



Dietary fiber intake, Low-FODMAP Adherence, and risk of irritable bowel syndrome: A case-control study among adult outpatients

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Abstract

Background: Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder with a multifactorial etiology in which dietary pattern, including fiber intake and fermentable carbohydrate consumption, has been increasingly implicated as a modifiable contributing factor.

Objective: This simulated case-control study examines the association between habitual dietary fiber intake, high fermentable oligosaccharide-disaccharide-monosaccharide-and-polyol (FODMAP) consumption, and risk of IBS among adult gastroenterology outpatients.

Method: A hypothetical case-control design was used, comparing 160 simulated Rome IV-diagnosed IBS cases with 160 simulated symptom-free controls, matched for age and sex. Simulated data on daily dietary fiber intake, high-FODMAP food consumption frequency, psychological stress score, and bowel habit subtype were analyzed using descriptive statistics, chi-square tests, and binary logistic regression.

Results: In this simulated dataset, cases reported lower mean daily fiber intake (14.2 ± 5.1 g) than controls (21.6 ± 6.3 g) and higher frequency of high-FODMAP food consumption. Logistic regression suggested low fiber intake (<18 g/day) was associated with elevated odds of IBS (simulated OR = 2.18, 95% CI: 1.41–3.37, $p < 0.001$), and frequent high-FODMAP consumption was independently associated with increased odds (simulated OR = 2.46, 95% CI: 1.58–3.83, $p < 0.001$), after adjustment for psychological stress score and body mass index.

Conclusion: These simulated findings illustrate the type of dietary association commonly reported in real-world literature between fiber intake, FODMAP consumption, and IBS risk, and demonstrate appropriate case-control methodology and statistical reporting for academic training purposes in gastroenterology research.

Keywords: Irritable bowel syndrome, dietary fiber, FODMAP, case-control study, functional gastrointestinal disorder

Introduction

Irritable bowel syndrome (IBS) is one of the most prevalent functional gastrointestinal disorders encountered in both primary care and specialist gastroenterology practice, characterized by recurrent abdominal pain associated with altered bowel habits in the absence of identifiable structural or biochemical abnormality [1]. Global prevalence estimates suggest that IBS affects a substantial proportion of the adult population, with considerable variation across regions and diagnostic criteria, and the condition is associated with significant impairment in quality of life, healthcare utilization, and economic burden through both direct medical costs and lost productivity [2]. Despite its high prevalence, the etiology of IBS remains incompletely understood, reflecting a multifactorial pathophysiology involving altered gut motility, visceral hypersensitivity, low-grade mucosal inflammation, dysregulation of the gut-brain axis, and increasingly, dietary and gut microbiota factors [3].

Among the dietary factors implicated in IBS symptomatology, fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) have received substantial research and clinical attention over the past decade [4]. These short-chain carbohydrates are poorly absorbed in the small intestine and undergo rapid fermentation by colonic bacteria, producing gas and exerting osmotic effects that are hypothesized to provoke luminal distension and visceral pain in individuals with underlying visceral hypersensitivity, a hallmark feature of

IBS pathophysiology [5]. The low-FODMAP diet, which restricts high-FODMAP foods such as certain fruits, dairy products, wheat-based products, and legumes, has demonstrated efficacy in symptom reduction across multiple randomized controlled trials, lending support to the pathophysiological relevance of dietary FODMAP intake in this condition [6].

Dietary fiber intake represents a related but distinct area of inquiry, with a more complex and historically inconsistent evidence base regarding its relationship to IBS. While soluble fiber has demonstrated symptom benefit in several trials, insoluble fiber has, in some studies, been associated with symptom exacerbation, particularly bloating and abdominal discomfort, suggesting that fiber subtype—rather than total fiber intake alone—may be clinically relevant [7]. Nonetheless, several population-based studies have reported lower habitual total fiber intake among individuals with IBS compared with asymptomatic controls, raising the possibility that low overall fiber intake may itself represent a risk factor or correlate of IBS, independent of FODMAP-specific mechanisms [8].

Beyond dietary factors, psychological stress and the gut-brain axis are recognized as central contributors to IBS pathophysiology, with stress exposure shown to influence gut motility, visceral sensitivity, and intestinal permeability through neuroendocrine and autonomic pathways [9]. Given the well-established bidirectional relationship between psychological stress and gastrointestinal symptom severity in IBS, dietary studies examining fiber or FODMAP intake

as risk factors must account for psychological stress as a potential confounder or effect modifier to avoid overstating the independent contribution of dietary pattern alone ^[10].

Despite the substantial clinical interest in dietary management of IBS, relatively few case-control studies have simultaneously examined total fiber intake and high-FODMAP food consumption frequency as independent risk factors within a single multivariable model that also accounts for psychological stress and body mass index, particularly within general adult outpatient gastroenterology populations rather than tertiary referral cohorts ^[11]. This study, conducted using simulated academic training data, was designed to illustrate the application of case-control methodology to this research question. The objective was to estimate the association between dietary fiber intake, high-FODMAP food consumption, and odds of IBS among adult gastroenterology outpatients, while controlling for psychological stress and body mass index, and to demonstrate the statistical and reporting conventions used in dietary epidemiological research applied to functional gastrointestinal disorders. It is emphasized that all results presented are simulated and intended solely for academic training and manuscript-writing practice rather than as findings derived from genuine data collection.

Literature review

1. Theoretical framework

The pathophysiology of IBS is increasingly understood through the lens of the gut-brain axis model, which conceptualizes bidirectional communication between the central nervous system and the enteric nervous system, mediated by neural, endocrine, and immune pathways, as well as the gut microbiota ^[3]. Within this framework, dietary substrates such as fermentable carbohydrates are understood to exert effects not only through direct luminal mechanisms, such as osmotic load and gas production, but also indirectly through modulation of gut microbiota composition and downstream microbial metabolite production, which may influence visceral sensitivity and mucosal immune activation ^[5].

The biopsychosocial model of functional gastrointestinal disorders provides a complementary theoretical framework, situating dietary triggers within a broader context that includes psychological stress, early-life experience, and individual visceral sensitivity thresholds, suggesting that the same dietary exposure may provoke markedly different symptomatic responses across individuals depending on underlying physiological and psychological vulnerability ^[9]. This framework supports the inclusion of psychological stress as a covariate in dietary case-control research, consistent with the analytic approach adopted in this study.

2. Empirical evidence

Multiple randomized controlled trials have demonstrated that a structured low-FODMAP diet produces clinically meaningful symptom improvement in a substantial proportion of IBS patients compared with habitual diet or sham dietary advice, with effect sizes generally consistent across trials conducted in different countries and healthcare settings ^[6]. Mechanistic studies using hydrogen breath testing and intestinal ultrasonography have corroborated the proposed mechanism of FODMAP-induced luminal distension, providing physiological support for the observed clinical associations ^[4].

Evidence regarding total dietary fiber intake and IBS risk has been comparatively more heterogeneous. Several population-based case-control and cross-sectional studies have reported lower habitual fiber intake among individuals with IBS compared with healthy controls, while fiber supplementation trials have shown that soluble fiber sources, such as psyllium, produce more consistent symptom benefit than insoluble fiber sources, such as wheat bran, which have in some trials been associated with worsened bloating and discomfort ^[7]. ^[8] This heterogeneity has led some researchers to caution against treating total fiber intake as a unidimensional exposure variable, analogous to similar methodological cautions raised in other areas of dietary epidemiology.

Psychological stress has been robustly associated with IBS symptom severity and healthcare-seeking behavior across numerous studies, with elevated perceived stress scores consistently reported among IBS patients compared with controls, and stress-reduction interventions, including cognitive behavioral therapy and gut-directed hypnotherapy, demonstrating efficacy in symptom management ^[10]. Given this robust association, several authors have emphasized the necessity of adjusting for psychological stress when estimating the independent contribution of dietary factors to IBS risk in observational research ^[9].

3. Research gap

While substantial trial evidence supports the symptomatic benefit of low-FODMAP dietary intervention in established IBS patients, comparatively fewer case-control studies have examined habitual pre-diagnosis dietary fiber intake and high-FODMAP food consumption frequency as potential risk factors for IBS case status within a single multivariable model that simultaneously adjusts for psychological stress and body mass index in a general adult outpatient population ^[11]. This study addresses this gap by applying a structured case-control design—using simulated data for academic training purposes—that incorporates both dietary fiber intake and FODMAP consumption frequency alongside relevant psychological and anthropometric covariates within a single analytic framework.

Methodology

1. Research design

This study employed a case-control design, a method well suited to investigating associations between dietary exposures and a chronic functional disorder such as IBS, particularly given practical constraints on prospective dietary cohort recruitment within academic training contexts.

2. Sampling and sample size

A simulated sample of 320 adult gastroenterology outpatients aged 18–60 years was constructed, comprising 160 “cases” meeting simulated Rome IV diagnostic criteria for IBS and 160 age- and sex-matched “controls” without gastrointestinal symptoms, drawn from a simulated outpatient clinic population. The simulated sample size was selected to approximate conventional case-control study sizes reported in the gastroenterology literature and to provide adequate statistical power for detecting moderate effect sizes (odds ratio $\approx$ 2.0–2.5) for the primary dietary exposures of interest.

3. Data collection

In a real implementation of this design, data collection would involve a structured interviewer-administered questionnaire covering sociodemographic characteristics, anthropometric measurements (height, weight, BMI), a validated food frequency questionnaire capturing total dietary fiber intake and high-FODMAP food consumption frequency, a validated perceived stress scale, and confirmation of IBS diagnosis and bowel habit subtype according to Rome IV criteria by a gastroenterologist. For the purposes of this training exercise, equivalent variables were generated synthetically to resemble plausible distributions reported in published literature, without reference to any actual participants or clinical records.

Results and discussion

1. Descriptive characteristics

Table 1: Baseline Characteristics of Cases and Controls (Simulated Data, N = 320)

Characteristic	Cases (n = 160)	Controls (n = 160)	p-value
Age, years (mean ± SD)	36.2 ± 9.8	35.7 ± 9.4	0.621
Female sex, n (%)	102 [63, 8]	96 [60, 0]	0.467
BMI, kg/m ² (mean ± SD)	24.8 ± 3.9	23.6 ± 3.4	0.003
Daily fiber intake, g (mean ± SD)	14.2 ± 5.1	21.6 ± 6.3	<0.001
Perceived stress score (mean ± SD)	24.3 ± 6.8	17.9 ± 6.1	<0.001
Diarrhea-predominant subtype, n (%)	61 [38, 1]	—	—
Constipation-predominant subtype, n (%)	54 [33, 8]	—	—
Mixed subtype, n (%)	45 [28, 1]	—	—

In this simulated dataset, cases and controls were comparable in age and sex distribution, consistent with the matched design, while cases showed significantly lower daily fiber intake, higher BMI, and substantially higher perceived stress scores than controls.

2. Dietary fiber category and IBS Status

Table 2: Cross-Tabulation of Daily Fiber Intake Category by Case-Control Status (Simulated Data)

Fiber Intake Category	Cases, n (%)	Controls, n (%)	Total
<18 g/day (low intake)	112 (70.0)	64 (40.0)	176
≥18 g/day (adequate intake)	48 (30.0)	96 (60.0)	144
Total	160 (100.0)	160 (100.0)	320

$\chi^2 = 29.63$, $df = 1$, $p < 0.001$ (simulated)

A markedly higher proportion of simulated cases (70.0%) fell into the low fiber intake category (<18 g/day) compared with controls (40.0%), and this difference was statistically significant in the simulated chi-square analysis.

3. Logistic regression results

Table 3: Adjusted Logistic Regression Estimating Odds of IBS by Dietary and Psychological Variables (Simulated Data)

Variable	Adjusted OR	95% CI	p-value
Low fiber intake, <18 g/day (ref: ≥18 g/day)	2.18	1.41–3.37	<0.001
Frequent high-FODMAP consumption (ref: infrequent)	2.46	1.58–3.83	<0.001
Perceived stress score (per 5-point increase)	1.42	1.21–1.67	<0.001
BMI (per 1 kg/m ² increase)	1.07	1.00–1.15	0.048
Female sex (vs. male)	1.21	0.78–1.88	0.392

In the simulated multivariable model, both low dietary fiber intake and frequent high-FODMAP food consumption remained independently associated with significantly increased odds of IBS case status after adjustment for perceived stress, BMI, and sex. Perceived stress score showed the strongest independent association of the

4. Statistical software and analysis

Simulated data were analyzed using standard statistical software conventions (e.g., SPSS or R, as would be used in a genuine study). Descriptive statistics (means, standard deviations, frequencies) were used to characterize case and control groups. Chi-square tests were used to compare categorical variables between groups, and independent-samples t-tests were used for continuous variables. Binary logistic regression was used to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the association between dietary fiber intake category, high-FODMAP consumption frequency, and IBS case status, adjusting for psychological stress score and BMI. A two-tailed p-value < 0.05 was considered statistically significant in this simulated analysis.

covariates examined, consistent with its established central role in IBS pathophysiology, while BMI showed a smaller but statistically significant independent association, and sex was not a significant independent predictor within this simulated model.

4. Discussion

The simulated findings generated for this training exercise illustrate a pattern broadly consistent with the published literature reviewed above: lower habitual dietary fiber intake and more frequent high-FODMAP food consumption were each independently associated with substantially higher odds of IBS case status, even after adjustment for psychological stress and BMI, two factors well established in the broader functional gastrointestinal disorder literature. This pattern mirrors findings from real case-control and cross-sectional dietary studies, which have similarly reported lower fiber intake and higher FODMAP consumption among IBS patients relative to controls, lending plausibility to both the luminal-mechanical mechanisms underlying FODMAP fermentation and the broader role of dietary pattern in gut-brain axis dysregulation discussed in the literature review [4, 8]. The independent and notably strong association observed for perceived stress score in the simulated model is consistent with the substantial body of real-world evidence implicating psychological stress as a central driver of IBS symptomatology and, in some formulations, diagnostic case status itself, reinforcing the importance of the biopsychosocial framework in interpreting dietary risk factor associations in this condition [9]. [10]. This finding underscores that dietary modification, while clinically important, should be considered alongside psychological and stress-management approaches in a comprehensive understanding of IBS risk and management, rather than as an isolated causal pathway.

A genuine implementation of this study would need to address several methodological considerations highlighted in the literature, including the potential for reverse causation, whereby individuals with early or subclinical IBS symptoms may modify their fiber and FODMAP intake in response to symptoms prior to formal diagnosis, rather than dietary pattern causing IBS onset [7]. Additionally, the heterogeneity of fiber subtype (soluble versus insoluble) noted in the literature review was not separately modeled in this simplified simulated analysis, despite evidence suggesting differential effects, and would warrant more granular dietary assessment in a real study design [7]. Recall bias inherent in food frequency questionnaire methodology, along with the cross-sectional, retrospective nature of case-control dietary assessment, would also represent important limitations in a genuine implementation.

Overall, this exercise demonstrates how case-control methodology, dietary epidemiological variables, and multivariable logistic regression are conventionally reported in gastroenterology research examining functional gastrointestinal disorders, while underscoring that the specific numerical findings presented here are illustrative constructs rather than evidence derived from real-world data collection.

Conclusion

This academic training exercise applied a simulated case-control design to illustrate the association between dietary fiber intake, high-FODMAP food consumption, and IBS risk among adult gastroenterology outpatients. Within the simulated dataset, low fiber intake and frequent high-FODMAP consumption were each independently associated with significantly elevated odds of IBS case status, and perceived psychological stress showed the strongest

independent association among covariates examined, a pattern consistent with associations reported in the published literature on dietary and psychosocial risk factors for IBS. These findings, although fictional, illustrate the type of evidence that has informed clinical dietary guidance, including low-FODMAP dietary intervention and fiber optimization, in the management of IBS.

From a training perspective, this exercise demonstrates the structure, statistical conventions, and reporting standards expected in gastroenterology case-control manuscripts, including appropriate table construction, regression reporting, and discussion of study limitations. Were this a genuine study, its implications would include support for incorporating structured dietary assessment, including fiber intake and FODMAP consumption screening, alongside psychological stress evaluation, into routine clinical assessment of patients presenting with possible IBS.

Genuine limitations that would apply to a real implementation of this design include the cross-sectional and retrospective nature of case-control dietary data collection, susceptibility to recall and selection bias inherent in food frequency questionnaire methodology, reliance on self-reported psychological stress measures, and the inability to establish definitive temporal or causal sequence between dietary pattern and IBS onset. Future research employing prospective dietary cohort designs with objectively validated dietary assessment tools and standardized longitudinal symptom tracking would be needed to strengthen causal inference in this area.

It is reiterated that this manuscript was produced entirely as a simulated academic writing exercise, and none of the results, tables, or figures presented should be interpreted as findings from an actual research study.

Ethical statement

This manuscript was prepared solely as a simulated academic writing and training exercise. No real human participants, patient records, dietary data, or institutional data were involved in its production. Consequently, no ethical approval, informed consent process, or institutional review board submission was required or sought. Should this design be implemented as an actual research study, approval from an appropriate institutional ethics review board and informed consent from all participants would be mandatory prior to data collection.

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