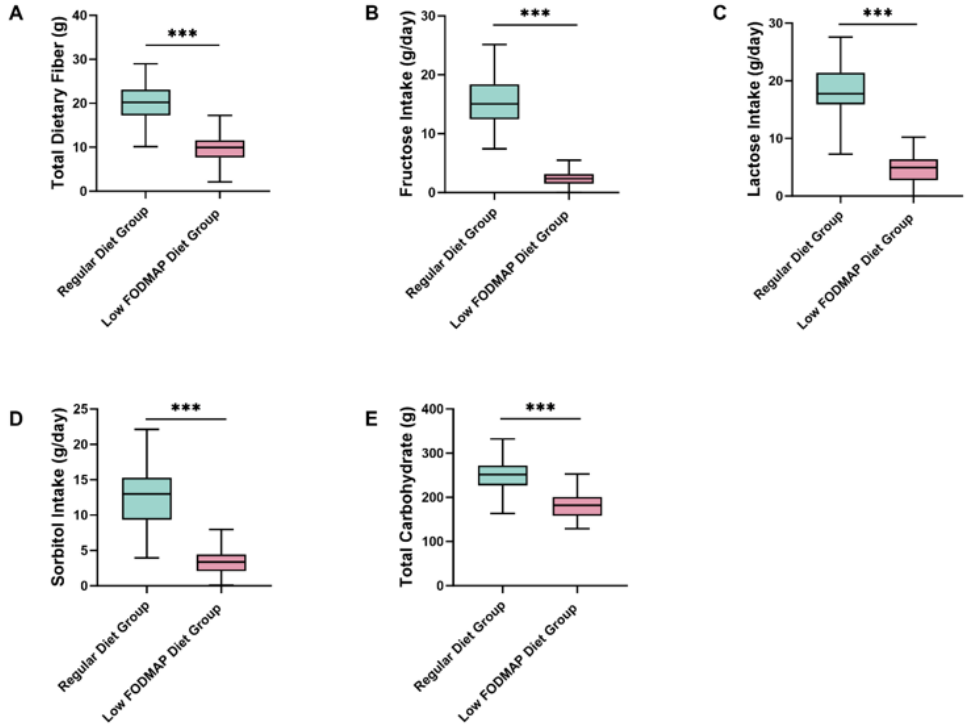


**Figure 2.** Daily FODMAP intake analysis

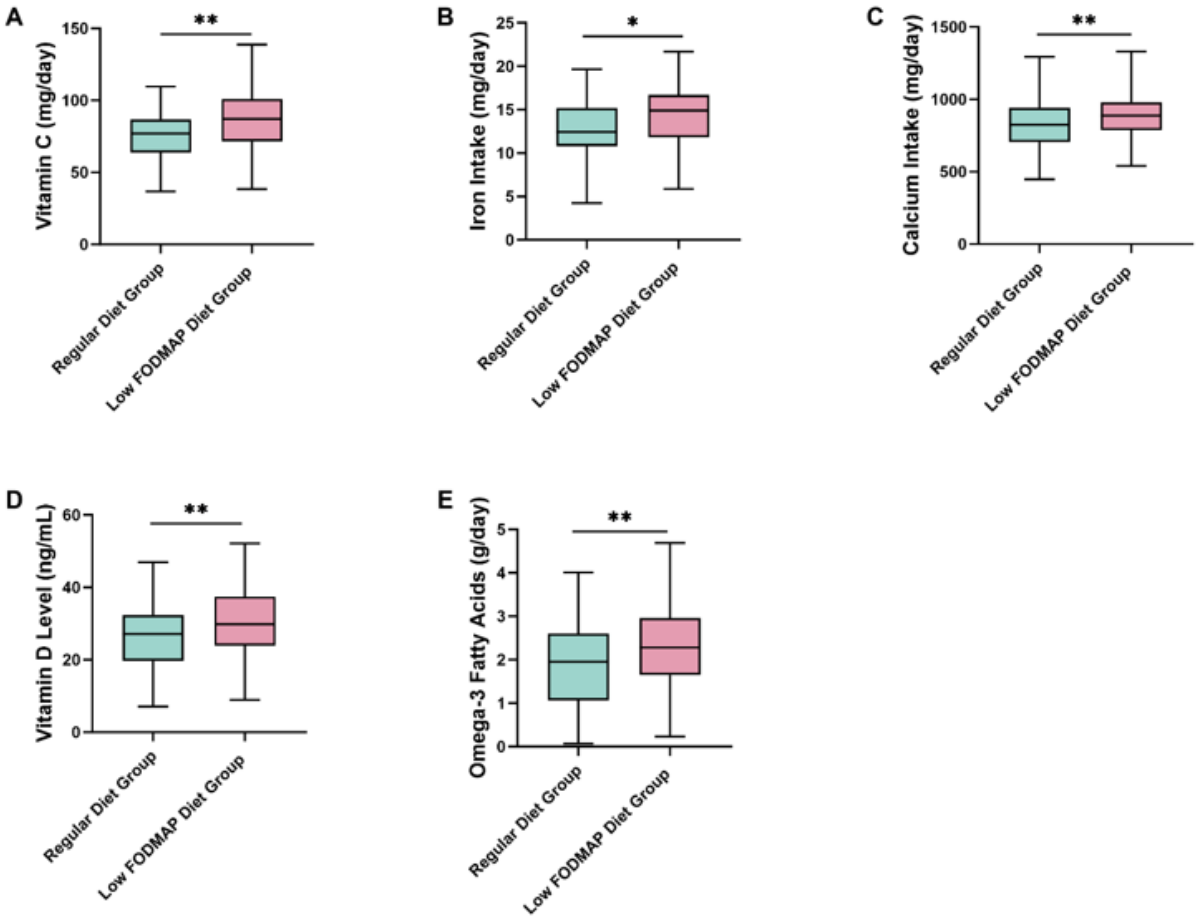


**Figure 3.** Daily nutrient intake

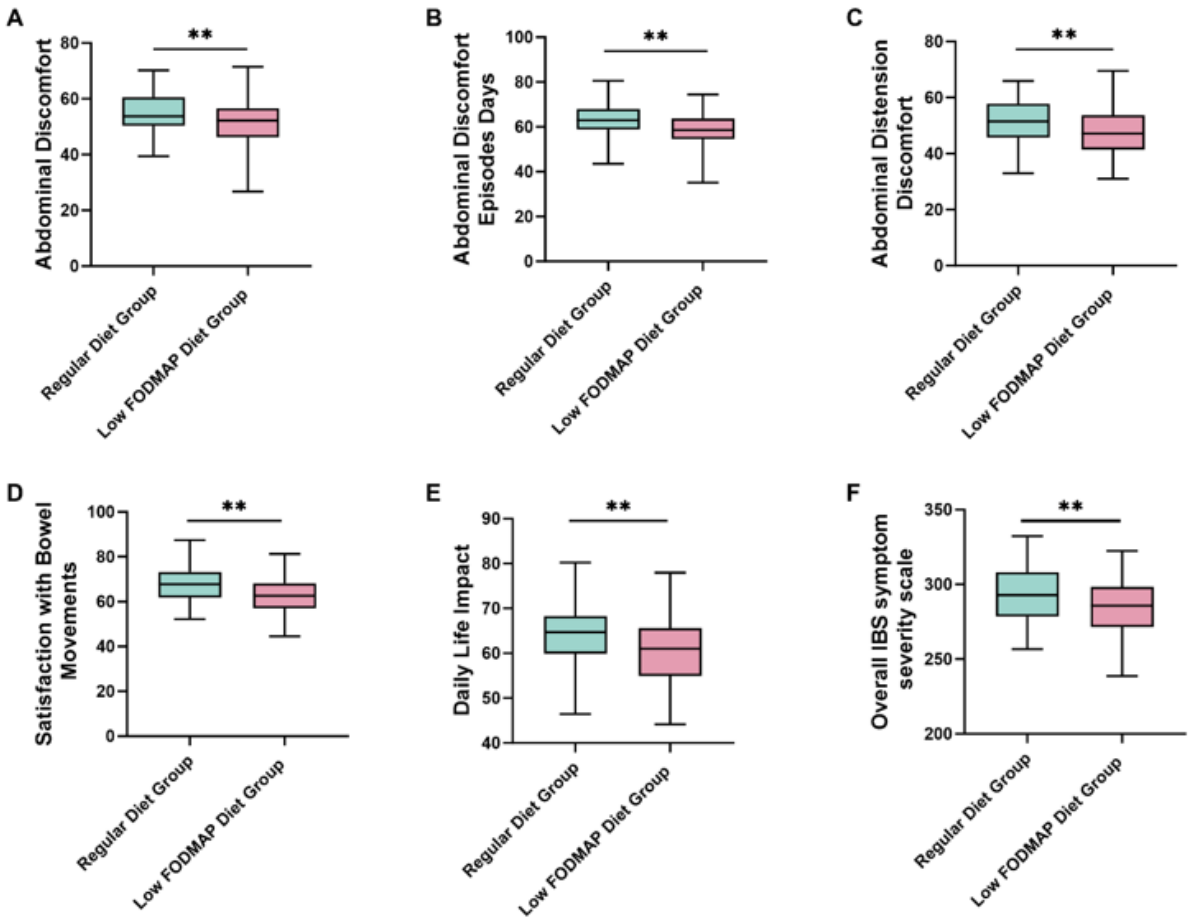


**Figure 4.** The score of IBS symptom severity scale