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Food avoidance and restriction in irritable bowel syndrome: relevance for symptoms, quality of life and nutrient intake

Short title: Food avoidance and restriction in IBS

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HT, MS, CM and SS planned and initiated the study. SS, HT, MS and JA conducted the study and collected the data. CM, JA and EC analysed and interpreted data, and drafted the manuscript. Each author has approved the final draft submitted.

Abstract

Background & Aims

Neither food intake, nor the clinical characteristics of irritable bowel syndrome (IBS) patients with severe food avoidance and restriction have been investigated. The aim of our study was to identify those patients and to characterize their symptoms, quality of life, and nutrient intake.

Methods

IBS patients who completed the IBS quality of life (IBSQOL) questionnaire at our secondary/tertiary centre were included. The three questions constituting the food domain were used to identify patients with reported severe food avoidance and restriction. The patients also completed validated questionnaires to assess stool form (BSF), GI symptom severity (z-score of IBS-SSS and GSRS-IBS), psychological distress (HADS), GI-specific anxiety (VSI), and somatic symptom severity (z-score of SCL-90-R and PHQ-15). A 4-day food diary was used to analyse food intake in 246 patients.

Results

We included 955 IBS patients (75% females; mean age 38.3 ± 13.3 years). In total, 13.2% of the patients reported severe food avoidance and restriction, and in these patients all aspects of quality of life were lower ($p < 0.01$) and psychological, GI, and somatic symptoms were more severe ($p < 0.05$). Reported severe food avoidance and restriction was associated with lower total energy intake ($p = 0.002$), lower intake of protein ($p = 0.001$) and carbohydrates ($p = 0.005$). In a logistic regression analysis, loose stools were found to be independently associated with reported severe food avoidance and restriction ($R^2 = 0.062$).

Conclusion

IBS patients with severe food avoidance and restriction constitute a subgroup with more severe symptoms overall, reduced quality of life and reduced intake of nutrients. This needs to be acknowledged in the clinical management of these patients.

Keywords: Rome criteria; dietician; self-reported, IBS with diarrhea

Introduction

Food intake is an important trigger of GI symptoms in IBS¹⁻³, and the presence of food-related GI symptoms are associated with more severe IBS symptoms and a reduced quality of life¹. However, the factors explaining these meal-related symptoms are still not clear, but could include atopy, female sex, somatic symptoms, depression, and anxiety^{1, 3-6}. The type of diet could also be of importance since some diets, such as the Western dietary pattern and ultra-processed foods, seem to be associated with a higher risk of IBS^{7, 8}. Food ingestion is regulated by humoral and neural mechanisms in order to allow the digestion and absorption of nutrients. Alterations in these pathways are involved in the IBS pathophysiology, and therefore also of potential relevance for food-related symptoms⁹.

These findings have recently led the majority of gastroenterologists to recommend restrictive diets to their IBS patients¹⁰. Among them, the low fermentable-, oligo-, di-, monosaccharides and polyols (FODMAPs) diet is nowadays the most recommended diet in IBS, but it is important to be aware of nutritional inadequacies as a potential consequence of this restrictive diet¹¹. Furthermore, it has been shown that IBS patients are more likely to avoid or restrict some food items themselves to improve their symptoms^{12, 13}, but the factors involved in food avoidance and restriction in IBS or the link to nutrient intake are not known.

Therefore, the aims of our study were to identify a subgroup of IBS patients with reported severe food avoidance and restriction and to identify associated clinical and demographic factors, as well as the relationship with quality of life, and nutrient intake.

Methods

Patients

We included patients with IBS from four prospective studies conducted at the Sahlgrenska University Hospital, Gothenburg, Sweden, one large study focusing on the link between pathophysiology and symptoms, and three intervention trials (NCT03869359, NCT02970591, NCT01252550), where baseline data before the intervention was used. In these studies, patients were primarily referred from primary care, thorough self-referral or recruited via advertisements in newspapers or social media. For the present study, we included patients who had completed the irritable bowel syndrome quality of life (IBSQOL) questionnaire¹⁴. IBS diagnosis was made by a gastroenterologist specialized in disorders of gut-brain interaction (MS and HS) and all patients fulfilled the Rome criteria for IBS at the time of inclusion, Rome II to IV¹⁵. The inclusion criteria were the same across the cohorts; IBS patients between 18 and 75 years old. Subjects with severe psychiatric or severe physical disease, celiac disease, known food allergies, conditions or surgery that affect GI function, or any other diseases explaining the symptoms were excluded from participation. Severe food avoidance and adherence to a specific diet were exclusion criteria for the dietary trials.

All the studies were approved by the Regional Ethical Review Board in Gothenburg. All patients gave verbal and written informed consent before any study related procedures were initiated, according to the declaration of Helsinki. All authors had access to the study data and reviewed and approved the final manuscript.

IBSQOL and food association

IBSQOL (n=955) is a disease-specific, self-administered questionnaire, measuring nine aspects of health-related quality of life during the past four weeks¹⁴. For each subscale, the score is transformed to a 0-100 scale. A higher score represents a better quality of life.

In IBSQOL, the food/diet domain is calculated using three questions: “*How much did IBS cause you to not eat when hungry?*”; “*How much did you avoid certain foods or drinks*

because of IBS?”; and *“How much did food seem unappealing because of IBS?”*. The possible answers include ‘none of the time’, ‘a little of the time’, ‘some of the time’, ‘a good bit of the time’, ‘most of the time’, or ‘all of the time’.

Measures of symptom severity and psychological factors

The patients also completed questionnaires to assess their symptom pattern and severity.

-IBS severity scoring system (IBS-SSS)¹⁶ (n=713) and Gastrointestinal symptom rating scale-IBS (GSRS-IBS)¹⁷ (n=628) assess GI symptom severity with higher scores representing more severe symptoms.

-The patients prospectively recorded the number of stools and stool consistency using the Bristol Stool Form (BSF) scale¹⁸ in a diary for 14 days, which also defined IBS subtypes (n=629) according to Rome III recommendations.

- Hospital anxiety and depression scale (HADS)¹⁹ (n=948) assesses the severity of psychological distress, with scores between 0 (absence) and 21 (severe symptoms) for anxiety and depression, respectively.

- Visceral sensitivity index (VSI)²⁰ (n=767) is a 15-item validated scale measuring GI symptom-specific anxiety. The total score ranges between 0 (absence) to 75 (high level).

- The Patient Health Questionnaire (PHQ)-15²¹ (n=582) comprises 15 somatic symptoms. The total score ranges from 0 to 30 for women and 28 for men, with higher scores indicating more severe somatic symptoms.

- The Symptom Checklist (SCL)-90-Revised²² (n=221) measures psychological problems and psychopathology. Here we only used the somatization dimension. A higher score means more severe somatic symptoms.

Food diary

A proportion of the patients completed a 4-days food diary, including three-week days and one weekend day (n=246, respectively 0%, 64% and 68% of the IBS patients included based on the Rome II, III and IV criteria, respectively). They were instructed to maintain their regular diet, and to report all foods and drinks consumed. A trained dietician entered the data in the software Dietist XP®, version 3.1 (Kostdata.se, Stockholm, Sweden), connected to an aggregated Swedish FODMAP database²³, which calculates the energy and nutrient composition of the foods¹¹.

Data analysis and statistics

Demographic and IBS characteristics were first presented in the global study population. We then divided the patients into three different cohorts based on the defining Rome criteria to verify the similarities between cohorts. To compare patient's characteristics between the cohorts, we used ANOVA test for parametric data and Kruskal-Wallis test for non-parametric data. The rest of the analyses were performed on the global study population, since the inclusion criteria and the data collection were similar between the cohorts.

As a first step in the data analysis, the patients with food avoidance and restriction were identified. We identified the proportion of patients answering \geq 'a good bit of the time' to the three individual questions of the IBSQOL food/diet subscale. The overlap between those three questions were assessed by Venn diagram and Spearman's correlation rho. Interaction between those three questions and symptom severity was assessed by Spearman's correlation rho. These responses were thereafter used to define a group of IBS patients "with reported severe food avoidance and restriction", including patients responding \geq 'a good bit of the time' to all three questions and the rest of the patients defined the group "without reported severe food avoidance and restriction". This grouping was thereafter used for additional analyses.

As a second step, the characteristics of patients “*with reported severe food avoidance and restriction*” were compared with patients “*without reported severe food avoidance and restriction*”. Non-parametric test (Mann-Whitney U test) were performed between the two groups for continuous variables and chi-squared test for categorical variables. To be able to use a single measure for IBS severity (IBS-SSS and GSRS-IBS) and somatic symptom severity (SCL-90 somatization and PHQ-15) across all cohorts, z scores were created, and used as the IBS and somatic symptom severity variables (n=919 for both) for all patients.

Finally, the factors independently associated (p value<0.1) with reported severe food avoidance and restriction were identified using binary logistic regression analysis. These factors were used as independent variables in the logistic regression analysis. Multicollinearity was excluded before the regression analysis, defined as a Spearman rho correlation coefficient > 0.7. Only factors used in all the cohorts were included in these analyses.

Continuous variables are expressed as mean values \pm standard deviation (SD) for normal data and median with interquartile range [IQR] for the non-normal data. Categorical variables are expressed as number of patients and percentages. A p-value ≤ 0.05 was considered to be statistically significant. Cohen's d index, Phi, and η^2 , measures for the effect size of observations were also determined for independent samples t test, chi-squared test and one-way ANOVA, respectively. Cohen's d was calculated as the difference between the means of two conditions divided by the pooled standard deviation (0.2=small effect, 0.5=medium effect, >0.8=large effect), Phi was equivalent to the Pearson's correlation coefficient, (0.1=small effect, 0.3=medium effect and >0.5=large effect), and η^2 refers to the percentage of the variance in the dependent variable attributable to a particular independent variable (0.01=small effect, 0.06=medium effect and >0.14=large effect). All statistical analyses were performed using the IBM SPSS Statistics 27 software (SPSS Inc., Chicago, IL, USA).

Results

Patients and characteristics

We included 955 IBS patients; 61% of the IBS patients were diagnosed according to the ROME II criteria, 18% according to the ROME III criteria, and 21% according to the Rome IV criteria. IBS with constipation (IBS-C) was seen in 27% of the patients, IBS with diarrhea (IBS-D) in 39% and mixed or unsubtyped IBS (combined into one group, IBS without predominant constipation or diarrhea, IBS nonCnonD) in 34%. The mean age of the population was 38.3 ± 13.3 years with 75% being females. The other clinical characteristics are presented in table 1. We found small but statistically significant differences between the three cohorts for age, gender, IBS duration, stool consistency, quality of life, fatigue and GI-specific anxiety (Supplementary table 1). Even though there were some statistical differences among the groups, these were overall relatively small (small to medium effect sizes), so for the main analyses we combined all cohorts, but also report analyses in the individual cohorts separately to justify this approach.

Food avoidance and restriction in IBS

Among the IBS patients, 26% reported that they frequently did not eat when they were hungry because of IBS, 54% that they frequently avoided foods because of IBS, and 31% that they frequently found food unappealing because of IBS (figure 1A-C). In our study population, 126 patients (13.2%) reported severe food avoidance and restriction (figure 1D). There was a substantial overlap among individual responses to these questions (figure 1E). In line with this, the correlations among these questions were significant with modest to moderate strength

(Supplementary table 2). Each of these questions was also significantly correlated with IBS severity (Supplementary table 2).

Characteristics of patients with reported severe food avoidance and restriction

IBS-D was more frequent (51.1% vs 36.3%) and IBS-C less frequent (18.5% vs 28.7%) in patients with reported severe food avoidance and restriction ($p=0.033$). IBS patients who reported severe food avoidance and restriction were younger and reported more loose stools, more severe IBS and somatic symptoms and higher levels of psychological distress (table 2). However, no associations were noted with sex, body mass index, IBS duration or stool frequency. All eight quality of life domains of the IBSQOL (excluding the food/diet domain itself) were reduced in the IBS patients with reported severe food avoidance and restriction (figure 2). Similar patterns when comparing characteristics among IBS patients with vs. without reported severe food avoidance and restriction were noted in the cohorts defined by the use of different Rome criteria, even though some of the statistical significances were lost in the smaller cohorts (supplementary tables 3-5).

Furthermore, when analyzing the 4-day food diaries, we identified that the IBS patients with reported severe food avoidance and restriction had a lower total caloric intake, a lower protein intake and a lower intake of carbohydrates, including fructan and fiber. In addition, the intake of several micronutrients and vitamins was lower, see table 3 for more details.

Finally, the full binary logistic regression analysis model contained five variables (age, IBS severity, loose stools, psychological distress, somatic symptom severity) and was significant ($p<0.0001$). Loose stools were independently associated with reported severe food avoidance and restriction, and made a unique statistically significant contribution to the model (Nagelkerke $R^2=0.062$ (table 4)).

Discussion

In this study, we have demonstrated in a large group of IBS patients that a subgroup of patients reports severe food avoidance and restriction. This subgroup was characterized by more severe overall GI, psychological and somatic symptoms as well as reduced quality of life and reduced nutrient intake. Loose stools were found to be independently associated with reported severe food avoidance and restriction.

Food is an important trigger of symptoms in IBS; most patients report worsening of symptoms after intake of specific food items¹⁻³. In this study, we confirmed that IBS patients with food-related symptoms are characterized by more severe IBS symptoms and a lower quality of life¹. An important point we also wanted to focus on was the daily intake of nutrients in patients with reported severe food avoidance and restriction, and the daily energy intake was indeed reduced in this subgroup. This result was not unexpected given the central role of food in IBS. Whether the food avoidance or restriction is due to the more intense IBS symptoms or resulting from an attempt to reduce intensive IBS symptoms cannot be decided by our current study. Among FODMAPs, the intake of fructan (an oligosaccharide found in wheat, garlic, and other foods) was reduced in patients with reported severe food and avoidance. Fructan, rather than gluten, is proposed to be involved in symptom generation after intake of wheat in IBS^{24, 25}. However, despite the reduced intake of fructan, the IBS patients with food avoidance and restriction still reported higher severity of symptoms. Furthermore, several micronutrients, calcium, thiamine, and folates were below the daily recommendations in patients with reported severe food avoidance and restriction. Therefore, we recommend clinicians to carefully assess micronutrients deficiencies and to involve a dietician in the management of these patients.

Another goal of our study was to not only focus on nutrient intake in the subgroup of

patients with self-reported severe food avoidance and restriction, but also on other clinical characteristics. In addition to the previously shown higher IBS severity and reduced quality of life in this subgroup, we identified the importance of more severe psychological distress and somatic symptoms in these patients⁶. We also demonstrated loose stools as newly identified factors associated with self-reported severe food avoidance and restriction. Loose stools are commonly associated with more severe IBS symptoms and reduced quality of life, but their association with food-related symptoms has not been previously recognized. When we look specifically for independent factors associated, only loose stools made a unique contribution to the logistic regression model, but they only explained 6% of the variance. The association with loose stools, could be explained by differences in the colonic motor response to food among subtypes based on the predominant bowel habit²⁶. However, our data implicates that other factors not included in our analyses could also be involved in food avoidance and restriction in IBS. Potentially, local gut factors such as visceral hypersensitivity or colonic transit time might be of relevance for food avoidance and restriction, as well as local allergy-like reactions in the gut²⁶⁻²⁸. The pathophysiological factors explaining this subgroup of IBS patients with self-reported severe food avoidance and restriction remains to be elucidated.

There are strengths and limitations with our study worth mentioning. Strengths include the high number of patients, the use of validated questionnaires, homogenous recruitment by gastroenterologists specialized in IBS (MS and HT) in a single center, exclusion of patients with severe psychiatric disorders and consistent use of a single questionnaire, IBS-QOL, to assess food restriction and avoidance. No metrics validation was performed in our study to assess the cut-off selected to define the subgroup of patients with severe food avoidance and restriction. Further studies should validate these cut-offs. However, we did not formally assess presence or absence of avoidant/restrictive food intake disorder (ARFID), even though patients with a clinically evident eating disorder were not included in the studies^{29, 30}. A

proportion of our patients with severe food avoidance and restriction are likely to fit ARFID criteria. Indeed, one of the criteria of ARFID is the association of food avoidance/dietary restriction with a negative impact on QOL or nutritional deficiency. Due to the association of poorer QOL and possibly nutritional deficiencies (i.e. lower total energy intake), a proportion of this group could therefore be considered as having “possible ARFID”. Unfortunately, we did not use the recently developed ARFID questionnaire in these cohorts³¹. Weight loss is also a criterion of ARFID. In our cohorts BMI did not differ between patients with and without severe food avoidance and restriction, but unfortunately, we do not have information about weight loss in our patients. Limitations include performing the study in a secondary/tertiary care center, thereby limiting generalizability to primary care populations, potential self-report bias when using food diaries, and the lack of information on physical activity and other factors that may influence nutrient intake including thermogenesis, and metabolic requirements. Another limitation is combining patients with different Rome diagnostic criteria. The Rome IV criteria constitute a more severe group of IBS patients³². However, our data show only minor differences between the cohorts in age, gender, stool form, IBS duration, and a few quality of life domains, but no differences in the severity of IBS symptoms, indicating that similar groups of IBS patients were indeed included in all studies.

In conclusion, in this study we have demonstrated that a substantial proportion of IBS patients report food avoidance and restriction. This subgroup suffered from more severe symptoms overall, reduced quality of life, and reduced intake of nutrients. Identifying these patients is important and will allow clinicians to propose a multidisciplinary management, including focus on diet and psychological factors, as well as IBS symptoms using an integrated care approach³³. Indeed, this specific subgroup seems to need extra attention from clinicians and dietitians in order to avoid nutritional deficiencies and reduce symptom burden

and improve poor quality of life³³. Further investigations are needed to understand the underlying pathophysiological mechanisms, including the role of the gut factors, and to assess the effects of dietary and behavioral management in this specific population.

Tables

Table 1: Demographic information, disease specific characteristics and questionnaire data

	Study population (n=955)
Female gender	719 (75.3)
Age (years)	38.3 ± 13.3
BMI (kg/m ²)	23.8 ± 4.0
Median IBS duration (years)	13.6 ± 12.1
Stools/day	2.1 ± 2.0
Stool form (BSF 1-7)	4.2 ± 1.2
IBSQOL (0-100%)	
-Emotional	51.6 ± 22.4
-Mental health	71.6 ± 22.2
-Sleep	73.1 ± 23.5
-Energy	57.0 ± 27.0
-Physical functioning	72.6 ± 24.0
-Food	62.1 ± 20.5
-Social role	62.6 ± 23.3
-Physical role	57.8 ± 30.3
-Sexual relations	66.8 ± 25.6
IBS severity (z score)	-0.1 ± 1.0
Psychological distress (HADS 0-42)	12.1 ± 7.0
GI-specific anxiety (VSI 0-75)	39.8 ± 16.6

Somatic symptom severity (Z score)	0.0 ± 1.0
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BMI: Body Mass Index, BSF: Bristol Stool Form, HADS: Hospital Anxiety and Depression

Scale, IBS: Irritable Bowel Syndrome, VSI: Visceral Sensitivity Index.

Results are presented as mean ± SD for parametric data and n (%).

Table 2: Comparison of IBS patients with vs. without reported severe food avoidance and restriction

Variable (n of group with - & n of group without severe food avoidance and restriction)	IBS patients with reported severe food avoidance and restriction (n=126)	IBS patients without reported severe food avoidance and restriction (n=828)	Effect size	p-value
Female gender	100 (79.4)	618 (74.6)	0.370†	0.270
Age (years) (n=122 & n=799)	33.0 [25.0-45.2]	36.0 [27.0-48.0]	0.187	0.045
BMI, (kg/m ²) (n=114 & n=630)	22.8 [20.8-26.0]	23.2 [21.1-26.0]	0.010	0.629
Mean IBS duration (years) (n=92 & n=498)	10.0 [2.0-20.0]	10.0 [4.0-20.0]	0.177	0.068
Stools/day (n=85 & n=521)	1.7 [1.1-2.7]	1.7 [1.2-2.5]	0.052	0.971
Stool form (BSF) (n=85 & 521)	4.5 ± 1.2	4.1 ± 1.2	0.375	0.001
IBS severity (z score) (n=125 & n=793)	0.1 ± 1.1	-0.1 ± 1.1	0.219	0.044
Psychological distress (HADS) (n=126 & n=821)	14.0 [8.0-19.2]	11.0 [6.0-16.0]	0.367	<0.001
GI-specific anxiety	43.5 [24.2-57.0]	39.0 [27.0-52.0]	0.167	0.167

(VSI) (n=112 & n=654)				
Somatic symptom severity (z score) (n=114 & n=688)	-0.0 [-0.7-1.0]	-0.1 [-0.8-0.6]	0.264	0.041

BMI: Body Mass Index, BSF: Bristol Stool Form, HADS: Hospital Anxiety and Depression scale, IBS: Irritable Bowel Syndrome, VSI: Visceral Sensitivity Index.

Results are presented as n (%) and mean \pm SD for parametric data and as median [IQR] for the non-parametric data. Effect sizes shown as Cohen's d index and Phi², measure.

Table 3: Nutrient intake in IBS patients with vs. without reported severe food avoidance and restriction

Nutrients/day	IBS patients with reported severe food avoidance and restriction (n=20)	IBS patients without reported severe food avoidance and restriction (n=226)	Effect size	p-value
Energy kcal	1714.4 ± 116.9	2102.2 ± 520.0	0.746	0.003
Protein g	64.6 [49.0-78.5]	80.4 [66.9-100.9]	0.785	<0.001
Fat g	80.1 [54.6-100.2]	88.0 [69.1-106.3]	0.369	0.116
Carbohydrate g	168.1 ± 74.7	212.5 ± 66.6	0.659	0.017
Dietary fiber g	14.6 [10.5-19.3]	18.7 [15.2-23.0]	0.560	0.005
FODMAP g				
- Fructose	11.0 [5.8-13.0]	11.4 [7.2-17.0]	0.200	0.253
- GOS	0.3 [0.1-0.6]	0.4 [0.2-0.8]	0.369	0.099
- Fructan	1.5 [1.0-2.3]	2.5 [1.8-3.4]	0.605	<0.001
- Polyols	0.6 [0.4-1.8]	0.5 [0.2-1.0]	0.208	0.055
- Lactose	8.7 [4.3-13.2]	9.0 [4.6-14.3]	0.139	0.696
- Excess fructose	0.5 [0.0 -2.5]	0.4 [0.0-1.3]	0.616	0.445
Calcium mg	630.2 [533.2-881.2]	851 [665.6-1108.1]	0.490	0.016
Zinc mg	8.5 [6.4-11.9]	10.7 [8.8-13.4]	0.601	0.009
Thiamin mg	0.9 [0.7-1.3]	1.3 [1.1-1.7]	0.559	0.002
Riboflavin mg	1.3 [1.0-1.4]	1.5 [1.2-1.9]	0.633	0.002
Niacin mg	14.6 [11.1-20.6]	18.7 [14.7-23.8]	0.624	0.007
Folate µg	222.7 [145.8-281.8]	264.4 [206.5-341.7]	0.484	0.023
Vit A µg	1214.0 [754.3-2523.2]	1516.5 [875.2-2787.3]	0.204	0.434
Vit C mg	89.0 [51.4-121.6]	79.4 [51.7-126.3]	0.112	0.990
Retinol µg	709.5 [496.4-804.4]	688.0 [511.2-889.4]	0.141	0.437

Vit D µg	3.2 [2.4-5.4]	4.2 [3.1-6.6]	0.322	0.090
Vit E mg	11.0 [7.9-14.4]	11.4 [9.1-14.9]	0.197	0.466
Vit B6 mg	1.6 [1.2-2.0]	2.1 ± 0.7	0.704	0.003
Vit B12 µg	3.1 [2.3-4.0]	4.1 [2.9-5.9]	0.493	0.021

FODMAP: Fermentable-, oligo-, di-, monosaccharides and polyols, GOS: Galacto-oligosaccharide, IBS: Irritable bowel syndrome

Results are presented as mean ±SD for parametric data and as median [IQR] for the non-parametric data. Effect sizes shown as Cohen's d index measure.

Table 4: Binary logistic regression analysis; dependent variable: reported severe food avoidance and restriction

	Estimate (B)	SE	p	OR	95% CI
Age (years)	-0.009	0.011	0.389	0.991	0.970-1.012
IBS severity (z score)	-0.211	0.167	0.207	0.810	0.584-1.124
Loose stools (BSF)	0.375	0.124	0.002	1.455	1.142-1.854
Psychological distress (HADS)	0.036	0.022	0.095	1.037	0.994-1.082
Somatic symptom severity (z score)	0.113	0.160	0.480	1.120	0.818-1.532
Constant	-1.556	0.129	<0.001		

Nagelkerke R²=0.062. BSF: Bristol stool form, HADS: Hospital anxiety and depression scale, IBS: Irritable bowel syndrome

Figures

Figure 1. Prevalence of reported food avoidance and restriction because of IBS

Panel A-C demonstrates the proportion of IBS patients with the respective responses to the food/diet domain questions in IBSQOL: A “How much did IBS cause you to not eat when hungry?”, B “How much did you avoid certain foods or drinks because of IBS?”, and C “How much did food seem unappealing because of IBS?”. Panel D shows the proportion of patients with versus without reported severe food avoidance and restriction, based on these three questions (reported severe food avoidance and restriction defined as \geq “a good bit of time” to all the three questions in the food/diet domain of IBSQOL). Panel E: Venn diagram demonstrating the percentage of patients who responded \geq “a good bite of the time” to each of the three questions in the food/diet domain of IBSQOL. Created by BioVenn, Hulsen et al. BMC Genomics 2008, 9 (1): 488.

IBS: irritable bowel syndrome, IBSQOL: Irritable bowel syndrome quality of life

Figure 2. IBSQOL in patients with and without reported severe food avoidance and restriction.

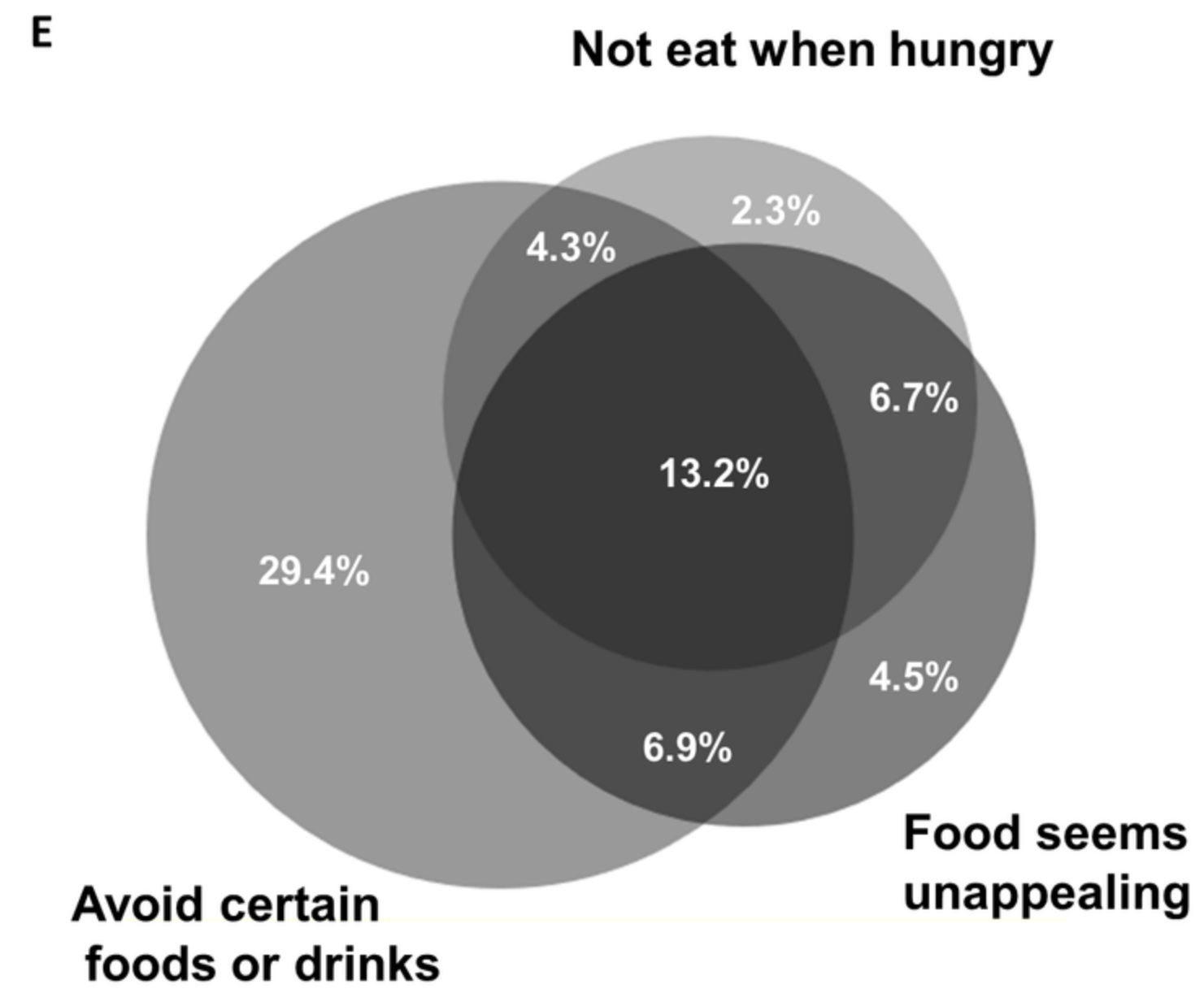
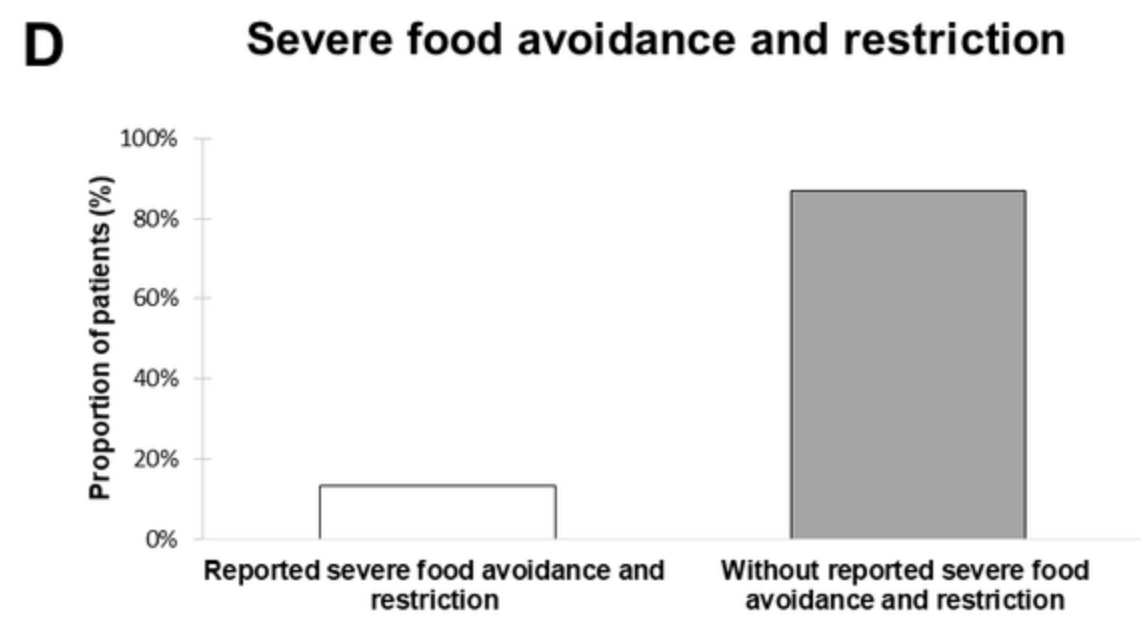
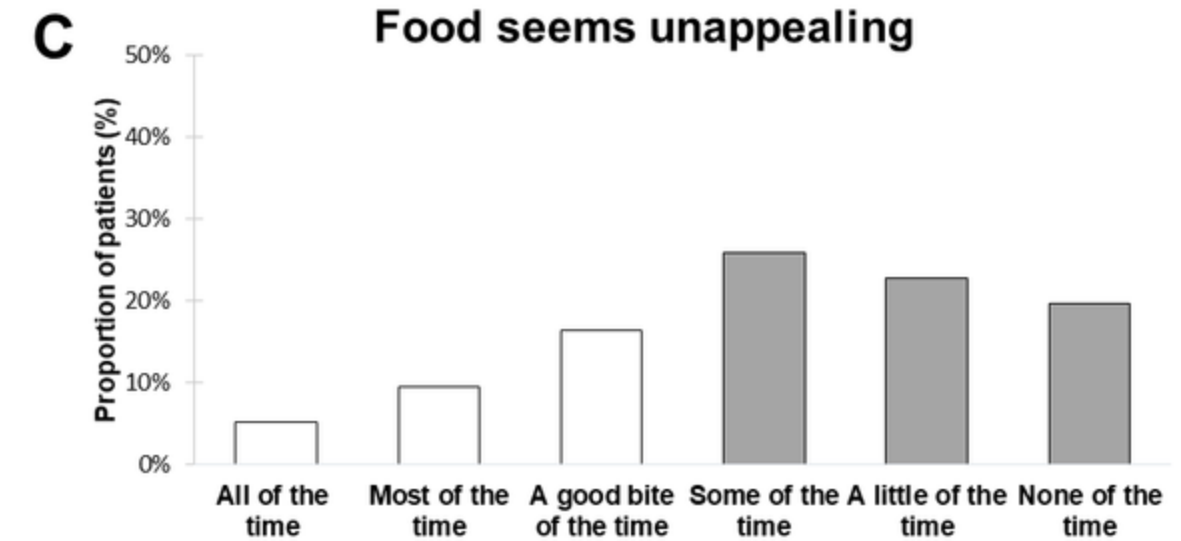
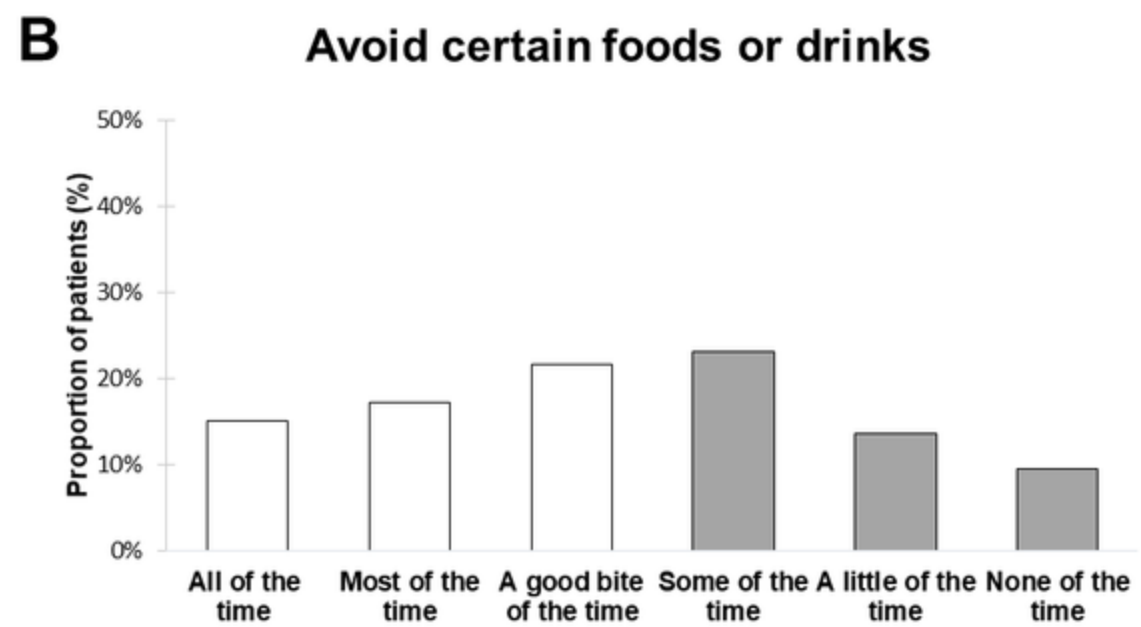
IBSQOL: Irritable bowel syndrome quality of life

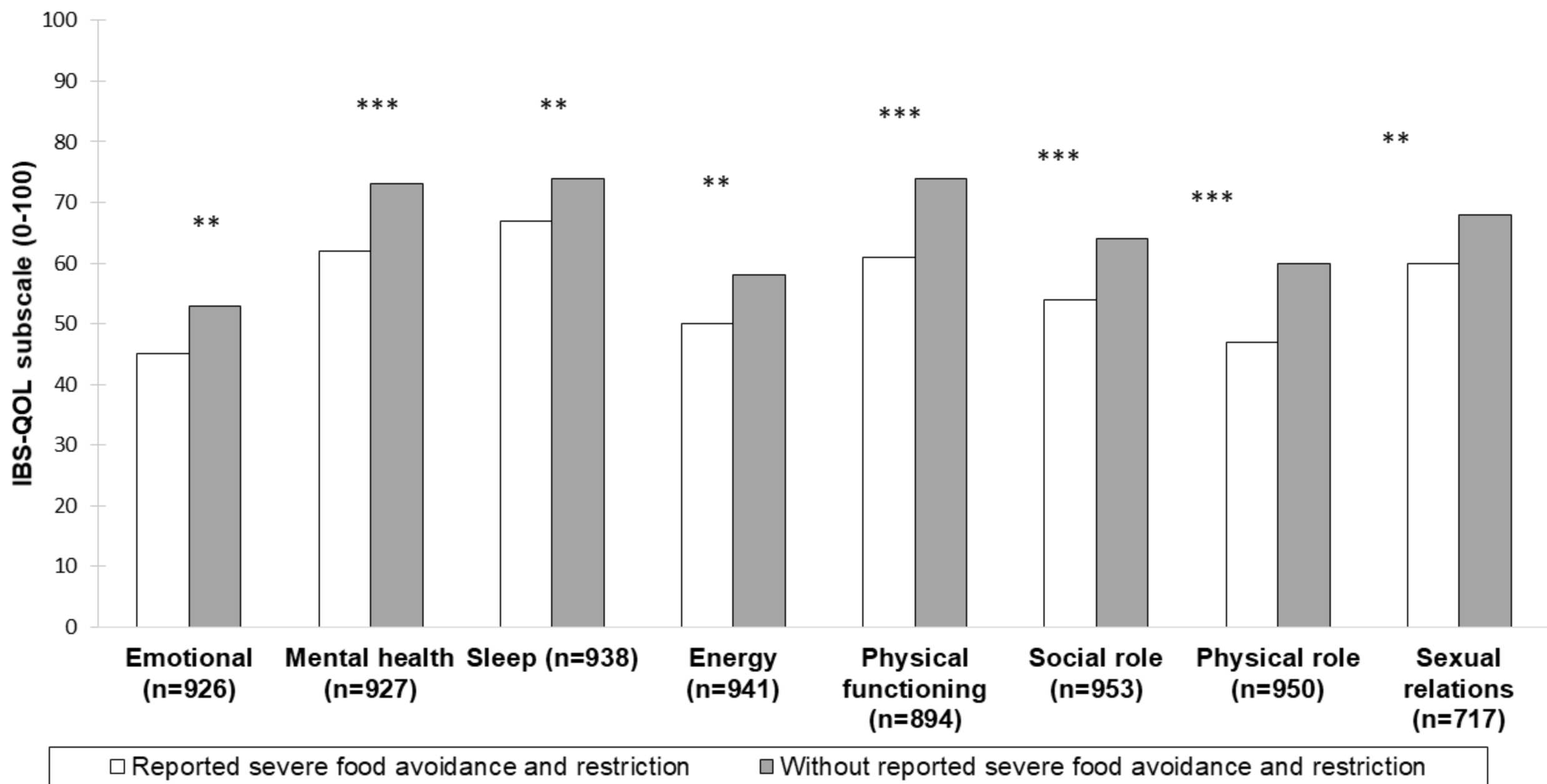
*Data are represented as the mean of each IBS-QOL subscale, **: $p < 0.01$, ***: $p < 0.001$*

References

1. Bohn L, Storsrud S, Tornblom H, et al. Self-reported food-related gastrointestinal symptoms in IBS are common and associated with more severe symptoms and reduced quality of life. *Am J Gastroenterol* 2013;108:634-41.
2. Lee HJ, Kim HJ, Kang EH, et al. Self-reported Food Intolerance in Korean Patients With Irritable Bowel Syndrome. *J Neurogastroenterol Motil* 2019;25:222-232.
3. Simren M, Mansson A, Langkilde AM, et al. Food-related gastrointestinal symptoms in the irritable bowel syndrome. *Digestion* 2001;63:108-15.
4. Faresjo A, Johansson S, Faresjo T, et al. Sex differences in dietary coping with gastrointestinal symptoms. *Eur J Gastroenterol Hepatol* 2010;22:327-33.
5. Nybacka S, Ohman L, Storsrud S, et al. Neither self-reported atopy nor IgE-mediated allergy are linked to gastrointestinal symptoms in patients with irritable bowel syndrome. *Neurogastroenterol Motil* 2018;30:e13379.
6. Van Oudenhove L, Tornblom H, Storsrud S, et al. Depression and Somatization Are Associated With Increased Postprandial Symptoms in Patients With Irritable Bowel Syndrome. *Gastroenterology* 2016;150:866-74.
7. Buscail C, Sabate JM, Bouchoucha M, et al. Western Dietary Pattern Is Associated with Irritable Bowel Syndrome in the French NutriNet Cohort. *Nutrients* 2017;9.
8. Schnabel L, Buscail C, Sabate JM, et al. Association Between Ultra-Processed Food Consumption and Functional Gastrointestinal Disorders: Results From the French NutriNet-Sante Cohort. *Am J Gastroenterol* 2018;113:1217-1228.
9. Farre R, Tack J. Food and symptom generation in functional gastrointestinal disorders: physiological aspects. *Am J Gastroenterol* 2013;108:698-706.
10. Lenhart A, Ferch C, Shaw M, et al. Use of Dietary Management in Irritable Bowel Syndrome: Results of a Survey of Over 1500 United States Gastroenterologists. *J Neurogastroenterol Motil* 2018;24:437-451.
11. 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;149:1399-1407 e2.
12. Soltani S, Hassanzadeh Keshteli A, Esmailzadeh A, et al. Food Item Avoidance of Patients with Irritable Bowel Syndrome Compared with Healthy People. *Arch Iran Med* 2019;22:369-375.
13. Lenhart A, Dong T, Joshi S, et al. Effect of Exclusion Diets on Symptom Severity and the Gut Microbiota in Patients with Irritable Bowel Syndrome. *Clin Gastroenterol Hepatol* 2021.
14. Hahn BA, Yan S, Strassels S. Impact of irritable bowel syndrome on quality of life and resource use in the United States and United Kingdom. *Digestion* 1999;60:77-81.
15. Mearin F, Lacy BE, Chang L, et al. Bowel Disorders. *Gastroenterology* 2016.
16. Francis CY, Morris J, Whorwell PJ. The irritable bowel severity scoring system: a simple method of monitoring irritable bowel syndrome and its progress. *Aliment Pharmacol Ther* 1997;11:395-402.
17. Wiklund IK, Fullerton S, Hawkey CJ, et al. An irritable bowel syndrome-specific symptom questionnaire: development and validation. *Scand J Gastroenterol* 2003;38:947-54.
18. O'Donnell LJ, Virjee J, Heaton KW. Detection of pseudodiarrhoea by simple clinical assessment of intestinal transit rate. *BMJ* 1990;300:439-40.
19. Bjelland I, Dahl AA, Haug TT, et al. The validity of the Hospital Anxiety and Depression Scale. An updated literature review. *J Psychosom Res* 2002;52:69-77.
20. Labus JS, Bolus R, Chang L, et al. The Visceral Sensitivity Index: development and validation of a gastrointestinal symptom-specific anxiety scale. *Aliment Pharmacol Ther* 2004;20:89-97.
21. Kroenke K, Spitzer RL, Williams JB. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. *Psychosom Med* 2002;64:258-66.

22. Derogatis LR, Rickels K, Rock AF. The SCL-90 and the MMPI: a step in the validation of a new self-report scale. *Br J Psychiatry* 1976;128:280-9.
23. Liljebo T, Storsrud S, Andreasson A. Presence of Fermentable Oligo-, Di-, Monosaccharides, and Polyols (FODMAPs) in commonly eaten foods: extension of a database to indicate dietary FODMAP content and calculation of intake in the general population from food diary data. *BMC Nutr* 2020;6:47.
24. Skodje GI, Sarna VK, Minelle IH, et al. Fructan, Rather Than Gluten, Induces Symptoms in Patients With Self-Reported Non-Celiac Gluten Sensitivity. *Gastroenterology* 2018;154:529-539 e2.
25. Shepherd SJ, Parker FC, Muir JG, et al. Dietary triggers of abdominal symptoms in patients with irritable bowel syndrome: randomized placebo-controlled evidence. *Clin Gastroenterol Hepatol* 2008;6:765-71.
26. Bouchoucha M, Devroede G, Raynaud JJ, et al. Is the colonic response to food different in IBS in contrast to simple constipation or diarrhea without abdominal pain? *Dig Dis Sci* 2011;56:2947-56.
27. Aguilera-Lizarraga J, Florens MV, Viola MF, et al. Local immune response to food antigens drives meal-induced abdominal pain. *Nature* 2021;590:151-156.
28. Simren M, Abrahamsson H, Bjornsson ES. An exaggerated sensory component of the gastrocolonic response in patients with irritable bowel syndrome. *Gut* 2001;48:20-7.
29. Murray HB, Bailey AP, Keshishian AC, et al. Prevalence and Characteristics of Avoidant/Restrictive Food Intake Disorder in Adult Neurogastroenterology Patients. *Clin Gastroenterol Hepatol* 2020;18:1995-2002 e1.
30. Murray HB, Kuo B, Eddy KT, et al. Disorders of gut-brain interaction common among outpatients with eating disorders including avoidant/restrictive food intake disorder. *Int J Eat Disord* 2020.
31. Zickgraf HF, Ellis JM. Initial validation of the Nine Item Avoidant/Restrictive Food Intake disorder screen (NIAS): A measure of three restrictive eating patterns. *Appetite* 2018;123:32-42.
32. Aziz I, Tornblom H, Palsson OS, et al. How the Change in IBS Criteria From Rome III to Rome IV Impacts on Clinical Characteristics and Key Pathophysiological Factors. *Am J Gastroenterol* 2018;113:1017-1025.
33. Chey WD, Keefer L, Whelan K, et al. Behavioral and Diet Therapies in Integrated Care for Patients With Irritable Bowel Syndrome. *Gastroenterology* 2021;160:47-62.





Presence of reported severe food avoidance and restriction in irritable bowel syndrome

