

Magdalena Mróz, Marcin Czub,  Anna Brytek-Matera

University of Wrocław, Institute of Psychology, Poland

Corresponding author – Marcin Czub – marcin.czub@uwr.edu.pl

Associations between eating behaviour, emotional state, and symptom severity in young women with Irritable Bowel Syndrome: A cross-sectional study

Abstract: Background: Irritable Bowel Syndrome (IBS) is a functional gastrointestinal (GI) disorder. GI-specific anxiety, stress, negative affect, and difficulties in emotion regulation are central to the severity of IBS symptoms. This study aimed to investigate the association between eating behaviour, emotional state and the severity of IBS symptoms in adult women with IBS. Methods: This cross-sectional study was conducted as an online survey using the following measures: Irritable Bowel Symptom Severity Scoring Scale (IBS-SSS), Visceral Sensitivity Index (VSI), Depression, Anxiety, and Stress Scale (DASS-21), Difficulties in Emotion Regulation Scale (DERS), and Three-Factor Eating Questionnaire – R18 (TFEQ-R18). In total, 58 women participated in the study (mean age = 23.7). The study was pre-registered at <https://osf.io/dws45>. Results: The VSI and DASS-21 scales predicted the IBS-SSS, adj. $R^2 = .45$, $F(2, 55) = 24.24$, $p < .001$. An exploratory analysis found a model with a better fit: the VSI, TFEQ-R18-CR (cognitive restraint subscale), and DASS-21 scales predicted the IBS-SSS, adj. $R^2 = .50$, $F(3, 54) = 19.85$, $p < .001$. Discussion: Our results showed that GI-specific anxiety and negative emotional states (stress, depression, and anxiety) predicted IBS symptom severity in young females.

Keywords: irritable bowel syndrome, eating behaviour, emotional state

INTRODUCTION

Irritable bowel syndrome (IBS) is a chronic and recurrent disorder of gut-brain interaction (DBGI). Impaired gut-brain interactions and autonomic nervous system deregulation are the primary etiological factors in IBS (Drossman, 2016). IBS is the most commonly diagnosed DBGI disorder. It primarily affects Western societies, women, and young people under 50 (Lacy et al., 2016; Lovell & Ford, 2012). Abdominal discomfort associated with IBS symptoms reduces quality of life (Faresjö et al., 2019; Trindade et al., 2022). Abdominal pain is the most bothersome symptom in women (Cain et al., 2006). The severity of IBS symptoms is influenced by psychological factors (Drossman, 2016; Moloney et al., 2016; Park et al., 2016) and nutritional factors (Van Den Houte et al., 2022).

The severity of symptoms of Irritable Bowel Syndrome (IBS-SSS)

The Rome Criteria IV (Lacy et al., 2016) defines IBS as recurrent abdominal pain that persists for at least one day per week over the last three months and is accompanied by at least two of the following symptoms: a) altered bowel movements, b) changes in bowel movement frequency, and c) alterations in stool consistency. IBS can be diagnosed when a patient presents with a history of symptoms for at least three months, with a period of at least six months between the onset of symptoms and diagnosis. The Bristol Stool Form Scale (BSF) allows for the classification of IBS into four subtypes: IBS with constipation IBS-C (hard stools $\geq 25\%$ and loose stools $< 25\%$), IBS with diarrhoea IBS-D (hard stools $< 25\%$ and loose stools $\geq 25\%$), mixed-type IBS-M (hard stools and loose stools $\geq 25\%$), and unsubtyped IBS-



U (hard stool and loose stool < 25%) (Lacy et al., 2016; Longstreth et al., 2006). Individuals diagnosed with IBS frequently present symptoms that extend beyond the gastrointestinal tract. These include headaches, lumbar back pain, lethargy, and frequent urination at night and/or with urgency. In women, menstrual disorders and dyspareunia (genital pain during sexual intercourse) often co-occur (Pietrzak et al., 2018; Zimmerman, 2003). Psychological factors are not included in the formal diagnostic criteria for IBS. However, they are also associated with the severity of symptoms and the decision to seek medical, psychological, or dietary help (Drossman, 2016).

Two models describe the aetiology of IBS. The first one is the biopsychosocial model (Drossman, 2016), which considers genetic factors and interactions with the environment, psychosocial factors, and physiological factors (Drossman, 2016). The second one, the integrative brain-gut microbiome model (Mayer et al., 2023), extends and refines the biopsychosocial model to include prenatal factors (maternal health, nutrition and stress levels), developmental factors (birth trajectory, early challenging experiences, diet) and identifies factors that may lead to both the development of IBS and co-occurring mood disorders: stressors; cortical changes; changes in brain networks contributing to increased anxiety, emotional reactivity and central hypersensitivity; stress perception; microbiota metabolites; immune cell activity; secondary changes in gut motility and secretory function (Mayer et al., 2023).

The negative emotional state and IBS

The psychological dynamics of individuals diagnosed with IBS can form a vicious circle. Stress and negative affect are both causes and effects of the gastrointestinal symptoms experienced by patients with IBS. Traumatic experiences (Park et al., 2016) and chronic stress (Moloney et al., 2016) are significant risk factors for the development of IBS and the severity of pain experienced (Moloney et al., 2016).

Increased anxiety, fear, and hypervigilance in the context of bowel symptoms are characteristics of DBGI (Spiegel et al., 2011). Studies have demonstrated that individuals diagnosed with IBS experience more severe stress (Moloney et al., 2016), anxiety, and depressive symptoms (Fond et al., 2014), as well as increased emotional reactivity (Fournier et al., 2018) and difficulty in regulating emotions (Güney et al., 2019). The prevalence of anxiety and depressive disorders is higher in IBS patients than in healthy controls (Fond et al., 2014; Hu et al., 2021; Lee et al., 2017).

The prevalence of psychiatric disorders among individuals with IBS is also indicative of significant challenges to emotional functioning. A positive correlation has been found between IBS symptoms and symptom severity of mood disorders (including depression and bipolar affective disorder), anxiety disorders (such as generalised anxiety), and somatoform disorders (Fadgyas-Stanculete et al., 2014; Faresjö et al., 2013). Individuals with IBS are three times more likely to develop mood disorders than the general population (Zamani et al., 2019).

Genetic research has revealed a significant relationship between a range of psychiatric disorders, including anxiety, depression, neuroticism, insomnia, schizophrenia, and IBS. These findings suggest that mood disorders and IBS have potential underlying etiologies (Eijsbouts et al., 2021). Moreover, a recent review of the literature on the neurobiological basis of IBS indicates that the pathophysiological pathways of IBS and anxiety disorders are similar (Mayer et al., 2023).

The difficulties in emotion regulation and IBS

Patients with IBS are more emotionally reactive and have a lower ability to regulate their emotions than healthy individuals, which may be due to the deregulation of the autonomic nervous system (Fournier et al., 2018). Impaired interoceptive abilities in IBS are also thought to be a reason for the difficulty in using adaptive emotion regulation strategies (Fournier et al., 2020). This is supported by the study's results on the efficacy of mindfulness-based stress reduction therapy (MBSR) in IBS. MBSR affects physiological processes and has a secondary effect on emotional processes, contributing to the reduction of IBS symptoms (Ghandi et al., 2018).

Gastrointestinal (GI)-specific anxiety and IBS

The feature that distinguishes DBGI (including IBS) from other somatic and psychiatric disorders (including generalised anxiety symptoms) is Gastrointestinal Specific Anxiety (GSA). GSA is an affective, cognitive, and behavioural response that occurs in response to feelings and symptoms that arise in the gastrointestinal tract in a particular situation/context. In particular, threatening situations involve eating in new, unfamiliar, and uncontrolled conditions (Mayer et al., 2001). GSA manifests as hypervigilance, anxiety, fear, and worry, combined with hypersensitive appraisal of discomfort or other gastrointestinal sensations (Labus et al., 2004, 2007).

Visceral hypersensitivity is the underlying cause of GSA. Under stress, neuro-immuno-physiological changes occur in the gut-brain axis (Bonaz et al., 2018), sensitising nociceptors. The increased sensitivity of nociceptors in the gut enhances the sensation of visceral pain in IBS (van Thiel et al., 2020). This phenomenon has been mechanistically investigated by assessing pain perception during rectal manometry or bloating severity. Hypersensitivity to bloating (Major et al., 2017) and rectal hypersensitivity (Roberts et al., 2023) have been observed in IBS patients. The effects of visceral hypersensitivity are manifested by increased anxiety in response to and anticipation of unpleasant gastrointestinal symptoms (Labus et al., 2004, 2007).

Eating behaviour - the emotional eating style and IBS

Diet and foods consumed modify the severity of IBS symptoms (Morcos et al., 2009). A previous study demonstrated that 84% of IBS patients reported that certain foods caused adverse gastrointestinal symptoms (Shah&Lacy, 2016). Too much fast and processed food, breakfast cereals, sweets, and soft drinks exacerbate gastrointestinal symptoms in IBS patients (Nilholm et al.,

2019). Unhealthy eating styles, including emotional eating, are characteristic of IBS patients (Jia et al., 2022). Emotional eating is defined as overeating in response to negative emotions and to regulate them. Emotional eaters consume high-carbohydrate, high-fat, and high-calorie foods with low nutritional value (Macht, 2008). High-carbohydrate, high-fat, and high-calorie foods are highly pro-inflammatory (Shivappa et al., 2014), and a pro-inflammatory diet increases the risk of IBS (Eslampour et al., 2021). Adverse bowel symptoms in IBS may be caused by FODMAP-rich foods (Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols), fatty foods, and intolerance to fructose, lactose, and gluten (Van Den Houte et al., 2022).

Consumption of these foods can lead to intestinal distension, secretion of harmful chemical molecules, and local microinflammation in the gut (Van Den Houte et al., 2022). Food-gut microbiome interactions are a source of neuroactive mediators/molecules that cause visceral hypersensitivity by modulating gut nociceptive signalling (Zhou et al., 2018) and gut-brain axis activity (Gao et al., 2020). Adverse changes in the microbiota lead to an inflammatory response or immune activation of the gut wall, which induces sensory, secretory, and enteromotor stimuli, ultimately causing or exacerbating IBS symptoms (Hayes et al., 2014). Dietary changes modulate gut flora and may reduce IBS symptoms (Deiteren et al., 2016) and visceral pain (Moloney et al., 2016).

Objective of the study

Research points to the crucial importance of the emotional state (level of stress experienced, anxiety, depression), ability to regulate emotions, level of GSA experienced, and emotional eating style on the severity of IBS symptoms. To the best of our knowledge, no study has investigated the joint effects of emotional state, emotion regulation difficulties, GSA, and emotional eating on IBS symptom severity. This study aimed to assess how the four predictors (X1. negative affective state, X2. difficulties in emotion regulation, and X3. Visceral Sensitivity Index, X4. Emotional eating style) explain the severity of IBS symptoms in adult women. We hypothesised that a higher negative affective state, difficulties in emotion regulation, visceral sensitivity, and emotional eating would predict more severe symptoms of IBS.

Novelty of the study

This study makes three novel contributions: First, we test a comprehensive model including four theoretically relevant predictors simultaneously. Second, we provide the first assessment of eating behaviors in IBS using the TFEQ-R18, which distinguishes cognitive restraint, emotional eating, and uncontrolled eating. Previous research on eating styles in IBS used the Dutch Eating Behavior Questionnaire (Jia et al., 2022), which assesses different constructs (restrained, emotional, and external eating). The TFEQ-R18 cognitive restraint subscale may be particularly relevant given dietary restriction recommendations for IBS (low FODMAP diet) and potential overlap with eating

disorder pathology. Third, we employ exploratory analyses to identify which specific dimensions within each domain (e.g., depression vs. anxiety within DASS-21; cognitive restraint vs. emotional eating within TFEQ-R18) show strongest associations with IBS severity.

METHODS

This study targeted adults of both sexes who had not previously been diagnosed with gastroenterological diseases with symptoms similar to IBS (Crohn's disease, ulcerative colitis, celiac disease, diverticulitis, peptic ulcer, or colorectal cancer). We looked for individuals with a medical diagnosis of IBS, those who suspected IBS, and those who experienced chronic abdominal pain related to the gastrointestinal tract. The participants were recruited from university centres, medical centres (for example, the Clinical Department of Gastroenterology and Hepatology of Wrocław Medical University), companies, and social media in Poland).

The study consisted of two stages that were completed online. All data were collected through an online survey. The first online survey consisted of a self-designed demographic and eligibility questionnaire and an IBS diagnostic questionnaire to measure the dependent variable and four predictors. The second stage of the study consisted of a 7-day food diary. Participants were instructed on how to make dietary observations. Food diaries were completed online for seven consecutive days. Based on the 7-day food diary, we planned to derive the Dietary Inflammatory Index (DII; Shivappa et al., 2014), the fifth predictor in our model.

The inclusion criteria in the present study were as follows: (1) women ≥ 18 years of age; (2) meeting the Rome IV criteria for IBS (Rome Foundation®); and (3) no other gastroenterological diseases. The study design assumed stricter inclusion/exclusion criteria, but we toned it down due to the low eligibility to be included in the study.

The current study was pre-registered in Open Science Framework: <https://osf.io/dws45>. The study protocol was approved by Research Ethics Committee of the Institute of Psychology, University of Wrocław, Poland (decision number 2022/GHLIQ). This study was designed and conducted in accordance with the guidelines of the Declaration of Helsinki. Participants were given written information about the study and asked to sign a consent form before starting the survey (by marking a box on the first page of the survey). Participants voluntarily responded to the survey. The participants were informed about the possibility of resignation at any stage of the study and about the anonymity of the study.

Data were collected from December 2022 to May 2024. Four participants (6.5%) with incomplete questionnaires were excluded using listwise deletion. This approach was chosen because: (1) missing data appeared to reflect incomplete survey submission rather than systematic item non-response, and (2) multiple regression requires complete data. While listwise deletion is less sophisticated than

modern missing data techniques (multiple imputation), it is appropriate when missing data is minimal (<10%).

According to the pre-registration for the study, the minimum sample size required for the analyses was 92. We recruited 113 participants, 48 of whom were excluded because they did not meet the inclusion criteria (mainly because they did not meet the Rome IV criteria for IBS). In total, 65 participants were recruited to participate in Stage 2 (food diary), of which 40 did not undertake (or complete) this stage. Due to the high dropout rate (62 %) from the study at stage 2, we did not include the DII predictor in the analyses.

Figure 1. explains how data were qualified for analysis in the current, adapted study. We focused on data from the questionnaire collected during stage I (n = 65). Due to the low participation of men (n = 3), we focused on analysing data collected from women. Due to missing data, we excluded four women. Finally, instead of the assumed 92 participants, the results of 58 women were included in the analyses. Therefore, we performed a sensitivity analysis using the G*Power software for multiple linear regression, a fixed model for four predictors, assuming $\alpha = .05$, power = .80, and total sample size n=58. The study was sufficiently sensitive to detect a medium effect size ($f^2 = .22$).

[1] The severity of symptoms of Irritable Bowel Syndrome (IBS-SSS)

The severity of IBS symptoms was measured using the Irritable Bowel symptom severity scoring scale (Francis et al., 1997). In the present study, we used the Polish

version of the IBS-SSS provided by the Rome Foundation. The IBS-SSS assessed the frequency and severity of IBS symptoms over the past ten days. The overall symptom severity score consists of assessments of abdominal pain on two scales: 1. frequency and severity, bloating, dissatisfaction with bowel movements, and 2. Impact of perceived symptoms on daily life. The internal consistency of the IBS-SSS is .72. Sum scores range from 0 to 500. Higher scores indicate more severe IBS symptoms (Francis et al., 1997). The internal consistency of the scale (Cronbach's alpha) was .78 in the present study.

[2] Gastrointestinal (GI)-specific anxiety

astrointestinal (GI)-specific anxiety (GSA) was assessed using a Visceral Sensitivity Index (Labus et al., 2004). The VSI is a brief tool developed to determine GSA in patients with IBS. The VSI is used to evaluate anxiety due to the perceived visceral symptoms of IBS. VSI is a 15-item self-report scale. The responses range from 1 (strongly agree) to 6 (strongly disagree) are reverse scored (1–6 becomes 5–0). The total scores range from 0 (no GI-specific anxiety) to 75 (severe GSA). The internal consistency of the VSI is $\alpha = .90-.92$ (Labus et al., 2007). The internal consistency of the scale (Cronbach's alpha) was .88 in the present study. The VSI has been translated into Japanese (Saigo et al., 2014) or Norwegian (Lind et al., 2010). The reliability and validity of the versions were confirmed. In this study, we used the Polish translation of the VSI, which was made available by a Polish IBS researcher (Mulak, 2003; Mulak & Paradowski, 2010).

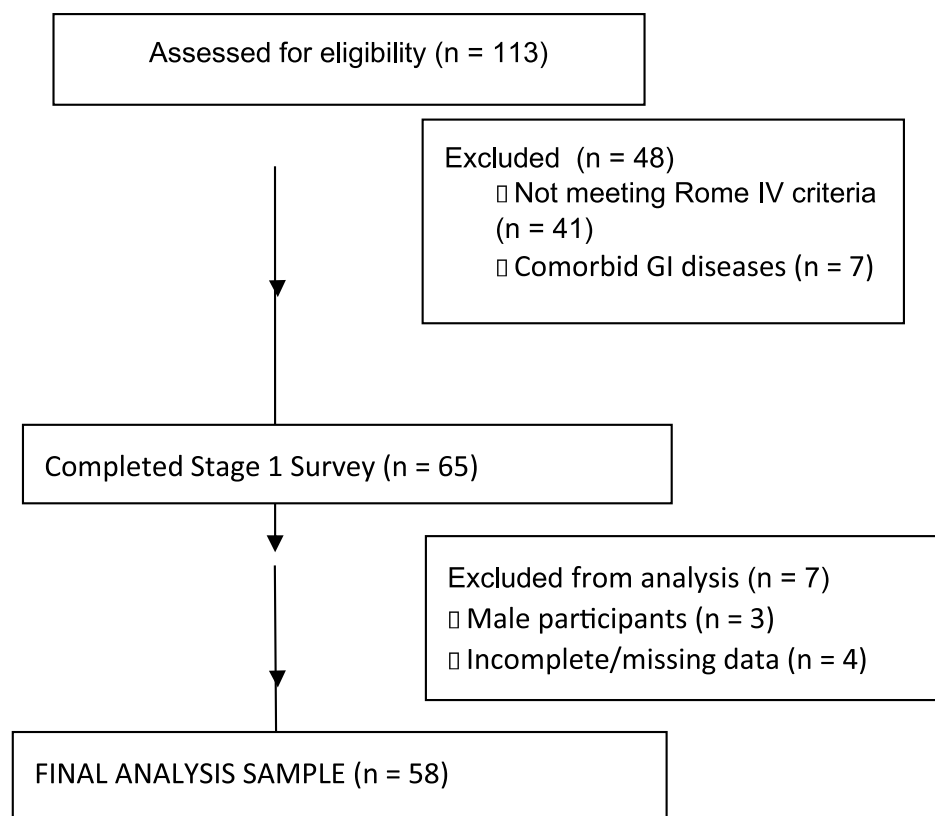


Figure 1. Flow diagram for the qualification of the final analysis sample

[3] The negative emotional state

The severity of the negative affective state was measured using the Depression, Anxiety and Stress Scale - 21 Items, DASS-21 (Lovibond & Lovibond, 1995). The DASS-21 was developed to measure negative emotional states of depression, anxiety, and stress over the past seven days. This self-report questionnaire consists of 21 items (seven items for each subscale: depression, anxiety, and stress). The responses range from 0 (did not apply to me at all) to 3 (applied to me very much). Sum scores are computed by adding the scores on the items per (sub)scale and multiplying them by a factor of 2. The total scores range from 0 to 126 (and for each subscale, ranging between 0 and 42) (Lovibond & Lovibond, 1995). Higher scores indicate a more severe negative affective state. The internal consistency of the DASS-21 for a general Polish sample is $\alpha = .93$ (Makara-Studzińska et al., 2022). Internal consistency for the scale (Cronbach's alpha) was .93 in the present study.

[4] The difficulties in emotion regulation – DERS

Difficulties in emotion regulation were assessed using the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) in the Polish adaptation (Dragan, 2015). It is a 36-item self-report scale that assesses problems related to emotion regulation. It consists of 6 subscales: 1. Non-acceptance of emotional responses; 2. Difficulties engaging in goal-directed behaviour; 3. Impulse control difficulties; 4. Lack of emotional awareness; 5. Limited access to emotion regulation strategies; 6. Lack of emotional clarity. We used the total DERS score as a predictor in our model. The responses are rated on a Likert-type scale of 1 (almost never, 0%–10%) to 5 (almost always, 91%–100%). Items are averaged to yield a total score and subscale scores. Higher scores indicate a greater severity of emotion regulation difficulties (Gratz & Roemer, 2004). The internal consistency of the DERS in a Polish sample of young females was $\alpha = .93$ (Dragan, 2015). Internal consistency for the scale (Cronbach's alpha) was .94 in the present study.

[5] Eating behaviour – the emotional eating style

The Three-Factor Eating Questionnaire (R18) was used to assess eating behaviours in three different styles (Karlsson et al., 2000a). The instrument is a shortened and revised version of the original 51-item TFEQ (Stunkard & Messick, 1985). The TFEQ-R18 was developed by Karlsson et al. (2000) and adapted to Polish samples by Brytek-Matera et al. (2017). The TFEQ-R18 measures three different aspects of eating behaviour: (1) emotional eating (inability to resist emotional cues/ tendency to overeat in response to negative emotions); (2) uncontrolled eating (tendency to eat more than usual due to a loss of control over intake accompanied by subjective feelings of hunger); and (3) restrained eating (cognitive restraint, conscious restriction of food intake to control body weight, or to promote weight loss). Cognitive restraint (CR) as measured by the TFEQ-R18 refers to conscious control over food intake and may occur in healthy individuals for weight management. While CR can co-occur with eating disorders, it is not synonymous with pathological restric-

tion. The TFEQ-R18 consists of a self-reported, 18-item scale. Seventeen items are rated on a 4-point Likert-type scale, and the 18th question ranges from 1 to 8 (Karlsson et al., 2000a). In the Polish version, the 18th question is recoded into a score between 1 and 4 (Brytek-Matera et al., 2017). Higher scores indicate greater emotional, uncontrolled, or restrictive eating (Karlsson et al. 2000a). The internal consistency of the TFEQ-R18 (Brytek-Matera et al., 2017): $\alpha_{\text{Cognitive restraint}} = .78$, $\alpha_{\text{Uncontrolled eating}} = .84$, and $\alpha_{\text{Emotional eating}} = .86$. In the present study, Internal consistency for the subscales were: $\alpha_{\text{Cognitive restraint}} = .85$, $\alpha_{\text{Uncontrolled eating}} = .81$, and $\alpha_{\text{Emotional eating}} = .82$.

[6] Sociodemographic and health-related information

We used the Polish version of the Irritable Bowel Syndrome Module from the ROME IV Diagnostic Questionnaire for Adults (Palsson et al., 2016), which was made available by the Rome Foundation®. The questionnaire is a diagnostic tool that checks for the fulfilment of the Rome IV criteria for the diagnosis of irritable bowel syndrome (Palsson et al., 2016). Based on this Questionnaire, the participants qualified for the present study. Information was gathered on the socio-demographic, health, and eating variables.

Statistical Analysis

Data were analysed using JASP for Windows, Version 0.18.3.0 (JASP Team, 2024). We conducted a multiple linear regression analysis with the Irritable Bowel Syndrome Severity Scoring Scale (IBS-SSS) as our dependent variable and four variables (Visceral Sensitivity Index, negative affective state, difficulties in emotion regulation, and emotional eating) as predictors. A p-value of less than .05 indicated a significant effect of the predictor variable(s) on our dependent variable, IBS-SSS.

We also conducted exploratory analyses (a forward stepwise regression), including the other TFEQ-R18 subscales, the DASS-21 subscales and the DERS subscales as predictors. We used a p-value of less than .05 to entry predictors and a p-value of more than .051 to remove predictors from the model. The predictor that provided the highest increase in R^2 was determined to be the most significant variable and added at each step.

Stepwise regression has important limitations, including inflation of Type I error and model instability, particularly with small samples. However, we employed this approach for exploratory purposes only to identify which specific subscales (among DASS-21, DERS, and TFEQ-R18 dimensions) showed strongest associations with IBS-SSS, given limited prior research on these specific relationships. Assumptions for all regression models were checked using Durbin-Watson test, VIF values, Residual vs predicted and Q-Q plots. For all five reported models all the assumptions have been met.

Our primary pre-registered analysis (Table 5: four-predictor model) used standard simultaneous entry regression. The stepwise analyses (Tables 6-9) should be considered hypothesis-generating rather than confirmatory, requiring replication in independent samples.

RESULTS

Fifty-eight women were included and analysed in the present study. Table 1 presents sociodemographic data. The mean age was 23.69 years (SD = 4.80). The mean body mass index (BMI) was 21.44 kg/m² (SD = 2.99).

The data on health, diet, and lifestyle are presented in Table 2.

Table 1. Sociodemographic Characteristics of Female Participants (N = 58)

	<i>n</i>	%
Marital status		
Single	51	87.93
Married/partnered	6	10.35
Divorced/widowed	1	1.72
Highest educational level		
High school or University	34	58.62
Postgraduate degree	24	41.38
Employment		
Student	33	56.90
Full-time Employed	11	18.97
Part-time Employed	1	1.72
Student + Employed	13	22.41

Table 2. Healthy and Life Style Characteristics of Female Participants (N = 58)

	<i>n</i>	%
Physical activity per week		
No	6	10.35
1/week	16	27.59
2-3/week	20	34.48
4-5/week	10	17.24
Everyday	6	10.35
Alcohol ^a	33	56.90
Smoking ^a	9	15.52
Diet ^a		
Non-vegetarian	43	74.14
Vegetarian	14	24.14
Vegan	4	6.90
Other	14	24.14
Food intolerance ^a	28	48.28
Food avoidance ^a	49	84.48
Normal BMI	44	75.86
Other chronic illnesses ^a	31	53.45
Antibiotic therapy ^a	2	3.45
Abdomen surgery ^a	3	5.17
Mental disorders currently ^a	24	41.38

^a Reflects the number and percentage of participants answering "yes" to this question.

The characteristics of the groups in terms of IBS experience and ways of managing IBS symptoms are shown in Table 3. Participants were eligible for the study if they met the Rome Criteria IV. However, almost 52% of the participants reported that a physician had also diagnosed them. 31% of individuals reported using medications to relieve IBS symptoms. Dietary changes, breathing exercises, yoga, and psychological counselling were the most common methods of symptom relief. Most women experienced moderate (37.93%) or severe (50%) IBS symptoms. Additionally, 43 respondents specified that they had experienced IBS symptoms for an average of 6.36 years (SD = 5.68).

Table 3. Characteristics of IBS (N = 58)

	<i>n</i>	%
IBS Type		
IBS-C	10	17.24
IBS-D	16	27.59
IBS-M	30	51.72
IBS-U	2	3.45
IBS-SSS category		
<75	1	1.72
75 to <175 Mild	6	10.35
175 to <300 Moderate	22	37.93
>300 Severe	29	50.00
medical diagnosis ^a	30	51.72
Current medications to relieve IBS ^a	18	31.03
Methods to alleviate IBS in the past ^a		
Psychological consultation	21	36.21
Cognitive behavioural therapy	17	29.31
Yoga	22	37.93
Hypnosis	0	0.00
Meditation	12	20.69
Breathing exercises	25	43.10
Change of diet	46	79.31

Note. IBS-C: IBS with Constipation, IBS-D: IBS with Diarrhea, IBS-M: IBS with mixed bowel habits IBS-U: IBS unsubtyped, IBS-SSS: The Irritable Bowel Symptom Severity Scoring Scale

^a Reflects the number and percentage of participants answering "yes" to this question.

Table 4 shows descriptive statistics for the dependent variable (IBS Severity Scoring Scale) and all predictors: main predictors (Visceral Sensitivity Index, DASS-21, DERS, TFEQ-R18 Emotional Eating) and exploratory predictors (DASS-21 subscales, DERS subscales, and other TFEQ-R18 subscales). The mean severity of IBS symptoms was 301.74 (SD = 105.67), as shown in Table 4. The results of the correlation analysis of the variables measured by the questionnaires are presented in Table 1 in Appendix A.

Table 4. Descriptive Statistics for Main Variable and Predictors (N = 58)

Variable	Mean	SD	Min	Max	Skewness		Kurtosis	
					Statistic	Std. Error	Statistic	Std. Error
IBS Severity Scoring Scale	301.74	105.67	30.00	510.00	-0.17	0.31	-0.42	0.62
Visceral Sensitivity Index	50.12	13.77	24.00	75.00	-0.31	0.31	-0.79	0.62
DASS-21	57.97 ^a	29.52	12.00	118.00	0.38	0.31	-0.74	0.62
DASS-21 Stress	22.86	11.01	2.00	42.00	-0.11	0.31	-0.87	0.62
DASS-21 Anxiety	18.59	10.62	0.00	40.00	0.32	0.31	-0.79	0.62
DASS-21 Depression	16.52 ^a	11.32	0.00	40.00	0.72	0.31	-0.55	0.62
DERS	105.98	24.56	60.00	157.00	-0.08	0.31	-0.87	0.62
DERS Nonaccept	17.91	6.17	6.00	30.00	-0.01	0.31	-0.93	0.62
DERS Goals	17.48 ^a	4.27	9.00	25.00	-0.12	0.31	-1.06	0.62
DERS Impulse	16.59	5.40	6.00	28.00	0.15	0.31	-0.73	0.62
DERS Awareness	15.22	4.96	6.00	26.00	0.22	0.31	-0.59	0.62
DERS Strategies	24.26	7.30	9.00	38.00	-0.16	0.31	-0.72	0.62
DERS Clarity	14.52	5.19	5.00	25.00	0.09	0.31	-0.98	0.62
TFEQ-R18 Cognitive Restraint	8.26	4.34	0.00	17.00	0.11	0.31	-0.55	0.62
TFEQ-R18 Uncontrolled Eating	10.64	5.30	0.00	22.00	0.19	0.31	-0.57	0.62
TFEQ-R18 Emotional Eating	4.10 ^a	2.62	0.00	9.00	0.04	0.31	-0.87	0.62

^a P-value of Shapiro-Wilk <.05

Note. DASS-21: Depression, Anxiety and Stress Scale - 21 Items, DERS: The Difficulties in Emotion Regulation Scale, IBS: Irritable Bowel Syndrome., TFEQ-R18: The Three-Factor Eating Questionnaire – R18.

The results of the primary analysis are presented in Table 5. In the study group of women (n = 58), the model tested was found to be statistically significant, but a detailed analysis showed that only one predictor (VSI) significantly predicted IBS symptom severity (explaining 43.5% of the variation). Key Finding: Only VSI significantly predicted IBS severity when all four variables were tested together (adj. R² = .44).

Stepwise analysis (Table 6) showed that a model with two predictors (VSI + DASS-21) predicted IBS symptom severity more accurately (adj. R² = 45 %) than model 1 (Table 6), with with one predictor (VSI; adj. R² = 39 %). In Model 2 (Table 6), both model and predictive factors

were statistically significant. Key Finding: Two-predictor model (VSI + DASS-21) improved fit to 45% explained variance. Both GI-specific anxiety and general negative affect predict IBS severity.

Tables 7, 8, and 9 present the results of the exploratory analyses (stepwise multiple linear regression). In each of the three analyses, we tested whether the DASS-21, DERS, and TFEQ-R18 subscales were more accurate predictors of IBS symptom severity than the total scores of the DASS-21, DERS, and TFEQ-R18-EE subscales.

Analysis of the DASS-21 subscales (Table 7) showed that both Model 2 overall and both predictors (VSI and

Table 5. Summary of Simple Regression Analyses for Variables Predicting the severity of Irritable Bowel Syndrome (N = 58)

Variable	B	SE B	β	95% CI	
				LL	UL
VSI	3.74	0.86	0.49***	2.01	5.47
DASS-21	0.88	0.49	0.25	-0.11	1.87
DERS	0.42	0.58	0.10	-0.75	1.59
TFEQ-R18-EE	-1.77	4.15	-0.04	-10.09	6.56
adj. R ²	0.44				
F	11.98***				

*p<.05. **p<.01. ***p<.001.

Table 6. Summary of Stepwise Regression Analyses for Variables Predicting the severity of Irritable Bowel Syndrome (N = 58)

Variable	Model 1					Model 2				
	95% CI					95% CI				
	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>
VSI	4.84	0.80	0.63***	3.25	6.44	3.86	0.84	0.50***	2.19	5.54
DASS-21						1.06	0.39	0.30**	0.28	1.84
<i>adj. R</i> ²	0.39					0.45				
<i>F</i>	36.96***					24.24***				

p*<.05. *p*<.01. ****p*<.001.

Note. The following covariates were considered but not included: DERS_TOT, TFEQR18_EE.

Table 7. Summary of Stepwise Regression Analyses for Main Predictors and subscales of DASS-21 Predicting the severity of Irritable Bowel Syndrome (N = 58)

Variable	Model 1					Model 2				
	95% CI					95% CI				
	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>
VSI	4.84	0.80	0.63***	3.25	6.44	3.91	0.81	0.51***	2.30	5.52
DASS-21-D						2.96	0.98	0.32**	1.00	4.93
<i>adj. R</i> ²	0.39					0.47				
<i>F</i>	36.96***					25.72***				

p*<.05. *p*<.01. ****p*<.001.

Note. The following covariates were considered but not included: DERS_TOT, TFEQR18_EE, DASS21_S, DASS21_A.

Table 8. Summary of Stepwise Regression Analyses for Main Predictors and subscales of DERS Predicting the severity of Irritable Bowel Syndrome (N = 58)

Variable	Model 1					Model 2				
	95% CI					95% CI				
	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>	<i>B</i>	<i>SE B</i>	β	<i>LL</i>	<i>UL</i>
VSI	4.84	0.80	0.63***	3.25	6.44	3.86	0.84	0.50***	2.19	5.54
DASS-21						1.06	0.39	0.30**	0.28	1.84
<i>adj. R</i> ²	0.39					0.45				
<i>F</i>	36.96***					24.24***				

p*<.05. *p*<.01. ****p*<.001.

Note. The following covariates were considered but not included: TFEQR18_EE, DERS_NONAC, DERS_GOALS, DERS_IMPU, DERS_AWAR, DERS_STRAT, DERS_CLAR.

depression subscale) significantly predicted IBS severity (*adj. R*² = 46.5%). Key Finding: Depression subscale (DASS-21-D) was the most predictive emotional component. Model with VSI + Depression explained 47% of variance.

None of the DERS subscales (Table 8) were included in the model. As none of the DERS subscales were included in the model (see the annotation at the end of Table 8), the data presented here are the same as those in Table 6. Key Finding: None of the six DERS emotion

regulation subscales improved prediction beyond VSI and DASS-21.

The most accurate model to explain IBS-SSS severity was the three-variable model (Table 9): VSI + TFEQ-R18-CR + DASS-21. Both the model and variables were significant predictors of IBS severity (adjusted. *R*² = 49.8%). Key Finding: Best fitting model. Cognitive restraint (restrictive eating), not emotional eating, predicted IBS severity alongside VSI and DASS-21 (50% variance explained).

Table 9. Summary of Stepwise Regression Analyses for Main Predictors and subscales of TFEQ-R18 Predicting the severity of Irritable Bowel Syndrome (N = 58)

Variable	Model 1					Model 2					Model 3				
	<i>B</i>	<i>SE B</i>	β	95% <i>CI</i>		<i>B</i>	<i>SE B</i>	β	95% <i>CI</i>		<i>B</i>	<i>SE B</i>	β	95% <i>CI</i>	
VSI	4.84	0.80	0.63***	3.25	6.44	3.98	0.80	0.52***	2.37	5.59	3.31	0.83	0.43***	1.65	4.97
DASS-21											0.87	0.38	0.24*	0.10	1.63
TFEQR18-CR						7.46	2.55	0.31**	2.35	12.56	6.32	2.51	0.26*	1.29	11.34
<i>adj. R²</i>	0.39					0.46					0.50				
<i>F</i>	36.96***					25.25***					19.85***				

* $p < .05$. ** $p < .01$. *** $p < .001$.

Note. The following covariates were considered but not included: DERS_TOT, TFEQR18_EE, TFEQR18_UE.

DISCUSSION

MAIN FINDINGS

This study aimed to assess the ability of a model consisting of four variables (VSI, DASS-21, DERS, and TFEQ-R18-EE) to predict the severity of IBS symptoms in women. Although the model was statistically significant (explaining 43.5% of the variance), only one predictor (VSI) had a significant effect. Stepwise analysis showed that the two-variable models (VSI and DASS-21) predicted IBS severity more accurately. Thus, anxiety specific to bowel symptoms and general negative affective states may be associated with IBS severity. In addition, exploratory analyses showed that a depressive state was the most predictive of IBS severity. Neither the overall nor the specific assessment of the severity of emotion regulation difficulties confirmed the hypothesised effect of IBS severity. The assessment of eating styles showed that it was not an emotional eating style but a restrictive eating style that predicted the severity of irritable bowel syndrome. The most accurate model for explaining IBS severity is the three-variable model: VSI, TFEQ-R18-CR, and DASS-21. According to this, more gut symptom-specific anxiety, a more restrictive eating style, and a higher overall negative affective state contribute to IBS symptom severity.

Affective state and IBS severity

Consistent with other studies (Jerndal et al., 2010), a higher GSA (GI symptom-specific anxiety as measured by the VSI) predicted IBS symptom severity. A positive association between GSA and IBS symptom severity has been previously reported (Labus et al., 2004, 2007; Saigo et al., 2014). GSA is also a mediator in the relationship between neuroticism, anxiety symptoms, and IBS symptom severity (Labus et al., 2007).

Experiencing a negative emotional state (DASS-21) predicted IBS severity. In the study sample, increased

depressive state (DASS-D) also predicted IBS severity. Experiencing stress, depressive states, anxiety, or anger are associated with the severity of visceral hypersensitivity and visceral pain (Elsenbruch et al., 2010; Moloney et al., 2016). Emotional arousal alone increases colonic motility, which can lead to diarrhoea in patients with IBS (Muscatello et al., 2016). Anxiety and depression have been shown to have a greater effect on reducing quality of life than symptom severity in IBS (Xie et al., 2024). However, psychological factors, particularly anxiety, strongly mediate the impact of physiological symptoms on the quality of life in IBS (Xie et al., 2024).

The overall level (and each of the dimensions) of the severity of emotion regulation difficulties was not found to be significantly predictive of IBS symptom severity. This finding contrasts with results from previous studies (Aliakbari-Dehkordi et al. 2015; Orzechowska et al. 2010). In the group of patients diagnosed with IBS, women were characterised by a lower ability to control external symptoms of experienced emotions than men (Orzechowska et al., 2010). Difficulties in emotion regulation (measured by DERS) predict the severity of psychological and somatic symptoms in functional gastrointestinal disorders (FGIDs), as shown in $n=167$, where women accounted for 80.8% (Aliakbari-Dehkordi et al., 2015).

Studies evaluating the effectiveness of emotion regulation therapy have shown significant improvements in emotion regulation, as well as reductions in the severity of IBS symptoms (Shafiei et al., 2024). However, the baseline of the DERS is lower $M_{\text{DERS-intervention}} = 120.93$, $SD_{\text{DERS-intervention}} = 8.55$ and $M_{\text{DERS-control}} = 122.6$, $SD_{\text{DERS-control}} = 7.62$ (Shafiei et al., 2024) than in our study ($M_{\text{DERS}} = 105.98$, $SD_{\text{DERS}} = 24.56$). We suspect that the hypothesized relationship between the severity of emotion regulation difficulties and IBS symptoms was challenging to observe because of the high variance of the study group in emotion regulation ability.

Additionally, research has demonstrated that in individuals with IBS ($n = 123$, female = 83.3%), internal resources, such as interpersonal forgiveness and psychological hardiness, may facilitate the application of more adaptive emotion regulation strategies (Mazaheri et al., 2015). It should be noted that these personality traits were not assessed in this study. Furthermore, our study examined a single dimension of affective processing: emotion regulation ability. The observed lack of effect of emotion regulation ability on IBS symptom severity is consistent with the findings of previous studies, which have indicated that other aspects of affective processing are of greater importance in IBS, namely, the ability to understand and tolerate unpleasant or negative affective states. However, all six dimensions examined demonstrated weaker abilities in IBS than in HC (Berens et al., 2021).

It is important to note that some predictor variables are not independent but show substantial intercorrelations. GSA (measured by VSI) correlates positively with general anxiety and depressive symptoms (Neverovskyi et al., 2023), which is theoretically expected given that GI-specific anxiety represents a domain-specific manifestation of broader disposition. Previous research using path analysis has shown that GI-specific anxiety acts as a mediating variable in the pathway from general psychological distress to gastrointestinal symptom severity (Labus et al., 2007). The lack of significant DERS effects when DASS-21 was included may reflect construct redundancy rather than absence of relationship. Both scales assess aspects of negative emotional experience: DASS-21 measures current severity of negative emotional states, and DERS assesses meta-cognitive difficulties managing emotions. Research shows moderate-to-strong correlations ($r=0.50-0.70$) between DASS-21 and DERS (Iannattone et al., 2023), suggesting shared variance. In multiple regression, DASS-21 may have captured the emotion-related variance, leaving little unique contribution for DERS. Alternatively, our findings may reflect that current emotional distress matters more than regulatory difficulties for IBS symptom severity.

Eating behaviour and IBS severity

The results of the eating style analysis were surprising. A restrictive eating style has been shown to predict the severity of IBS, although this was thought to be an emotional eating style. A study assessing the three eating styles in IBS found that restrictive, emotional, and external eating styles were associated with the occurrence of IBS (Jia et al., 2022). Our data are partly consistent with this finding, and discrepancies may be due to methodological issues. The study (Jia et al., 2022) was primarily conducted in a group of men using a different measurement tool: the Dutch Eating Behavior Questionnaire (Jia et al., 2022). To our knowledge, no other study on eating styles (TFEQ-R18) has been conducted among women with IBS. There are several possible explanations for the relationship between CR and IBS severity. These include: 1) comorbidity of IBS and eating disorders, 2) Western

cultural conditioning of body image, 3) personality factors, 4) diet recommendations for IBS, and 5) accuracy of the instrument.

(1) Comorbidity of IBS and eating disorders: A restrictive eating style, defined as cognitive restraint, involves the conscious limitation of food intake to control or support weight loss (Karlsson et al., 2000b). A higher level of cognitive restraint has been demonstrated to be significantly associated with calorie intake restriction in both healthy individuals and those with eating disorders (Zambrowicz et al., 2019). Nevertheless, there is currently no evidence suggesting a causal relationship between eating disorders and DGBI (Stanculete et al., 2021). This may be due to shared symptomatology (Stanculete et al., 2021) and co-occurrence of ED and IBS (Spillebout et al., 2019; Sultan et al., 2024). Similar to IBS, ED is characterised by increased anxiety about bowel symptoms. Furthermore, increased VSI in individuals with eating disorders has been linked to increased cognitive restraint (Brown et al., 2021). However, it is important to note the fundamental contrast between IBS and ED. In IBS, motivation is driven by fear of negative consequences and a desire to avoid GI symptoms rather than a compulsion to eat healthy foods or to avoid foods for fear of weight gain (Harer & Eswaran, 2021).

(2) Western cultural conditioning of body image: The results of studies conducted in Poland, primarily among female health sciences students, indicate several recurrent characteristics in this group. These include a lower BMI, a higher-quality diet, greater levels of physical activity, tendencies towards orthorexia, and a higher prevalence of restrictive eating (Rozmiarek et al., 2024). The attributes of this cohort (Rozmiarek et al., 2024) are analogous to those observed in our sample. It seems plausible to suggest that increased CR may not be a characteristic exclusive to the IBS group but rather a phenomenon prevalent among young women in general. This is consistent with a broader trend in Western culture, namely, anxiety about weight control and adherence to more restrictive eating habits (Wardle et al., 2000). Furthermore, a restrictive and emotional eating style has been demonstrated to be prevalent among the general French population of adolescents and young women. A positive correlation was observed between CR and healthy food items, whereas a negative correlation was noted between CR and chips and sugar. Women exhibiting CR demonstrated lower energy intake than other subjects (De Lauzon et al., 2004).

(3) Personality factors: A study conducted on a group of healthy Polish women ($n=556$, age=34) revealed that higher levels of neuroticism were a predictor of higher scores on measures of cognitive eating inhibition, uncontrolled eating, and emotional eating (Rachubińska et al., 2023). Among the personality traits that predispose individuals to the development of IBS symptoms and the worsening of unpleasant gastrointestinal symptoms, increased neuroticism is indicated (Talley et al., 1998). Moreover, genetic studies have demonstrated a notable correlation between anxiety, depression, neuroticism, and

IBS (Eijssbouts et al., 2021). Further investigations are recommended to ascertain whether CR acts as a mediator between neuroticism and IBS symptom severity.

(4) Diet recommendations for IBS: A restrictive eating style has been demonstrated to be a significant predictor of overeating (van Strien et al., 2020). The influence of affect on cognitive control of eating behaviour results in weakening this control, leading to overeating (Reichenberger et al., 2020). Given the prevalence of negative affect in individuals with IBS, this phenomenon may also occur in people with IBS who are characterised by a restrictive eating style. The co-occurrence of restrictive eating and negative affect has been demonstrated to predict a reduction in the efficacy of CBT in BED (Douchis et al., 2021). Consequently, it may be hypothesised that a combination of these characteristics in the study group will result in a higher frequency of overeating episodes. Correlations have been demonstrated between IBS symptom severity and the frequency of overeating episodes (Crowell et al., 1994), irregular meal rhythms, lower fruit and vegetable intake, higher intake of high-calorie foods, and fast food consumption (Cozma-Petrut et al., 2017; McKenzie et al., 2016). Accordingly, one of the dietary recommendations for individuals with IBS is to avoid overeating (Cozma-Petrut et al., 2017; McKenzie et al., 2016). Another recommendation for the treatment of IBS is a low FODMAP diet, which is an elimination diet that restricts certain foods. This diet should be implemented by a specialist. Furthermore, it is recommended that before recommending a low FODMAP diet (Black & Ford, 2020), the risk of eating disorders in individuals with IBS should be assessed (Bertin et al., 2024). An intensified restrictive eating style may provide an additional rationale for determining the prevalence of eating disorders and the risks associated with implementing a low FODMAP diet in IBS. This is recommended considering the elevated CR scores (TFEQ-13) observed in the low FODMAP group relative to vegetarians and those following a traditional diet, as reported in a study conducted on a Polish sample of healthy women (Gwioździk et al., 2022).

(5) Relevance of the TFEQ-R18-CR: A recent literature review suggests an inconsistent relationship between cognitive restraint and eating behaviour (Bryant et al., 2019). On one hand, restraint is associated with better diet quality, better weight regulation, and lower body weight. On the other hand, restraint is also related to poor diet quality, overeating, and susceptibility to obesity. This variation may be due to the complexity of the construct of cognitive restraint, which can also be distinguished into rigid CR and flexible CR (Bryant et al., 2019). This rigid CR, measured by the rigid control of eating behaviour subscale (Westenhoefer et al., 1999), is a strong predictor of both eating disorders and negative body image (Linardon and Mitchell, 2017). We suggest that CR, as measured by the TFEQ-R18, may be too general of a construct. Therefore, its association with eating disorders has not been demonstrated previously (Safer et al. 2004). Differences were noted in the accuracy of the TFEQ-CR compared with the EDE-R, which translates

into accuracy in describing the group with ED. The EDE-R reflects eating behaviours that lead to weight loss, whereas the TFEQ-CR reflects eating behaviours that lead to avoidance of weight gain (Safer et al., 2004). Given the diversity of tools for measuring restrictive eating styles (Bryant et al., 2019), it is advisable to investigate which tool most accurately measures eating behaviour in the IBS group and the mechanisms underlying eating behaviour in IBS.

Furthermore, the relationship between cognitive restraint and IBS symptom severity requires careful interpretation. Unlike weight-control motivation in eating disorders, IBS patients may develop CR primarily as a learned response to manage unpredictable GI symptoms. This "defensive" CR aims to prevent symptom flares rather than control body weight, though the TFEQ-R18-CR subscale cannot distinguish these motivations. Also, the elevated CR in our young, educated female sample may partly reflect normative dietary attitudes rather than IBS-specific pathology. However, the predictive relationship with IBS-SSS suggests CR contributes to symptom severity beyond population baseline levels. We recommend future research explicitly measure motivation for dietary restriction (weight control vs. symptom management), and temporal relationships between CR development and IBS symptom onset.

Limitations of the Study and Future Directions

The present study has several limitations. First, less data was available for analysis than was assumed in the study design. In addition, the focus of the analysis is on women. The reasons for these changes are described in the Methodology section. The substantial reduction from our planned sample size has important consequences. With four predictors, our achieved power can detect medium effects but may miss small-to-medium effects. This means an increased Type II error risk. Additionally, smaller samples produce wider confidence intervals and less reliable beta coefficients, particularly in exploratory stepwise models. We initially screened 113 participants but excluded 48 primarily for not meeting Rome IV criteria (n=41). This suggests that self-reported IBS symptoms often do not meet diagnostic thresholds. Future studies should oversample to account for 40-50% exclusion rates, and consider multi-site recruitment to achieve adequate power.

Physician-diagnosed versus self-identified IBS may represent different populations. However, all participants met Rome IV criteria, which are the current diagnostic gold standard. The Rome Foundation explicitly states that IBS can be diagnosed using symptom-based criteria without requiring physician evaluation. Nevertheless, it needs to be stated that diagnostic certainty may vary. Participants self-selected into an online study about emotional factors and eating behaviors in IBS. This may have attracted individuals more psychologically minded, more distressed, or more interested in emotional aspects of their condition. We did not implement prospective data quality control measures for online survey

responses. While indirect evidence (high internal consistency, theoretically coherent results) suggests reasonable data quality, we cannot definitively exclude some inattentive responding. This may have introduced measurement error, potentially attenuating effect sizes and relationships. However, such error would likely bias results toward null findings rather than create spurious significant effects. All measures demonstrated good-to-excellent internal consistency (Cronbach's $\alpha = .78-.94$), suggesting coherent and attentive responding. Random or careless responding typically reduces internal consistency by introducing measurement error.

Regarding the original study design: only 38% of women completed the 7-day food diary despite email reminders (2-3 attempts per missing entry), resulting in high attrition and exclusion of the DII predictor. We did not systematically assess dropout reasons, which is a methodological limitation. Likely contributors include: (1) high participant burden for students managing academic responsibilities, (2) lack of compensation, and (3) possible anxiety about detailed food tracking in IBS patients. This attrition prevented testing our fifth hypothesis and may have introduced selection bias if completers differed systematically from non-completers in symptom severity, motivation, or organizational skills. We verified that stage 2 completers did not differ significantly from non-completers on any Stage 1 variables (all $ps > .05$, and effect sizes small), suggesting attrition was relatively random rather than systematic. Future research should systematically assess dropout reasons to improve retention, provide compensation or use less burdensome dietary assessment (3-day records, food frequency questionnaires).

Second, the study used an instrument (VSI) that has not been adapted and validated in a Polish group of people with IBS. A gastroenterologist who clinically researches DGBI, including IBS, translated the VSI for the study. Notably, the VSI has been adapted several times in different countries, including Italy (Rizzo et al., 2024), Ukraine (Neverovskyi et al., 2023), Japan (Saigo et al., 2014b), and Norway (Lind et al., 2010). Regardless of country, the tool's structure, relevance, and reliability have been confirmed. Thus, it can be used as a transcultural tool.

Third, several potentially important confounding variables were not controlled: While mean BMI was 21.44, indicating generally healthy weight, BMI can affect both eating behaviors and IBS symptoms. Future studies should test whether CR-IBS relationships persist after controlling for BMI. Also, hormonal fluctuations across the menstrual cycle affect both GI symptoms and emotional states in women. We did not record cycle phase at assessment, introducing potential unaccounted for variability in IBS-SSS and DASS-21 scores. While 31.03% reported current IBS medications and 41.38% had diagnosed mental health conditions. We did not control for psychiatric medication use or comorbid conditions. However, high psychiatric comorbidity is characteristic of IBS populations. Meta-analyses show 29-39% of IBS pa-

tients have anxiety or depression symptoms (Zamani et al., 2019), similar to our 41.4%, therefore our sample may represent the clinically complex patients seen in gastroenterology practice. We did not assess treatment history, but self-reported duration of symptoms varied greatly in the sample. Recent-onset versus chronic IBS likely differs in psychological adaptation, coping strategies, and symptom management. We did not exclude or assess pregnancy, which substantially affects both GI symptoms and emotional states in women. To our knowledge, no participants reported pregnancy, though this was not systematically screened. We did not screen for eating disorders using validated instruments (e.g., EAT-26, SCOFF questionnaire). Most participants had normal BMI (75.86%) and only few reported recent sudden weight loss (15.5%, $n=9$). However, this does not exclude eating disorder presence. Individuals with bulimia nervosa or binge eating disorder often maintain normal weight, and cognitive restraint can occur across the eating disorder spectrum. The significant relationship between cognitive restraint (TFEQ-CR) and IBS severity may be confounded by undiagnosed eating pathology. These unmeasured confounds limit our ability to isolate their specific effects of emotional states and eating behaviors on IBS severity.

Fourth, due to the lack of results from other studies on feeding styles (TFEQ-R18) in IBS, the results were compared to those of studies using other CR measurement instruments, such as EDE-R (Fairburn & Cooper, 1993), DEBQ (Strien et al., 1986), and different versions of the TFEQ-R18: TFEQ (Stunkard & Messick, 1985) and TFEQ-R21 (de Medeiros et al., 2017). Given the complexity of the CR construct described above, assessing the differences between the scale scores for IBS without ED, IBS with restricted ED, and IBS with overeating ED would be advisable.

Fifth, causal inferences are not possible with the cross-sectional design. We cannot determine whether emotional states and eating behaviors cause IBS symptom severity, result from living with chronic IBS, or reflect bidirectional relationships. Longitudinal designs are needed to establish temporal precedence and test causal hypotheses. Our sample (young, female, university-educated) limits generalizability to older adults, men, lower education groups, and culturally diverse populations. Results should be replicated in more representative IBS samples. The exploratory stepwise regression analyses are susceptible to overfitting and may not replicate in new samples. The selected predictors (e.g., TFEQ-CR in Table 9) should be tested in pre-registered, confirmatory studies before drawing strong conclusions.

Finally, the results may not be generalisable to other samples or all people with IBS, as the survey involved people who were interested in participating (not a random selection). Young age in our sample limits generalizability, but it may also represent a clinically important subgroup - young adults face unique challenges: academic stress, dietary transitions, and developing coping strategies. Our sample may reflect emerging IBS in young women, a group understudied relative to older adults.

Strengths of the Study

This is the first study to collectively assess the cause-and-effect relationship between GSA, emotional state, difficulties in emotion regulation, eating styles, and IBS symptom severity. The study was pre-registered before data collection, and modifications were described and justified. Eligibility for the study was based on the current IBS diagnostic criteria (Rome IV). This is the first study to assess eating styles in IBS patients based on the TFEQ-R18 (Brytek-Matera et al., 2017; De Lauzon et al., 2004). Previously, such an assessment was performed using the DEBQ in a population of Chinese students (Jia et al., 2022). In addition, our article provides the names of the other instruments used to measure eating behaviour and the types of groups to which the results have been related.

CONCLUSION

This study confirmed that gastrointestinal anxiety and negative emotional states (stress, depression, anxiety) increase the severity of IBS symptoms in young women. Previous research (Xie et al., 2024) has shown the importance of negative affective states in reducing the quality of life in patients with IBS. Our study adds to this by showing that emotional state (stress, anxiety, and depression) is associated with IBS symptom severity. Further research is needed to establish a causal relationship and test whether targeted support to improve specific aspects of the emotional state in women with IBS can reduce the severity of IBS symptoms.

We also found that restrictive eating style (together with increased GSA and negative affect) predicted the severity of IBS symptoms. Given the co-occurrence of IBS with ED, it is essential to assess the extent to which a focus on appearance/body weight (which is crucial in ED) is relevant for people with IBS and to what extent GSA drives restrictive behaviours and attempts to limit unpleasant GI and GSA experiences. Further research should also focus on assessing eating styles in a group of women with IBS and determining the role of cognitive restraint-based eating styles in this group.

Data sharing: Data will be shared upon reasonable request.

CONFLICT OF INTEREST

No relevant financial or non-financial competing interests exist for this study.

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Table 1. Pearson's and Spearman's Correlations with confidence intervals

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. IBS-SSS_TOT	301.74	105.67															
2. VSI_TOT	50.12	13.77	.63***														
			[.45, .76]														
3. DASS21_TOT	57.97	29.52	.51***	.43***													
			[.29, .68]	[.20, .62]													
4. DASS21_Stress	22.86	11.01	.45***	.05	.46***												
			[.22, .64]	[-.22, .30]	[.21, .63]												
5. DASS21_Anxiety	18.59	10.62	.41**	.37**	.88***	.72***											
			[.17, .61]	[.12, .57]	[.80, .93]	[.57, .83]											
6. DASS21_Depression	16.52	11.32	.51***	.38**	.89***	.75***	.64***										
			[.29, .68]	[.14, .58]	[.82, .94]	[.60, .84]	[.46, .77]										
7. TFEQR18_CR	8.26	4.34	.50***	.37**	.33*	.32*	.35**	.21									
			[.27, .67]	[.12, .57]	[.07, .54]	[.07, .54]	[.10, .56]	[.10, .44]									
8. TFEQR18_UE	10.64	5.30	.14	.01	.23	.10	.27*	.26	.20								
			[-.12, .39]	[-.25, .27]	[-.03, .46]	[-.16, .35]	[.01, .49]	[-.00, .48]	[-.07, .43]								
9. TFEQR18_EE	4.10	2.62	.05	.03	.21	.15	.19	.23	.20	.67***							
			[-.22, .30]	[-.23, .29]	[-.05, .45]	[-.12, .39]	[-.07, .43]	[-.03, .46]	[-.06, .44]	[.50, .79]							
10. DERS_TOT	105.98	24.56	.45***	.40**	.66***	.63***	.44***	.73*** ^a	.31*	.31*	.22						
			[.21, .63]	[.15, .59]	[.49, .79]	[.45, .76]	[.20, .63]	[.59, .83]	[.05, .53]	[.06, .52]	[-.04, .46]						
11. DERS_NONAC	17.91	6.17	.41**	.38**	.54***	.60***	.32*	.54***	.28*	.21	.16	.78***					
			[.17, .61]	[.13, .58]	[.33, .70]	[.40, .74]	[.06, .53]	[.33, .70]	[.03, .51]	[-.05, .45]	[-.10, .40]	[.65, .86]					
12. DERS_GOALS	17.48	4.27	.28*	.32*	.32*	.28*	.22	.36**	.19	.03	.07	.58***	.27*				
			[.02, .50]	[.06, .53]	[.07, .53]	[.03, .50]	[-.05, .45]	[.11, .56]	[-.07, .43]	[-.23, .29]	[-.19, .32]	[.37, .73]	[.02, .50]				

Appendix A.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13. DERS_IMPU	16.59	5.40	.41**	.41**	.62***	.63***	.43***	.61***	.38**	.22	.26*	.87***	.61***	.63***			
			[.17, .61]	[.17, .60]	[.43, .76]	[.45, .77]	[.19, .62]	[.41, .75]	[.14, .58]	[-.04, .46]	[.01, .49]	[.78, .92]	[.42, .75]	[.45, .77]			
14. DERS_AWAR	15.22	4.96	.10	-.03	.13	.08	.05	.25 ^a	-.04	.33*	-.01	.42**	.29*	-.20	.07		
			[-.16, .35]	[-.29, .23]	[-.13, .38]	[-.18, .33]	[-.21, .31]	[-.01, .48]	[-.30, .22]	[.08, .54]	[-.27, .25]	[.18, .61]	[.04, .51]	[-.44, .06]	[-.19, .33]		
15. DERS_STRAT	24.26	7.30	.43***	.42***	.67***	.61***	.46***	.73***	.26	.17	.22	.89***	.62***	.66***	.79***	.16	
			[.19, .62]	[.19, .62]	[.50, .79]	[.42, .75]	[.23, .64]	[.58, .83]	[-.05, .45]	[-.10, .41]	[-.04, .45]	[.82, .93]	[.43, .76]	[.48, .78]	[.66, .87]	[-.10, .40]	
16. DERS_CLAR	14.52	5.19	.26*	.18	.50***	.45***	.38**	.52***	.30*	.39**	.23	.78***	.49***	.19	.64***	.54***	.55***
			[.00, .49]	[-.09, .42]	[.28, .67]	[.22, .63]	[.13, .58]	[.30, .68]	[.05, .52]	[.15, .59]	[-.03, .46]	[.65, .86]	[.26, .66]	[-.07, .43]	[.45, .77]	[.32, .70]	[.35, .71]

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, a - Spearman's Correlations