Co-occurrence of fecal incontinence with constipation or irritable bowel syndrome indicates the need for personalized treatment

Sun, Ge; Trzpis, Monika; Ding, Haibo; Gao, Xianhua; Broens, Paul M.A.; Zhang, Wei

Published in:
Neurogastroenterology and motility

DOI:
10.1111/nmo.14633

Publication date:
2023

Received: 15 September 2022 | Revised: 23 May 2023 | Accepted: 31 May 2023

DOI: 10.1111/nmo.14633

ORIGINAL ARTICLE

Neurogastroenterology & Motility NGM WILEY

Co-occurrence of fecal incontinence with constipation or irritable bowel syndrome indicates the need for personalized treatment

Ge Sun[1,2] | Monika Trzpis[1] | Haibo Ding[2] | Xianhua Gao[2] | Paul M. A. Broens[1,3] | Wei Zhang[2]

[1]Department of Surgery, Anorectal Physiology Laboratory, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

[2]Department of Colorectal Surgery, Changhai Hospital, Naval Medical University, Shanghai, China

[3]Department of Surgery, Division of Pediatric Surgery, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

Correspondence
Wei Zhang, Department of Colorectal Surgery, Changhai Hospital, 168 Changhai Rd, Shanghai 200433, China.
Email: weizhang2000cn@163.com

Funding information
234 Subject Climbing Plan of Changhai Hospital; China Scholarship Council; National Natural Science Foundation of China; Natural Science Foundation of Shanghai; Shanghai Pujiang Program

Abstract

Background: This study aimed to compare the prevalence and symptoms of fecal incontinence (FI) in relation to irritable bowel syndrome (IBS-associated FI), constipation (constipation-associated FI), and isolation (isolated FI).

Methods: Data were analyzed from 3145 respondents without organic comorbidities known to influence defecation function from the general Chinese population who filled in the online Groningen Defecation and Fecal Continence questionnaire. FI, IBS, and constipation were evaluated with the Rome IV criteria.

Key Results: The prevalence of FI was 10.5% ($n = 329$) in the non-comorbidity group. After multivariable logistic regression analysis, IBS (odds ratio [OR]: 12.55, 95% confidence interval [CI]: 9.06–17.36) and constipation (OR: 4.38, 95% CI: 3.27–5.85) were the most significant factors contributing to FI. Based on this finding, 106/329 (32.2%) had IBS-associated FI, 119/329 (36.2%) had constipation-associated FI, and 104/329 (31.6%) had isolated FI. Among the 329 FI respondents, there was a high prevalence of IBS and constipation-related symptoms, including abdominal pain (81.5%) and abdominal bloating (77.8%) for IBS and straining during defecation (75.4%), incomplete defecation (72.3%), defecation blockage (63.2%), anal pain during defecation (59.3%), and hard stools (24%) for constipation. The patients with IBS-associated FI asked for specialists' help less frequently than those with isolated FI. Interestingly, among the patients with constipation-associated FI, 56.3% used anti-diarrhea medicine.

Conclusions and Inferences: The prevalence of IBS-associated FI, constipation-associated FI, and isolated FI is comparably high. It is important to diagnose and target the cause of FI to provide personalized and cause-targeting care instead of treating only the FI symptoms.

KEYWORDS
constipation, co-occurrence, diagnosis, fecal incontinence, irritable bowel syndrome, personalized treatment

Wei Zhang and Paul M.A. Broens shared the last authorship.

1 | INTRODUCTION

Fecal incontinence (FI) is attributed to different factors, including organic and functional aspects. Multiple studies have comprehensively described the prevalence of FI associated with organic problems, such as rectocele,[1] rectal prolapse, high-grade intussusception,[2] or megarectum.[3,4] Identification of the afore-described organic problems is rather straightforward with current diagnostic possibilities. In contrast, the diagnosis of functional FI, and especially its underlying factors, is still challenging, which hampers treatment efficacy.[5] Different gastrointestinal dysfunctions have been reported to contribute to FI development. For instance, FI can be secondary to irritable bowel syndrome (IBS), as patients with IBS who have chronic diarrhea are more susceptible to FI,[6,7] while diarrhea is a known risk factor for FI.[8] Also, constipation is often reported to be a risk factor for FI,[9–19] as fecal impaction during constipation may lead to overflow FI.[9–11] In addition, chronic constipation can lead to pudendal neuropathy and, consequently, urge FI.[12,13,20]

Surprisingly, although IBS and constipation are known causes of FI, patients reporting an involuntary loss of feces are not routinely examined for possible constipation or IBS by many clinicians, as indicated in the studies by Vollebregt et al.[18] and Burgell et al.[21] As a result, these two possible causes of FI remain largely unrecognized and untreated. The current treatment of functional FI mainly focuses on symptoms instead of the underlying causes, which may contribute to suboptimal outcomes or even worsen the outcomes. To our knowledge, the symptoms typical for constipation- and IBS-associated FI, as well as the isolated form of FI, have not been comprehensively compared, which may hamper the distinction of these forms of FI. Of note, FI is frequently investigated in a patient population. Importantly, the prevalence of FI, including its isolated forms and coexistence with constipation, has been shown to be relatively high in the non-patients population.[15] This has, however, not been confirmed for the Chinese population yet.

This study aimed to determine how often functional FI coexists with constipation or IBS in the non-patient population.[22,23] Secondarily, we aimed to compare symptoms demonstrating bowel dysfunction between respondents with constipation- and IBS-associated FI and the isolated form of FI. In addition, we also aimed to compare the severity of FI and how participants deal with the different forms of FI.

Key points

- The prevalence of IBS-associated FI, constipation-associated FI, and isolated FI is comparably high.
- Among the patients with constipation-associated FI, 56.3% used anti-diarrhea medicine.
- It is important to diagnose and target the cause of FI to provide personalized and cause-targeting care instead of treating only the FI symptoms.

2 | METHODS

2.1 | Study design

This is a cross-sectional, prospective study for which the Chinese version of the Defecation and Fecal Continence (DeFeC) questionnaire was used (ref: Ge Sun et al., "Validation of the Chinese DeFeC questionnaire: A comprehensive screening tool for symptoms and causes of constipation and incontinence", accepted for publication by Annals of Palliative Medicine). The original Dutch version of the Groningen DeFeC questionnaire was validated by Meinds et al.[24] Shortly, Meinds et al. used outcomes of the anorectal manometry as the gold standard to calculate the sensitivity and specificity of the outcomes of DeFeC for FI and constipation. Moreover, the DeFeC questionnaire contains questions that correspond to those defined by the validated Rome IV criteria for functional constipation, FI, and IBS.[25] The validated Dutch version of the DeFeC questionnaire was translated into Chinese and then validated for the Chinese population according to the internationally acknowledged COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN).[26]

2.2 | Data collection

The survey was, at our request, conducted by the Dynata company, an international data platform (https://www.dynata.com).[27] These Chinese citizens, that is, respondents who had registered themselves in the database of Dynata, were provided with the DeFeC questionnaire between May 2021 and November 2021. The respondents logged into their accounts and filled in the questionnaire online, using their smartphone, tablet, or computer. A sample of completed DeFeC questionnaires was selected according to the population pyramid of age, demographic region, and sex, as reported by the National Statistics Bureau of China.[28] Respondents who decided to fill in the DeFeC questionnaire were offered different incentives. The reason for providing different incentives is to attract a more diverse population, increasing the representativeness of the sample and actually avoiding bias. Respondents did not see incentives when clicking on an invitation to avoid selection bias. This study was approved by the ethics committee of University Medical Center Groningen (M22.298229).

The DeFeC questionnaire included questions about symptoms and defecation habits related to FI.[29] According to Rome IV criteria, FI was diagnosed when the following two symptoms were present[1]: recurrent uncontrolled passage of fecal material at least twice a month; and[2] onset of symptoms for at least 6 months.[22] The severity of FI was evaluated according to the Wexner incontinence score (range 0–20, where 0 indicated perfect continence and 20 indicated the most severe form of FI).[30] The Wexner incontinence score evaluated the incontinence severity based on five questions regarding

solid stool incontinence, liquid stool incontinence, gas incontinence, wearing pads, and lifestyle alteration related to FI.

Respondents experiencing FI only, that is, those who did not meet the criteria for either constipation or IBS, were defined as having "isolated FI." Respondents experiencing FI co-occurring with IBS or constipation were defined as having IBS- or constipation-associated FI, respectively.

IBS was evaluated based on Rome IV criteria[1]: recurrent abdominal pain, at least 1 day per week in the last 3 months, associated with two or more of the following criteria: (a) related to defecation, (b) associated with a change in stool frequency, and/or (c) associated with a change in the form of stool and[2] the criteria were fulfilled for the last 3 months, with symptoms onset at least 6 months before diagnosis.[23]

Constipation was also evaluated based on the Rome IV criteria for functional constipation.[23] The respondents were determined to be constipated when satisfying the following three criteria[1]: reporting at least two of the following six symptoms in the last 3 months: straining, hard stools or lumpy stools, the sensation of incomplete evacuation, the sensation of anorectal obstruction, manual defecation, and maximally two defecations per week[2]; loose stools were rarely present without laxatives; and[3] do not follow the irritable bowel syndrome criteria.[29]

The severity of obstructive defecation symptoms was evaluated using the Renzi score (range, 0–20; 0 indicates no symptoms, and 20 means very severe symptoms of obstructive defecation).[31]

Consistency of the stool was evaluated according to the Bristol stool chart, where 1–2 indicated hard or lumpy stool and 6–7 indicated very soft/liquid stool.[32]

The self-perception of health concerning the ability to hold and pass stools was evaluated by asking, "In general, how would you describe your health in relation to the ability to hold and pass stools?" The answer had three choices "good," "reasonable," and "poor".[33] We deliberately positioned this question at the beginning of the DeFeC questionnaire before we continued with specific and detailed questions about defecation and continence. We did so because after reading all the questions about defecation and continence, respondents who originally were unaware of their suboptimal condition could become aware of having a dysfunction after answering all the questions. Regarding the validation of this question (and other questions belonging to the DeFeC questionnaire) and the scale used for the evaluation of the outcome, the process has been comprehensively described first by Meinds et al.,[24] and second by us when translating the questionnaire into Chinese language (Ge Sun et al., "Validation of the Chinese DeFeC questionnaire: A comprehensive screening tool for symptoms and causes of constipation and incontinence," accepted for publication by Annals of Palliative Medicine).

2.3 | Data analysis

To constitute a non-comorbidity group, we have excluded respondents who reported having organic diseases and had operations known to influence bowel outcomes. Information regarding organic causes and operations in the anorectal region was collected using the DeFeC questionnaire.[24] Specifically, we excluded respondents who had reported at least one of the following[1]: anorectal, colorectal, or pelvic floor surgery, such as resection of the intestine ($n=39$), operation for anal fistula ($n=31$), hemorrhoids ($n=84$), prostate ($n=17$), or operation on the anal sphincter ($n=47$)[2]; somatic diseases, such as inflammatory bowel disease ($n=50$), diabetes ($n=78$), neurological disorders ($n=14$), spina bifida ($n=14$), and cerebral hemorrhage and infarction ($n=31$)[3]; rectal prolapse ($n=66$); or[4] congenital anorectal malformation ($n=30$), Hirschsprung disease ($n=34$), and sacrococcygeal syndrome ($n=24$). We further divided the non-comorbidity group into the following age groups: 18–34, 35–44, 45–54, 55–64, and 65–85 years. Body mass index (BMI) was calculated based on height (m) and weight (kg) and classified as underweight (<18.5 kg/m^2), normal (18.5–23.9 kg/m^2), overweight (24.0–27.9 kg/m^2), and obese (≥28 kg/m^2) according to the Chinese population norms.[34] For analysis, the respondents in the four provincial-level cities in China (Beijing, Shanghai, Chongqing, and Tianjin) were considered metropolitan residents.

2.4 | Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics, Version 23.0. Association analysis between categorical variables was performed using the chi-square test. Correlation analysis between two continuous variables was conducted by the Spearman test, depending on non-normal distribution, and this was tested using the Q-Q plot. Univariable and multivariable backward stepwise logistic regression analyses were used to find the odds ratio (OR) for the factors associated with FI. We first conducted univariable analyses before multivariable analyses. As we found that most studies of FI often overlook IBS and constipation, we first performed a multivariable analysis wherein we did not add IBS and constipation as risk factors. Thereafter, we added IBS and constipation into the analysis to look for the difference in risk factors. A two-sided p-value of less than 0.05 was considered statistically significant. The receiver operating characteristic (ROC) curve was utilized to evaluate the model's predictive value by calculating the area under the curve (AUC) value.

3 | RESULTS

3.1 | Baseline characteristics

Originally, 6150 respondents logged into their online accounts to fill in the DeFeC questionnaire. Meanwhile, 1732 people dropped out (28.2% dropout rate), and 4418 finished the questionnaire. Out of the 4418 finished questionnaires, we excluded 968 respondents due to illogical answers. Finally, 3450 respondents were included for analysis. Of the 3450 respondents included in the study, 3145 had no organic comorbidities that might contribute to defecation

disorders, and they constituted the non-comorbidity group used for analysis. The average age of the non-comorbidity group was 40.5 ± 14.7 years, and 1607 (51.1%) men were in this group (Table 1).

3.2 | Prevalence and severity of fecal incontinence in the non-comorbidity group

The prevalence of FI, IBS, and constipation in the non-comorbidity group was 10.5% (329/3145), 8.2% (256/3145), and 18.7% (588/3145), respectively (Figure 1). Furthermore, out of the FI respondents, 106/329 (32.2%) had IBS-associated FI, 119/329 (36.2%) had constipation-associated FI, and 104/329 (31.6%) had isolated FI.

The median (interquartile range [IQR]) Wexner incontinence score was 0 (0–3) in the non-comorbidity respondents ($n = 3145$) and 7[5–10] in the FI subgroup of the non-comorbidity respondents (329/3145).

Specifically, respondents with IBS-associated FI had higher Wexner incontinence scores than those with constipation-associated FI and those with isolated FI (9.3 ± 3.7 vs. 7.7 ± 2.8 vs. 5.3 ± 2.7, respectively). Furthermore, in respondents with constipation-associated FI, the median Renzi score was 7.0 (6.0–8.5), and it was positively correlated with the Wexner incontinence score ($r = 0.373$, $p < 0.001$).

3.3 | IBS and constipation are risk factors for fecal incontinence

Using univariable and multivariable logistic regression analyses 1 (Tables 2 and 3), we found that factors such as age above 55 years, underweight, overweight, or obesity, metropolitan residents, and eating spicy food ($p < 0.05$) significantly increased the OR for having FI.

Furthermore, using multivariable logistic regression analysis 2 (Table 3), we found that respondents with IBS and constipation had the highest OR for FI (OR: 12.55, 95% confidence interval [CI]: 9.06–17.36 and OR: 4.38, 95% CI: 3.27–5.85, respectively). Respondents who were underweight (OR: 1.99, 95% CI: 1.38–2.87), overweight (OR: 1.45, 95% CI: 1.07–1.98), obese (OR: 2.03, 95% CI: 1.37–3), and ate spicy food ($p < 0.01$) were still significantly more prone to be fecal incontinent in multivariable analysis 2 similar to multivariable analysis 1 (Table 3). However, FI was not significantly correlated with age and metropolitan residents in multivariable analysis 2 in contrast to multivariable analysis 1.

All the variables, including IBS and constipation in multivariable analysis 2 were utilized to calculate the ROC curve. The AUC value of multivariable analysis 2 was 0.971, which indicated a good prediction value (Figure 2).

Different risk factors for the three types of FI have also been determined using multivariable analysis (Table S1).

TABLE 1 Respondent characteristics in the non-comorbidity group.

	Number	Percent
Overall	3145	100.0
Gender		
Male	1607	51.1
Female	1538	48.9
Age (years)		
18–34	1207	38.4
35–44	687	21.8
45–54	564	17.9
55–64	458	14.6
65–85	229	7.3
Highest education level		
Primary	60	1.9
Secondary	935	29.7
Tertiary	2150	68.4
Residence		
Rural	853	27.1
City	2292	72.9

3.4 | Symptoms typical for IBS- and constipation-associated fecal incontinence and its isolated form

Of the 329 respondents with FI, liquid incontinence was experienced by 57.8%, soiling incontinence by 52.6%, urge incontinence by 49.5%, and solid incontinence by 43.8%. In addition, 62.6% of the FI respondents reported accidental wind passage, 38.6% wore incontinence pads, and 36.8% admitted that they had adjusted daily activities because of FI. The prevalence of these FI symptoms was higher in IBS-associated FI than in constipation-associated FI or isolated FI (Figure 3, Table S2).

Regarding symptoms typical for IBS, 77.8% of the FI respondents experienced abdominal bloating, and 81.5% had abdominal pain. In patients with FI with abdominal pain, abdominal pain was reported to be associated with stool consistency (85.1%), defecation frequency (85.4%), and after defecation (91.8%).

We also found that the prevalence of constipation symptoms was high in all FI respondents, where 75.4% experienced straining during defecation, 63.2% felt blockage during defecation, 72.3% had incomplete defecation, and 59.3% had anal pain during defecation. Only 24% of the FI respondents reported having lumpy or hard stools, and 21.3% reported less than three episodes of defecation per week. Out of the constipated respondents, people with co-occurrence of FI reported a longer history of defecation difficulty than those without FI co-occurrence ($p = 0.013$).

Finally, in the 329 FI respondents, the IBS and constipation symptoms were more prevalent than FI-related symptoms, such as liquid incontinence, urge incontinence, and solid incontinence (Figure 3).

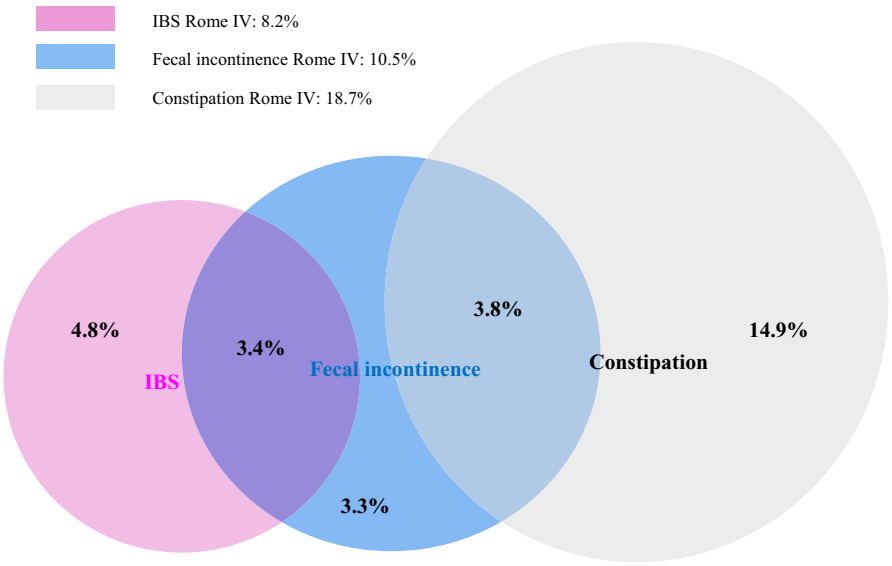

FIGURE 1 The prevalence of fecal incontinence, constipation, irritable bowel syndrome, and their overlap according to Rome IV criteria in the non-comorbidity group.

3.5 | Self-perception regarding bowel function and treatment for its dysfunction

Among the 329 FI respondents in the non-comorbidity group, 33.1% evaluated their bowel habits as good. Respondents with IBS-associated FI evaluated the ability to hold and pass stools as poor four times more often than respondents experiencing isolated FI (Figure 4A).

FI respondents with good self-evaluation of health regarding the ability to hold and pass stools had significantly lower Wexner incontinence scores than those with poor self-evaluation of health concerning defecation (median [IQR]: 6 [4–8] vs. 7 [6–10], $p < 0.001$). Furthermore, 24.7% of fecal incontinent respondents did not seek any help for FI. FI respondents who did seek help had a significantly higher Wexner incontinence score than those who did not (median [IQR]: 8 [6–10] vs. 5.5 [4–7], $p < 0.001$).

The patients with IBS-associated FI asked for specialists' help less frequently than those with isolated FI (Figure 4B). We also found that 50.2% of FI respondents used anti-diarrhea medicine to solidify stools, 9.1% used an adapted diet to control their FI, and 7.3% used warm water to irrigate the rectum. Surprisingly, out of the patients with constipation-associated FI, 56.3% used anti-diarrhea medicine. Moreover, IBS-associated FI respondents used more anti-diarrhea medication and rectal irrigation than constipation-associated FI respondents and respondents with isolated FI (Figure 4C).

4 | DISCUSSION

This study shows three dominating forms of FI in the non-comorbidity population: IBS-associated FI, constipation-associated FI, and isolated FI. The prevalence of these three forms of FI is comparable with each other and relatively high.

The overall prevalence of FI in this study is up to 10.5%, higher than that in a previous report on the Chinese population.[35] This difference might result from different methods of data collection. In contrast to another study,[18] we did not perform a face-to-face interview in the current study. Instead, we completed an online survey to increase the respondents' comfort and reduce intimidation when answering questions about defecation habits and problems.[19] Lowering the embarrassment level of the respondents might have resulted in more honest answers than in the previous survey, which could have contributed to the higher prevalence of FI observed in our study. Surprisingly, over one-third of FI respondents still perceive themselves as having good bowel function. This may indicate that people might ignore mild FI symptoms. However, the quality of life was negatively correlated with FI severity in patients with FI, according to the literature.[36–42] This is not contradictory to our current research because our research population consisted of non-comorbidity people, who are different and have less severe symptoms than the patients with FI mentioned in the above literature. Our assumption is supported by the fact that the severity of FI expressed by the Wexner score was relatively low (six) in FI respondents with good self-evaluation of health regarding the ability to hold and pass stools. The Wexner score of six is also lower than the cutoff value for the Wexner score for clinically relevant FI being nine, proposed by Rothbarth et al.[43]

Commonly, subtypes of FI are being studied in terms of their symptomatic presentation, for instance, according to stool consistency, such as liquid and solid. FI can also be categorized as urge incontinence[44] or post-defecatory incontinence.[45] With the findings of our study, we propose that to optimize the treatment of FI, distinguishing between the cause-based type of FI is clinically important, as only this enables us to provide patients with personalized treatment that targets the underlying cause of FI rather than just the FI symptoms. Consequently, we distinguish three types of FI: IBS-associated FI, constipation-associated FI, and isolated FI (FI presenting without either constipation or IBS).

Our study shows that IBS respondents are highly prone to experiencing FI. This finding corroborates recent studies of Bharucha et al. and Meness et al.,[8,14] who showed that IBS is a strong risk factor

TABLE 2 Prevalence of fecal incontinence (FI) in relation to demographic characteristics and risk factors influencing fecal incontinence.

	Chi-square test			Univariable analysis	
	Number	Percentage	*p* Value	Odds ratio (95% CI)	*p* Value
Overall	3145	10.5			
Constipation					
Yes	587	20.3	<0.001	2.84 (2.22–3.64)	<0.001
No	2558	8.2		Reference	
IBS					
Yes	258	41.1	<0.001	8.33 (6.28–11.06)	<0.001
No	2887	7.7		Reference	
Age (years)					
18–34	1207	12	<0.001	Reference	
35–44	687	14		1.19 (0.90–1.57)	0.22
45–54	564	8.5		0.68 (0.48–0.96)	0.03
55–64	458	5.9		0.46 (0.30–0.70)	<0.001
65–85	229	5.7		0.44 (0.25–0.79)	0.006
Gender					
Male	1607	9.5	0.078	Reference	
Female	1538	11.4		1.23 (0.98–1.54)	0.08
BMI (kg/m^2)					
<18.5	302	18.9	<0.001	2.726 (1.97–3.85)	<0.001
18.5–23.9	1864	7.8		Reference	
24–27.9	690	11.9		1.60 (1.2–2.13)	0.001
>=28	289	15.6		2.19 (1.52–3.13)	<0.001
Metropolitan residents					
Yes	691	12	0.139	1.23 (0.94–1.60)	0.13
No	2454	10		Reference	
Residence					
Urban	2292	10.9	0.226	1.18 (0.90–1.54)	0.23
Rural	853	9.4		Reference	
Area					
West	937	9.7	0.342	0.84 (0.65–1.11)	0.22
Middle	703	9.7		0.84 (0.63–1.13)	0.25
East	1505	11.3		Reference	
Highest education level					
Non-tertiary	995	9.3	0.165	Reference	
Tertiary	2150	11		1.20 (0.93–1.54)	0.17
Frequency of spicy food intake					
Every day	587	12.9	<0.001	3.33 (2.06–5.39)	<0.001
4–5 times a week	493	16.8		4.53 (2.81–7.32)	<0.001
1–3 times a week	908	12.7		3.26 (2.05–5.16)	<0.001
<1 time a week	621	5.2		1.22 (0.70–2.11)	0.484
Never	538	4.3		Reference	
Eating at least two pieces of fruits a day					
Yes	2038	10	0.262	0.87 (0.69–1.11)	0.262
No	1107	11.3		Reference	
Eating cereals (daily)					
Yes	1461	11.2	0.192	1.16 (0.93–1.46)	0.192
No	1684	9.8		Reference	

TABLE 2 (Continued)

	Chi-square test			Univariable analysis	
	Number	Percentage	*p* Value	Odds ratio (95% CI)	*p* Value
Eating at least three spoons of vegetables a day					
Yes	2291	9.5	0.003	0.69 (0.54–0.88)	0.003
No	854	13.1		Reference	
Drinking at least 1.5 liter water a day					
Yes	2067	10.9	0.282	1.14 (0.90–1.46)	0.282
No	1078	9.6		Reference	

TABLE 3 Analyses of association between risk factors and fecal incontinence.

	Multivariable analysis 1 (without constipation and IBS as risk factors)		Multivariable analysis 2[a] (with constipation and IBS as risk factors)	
	Odds ratio (95% CI)	*p* Value	Odds ratio (95% CI)	*p* Value
Constipation				
Yes			4.38 (3.27–5.85)	**<0.001**
No			Reference	
IBS				
Yes			12.55 (9.06–17.36)	**<0.001**
No			Reference	
Age (years)				
18–34	Reference		Reference	
35–44	1.26 (0.94–1.68)	0.12	1.19 (0.87–1.62)	0.27
45–54	0.87 (0.61–1.24)	0.44	0.99 (0.68–1.45)	0.96
55–64	0.60 (0.38–0.93)	**0.02**	0.84 (0.53–1.34)	0.47
65–85	0.49 (0.27–0.89)	**0.02**	0.61 (0.33–1.13)	0.12
Gender				
Female	1.12 (0.88–1.45)	0.36	0.93 (0.72–1.20)	0.58
Male	Reference		Reference	
BMI (kg/m^2)				
<18.5	2.18 (1.55–3.08)	**<0.001**	1.99 (1.38–2.87)	**<0.001**
18.5–23.9	Reference		Reference	
24–27.9	1.55 (1.15–2.08)	**0.004**	1.45 (1.07–1.98)	**0.018**
>=28	1.89 (1.31–2.74)	**<0.001**	2.03 (1.37–3.00)	**<0.001**
Metropolitan cities residence				
Yes	1.33 (1.01–1.74)	**0.04**	1.07 (0.80–1.43)	0.64
No	Reference		Reference	
Frequency of spicy food intake				
Every day	3.09 (1.89–5.04)	**<0.001**	2.20 (1.32–3.67)	**0.002**
4–5 times a week	3.96 (2.43–6.45)	**<0.001**	2.54 (1.52–4.23)	**<0.001**
1–3 times a week	2.89 (1.81–4.61)	**<0.001**	1.94 (1.19–3.16)	**0.008**
<1 time a week	1.26 (0.73–2.20)	0.40	1.24 (0.70–2.19)	0.47
Never	Reference		Reference	
Eat >=3 spoons of vegetables a day				
Yes	0.79 (0.61–1.01)	0.07	0.79 (0.61–1.02)	0.23
No	Reference		Reference	

The bolded *p*-value signifies statistical significance, with two-sided *p*-value being less than 0.05.

[a] Stepwise backward regression analysis.

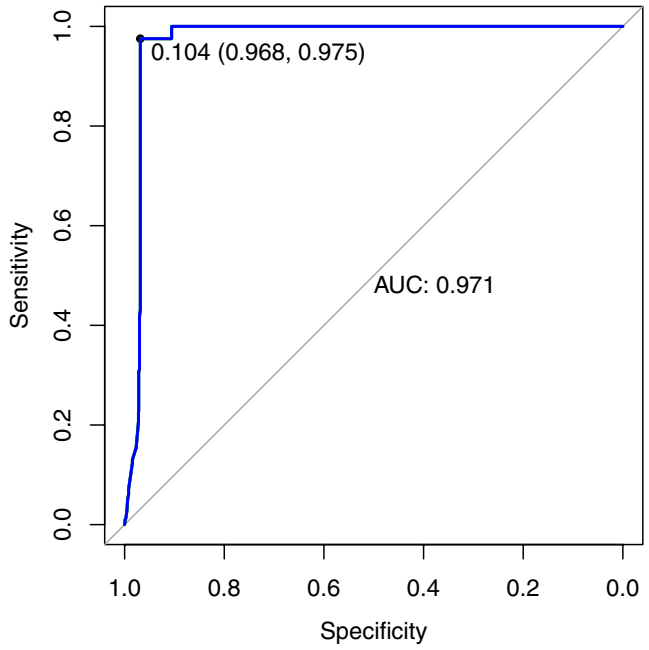

FIGURE 2 Receiver operating characteristic curve of multivariable logistic regression models for risk factors of fecal incontinence after adjusting for constipation and irritable bowel syndrome.

for FI. Moreover, we found that IBS-associated FI respondents had a higher Wexner incontinence score than FI respondents without IBS, consistent with the study, which found IBS patients had higher FI severity.[14] FI severity, defecation dysfunction symptoms, and self-perception of health concerning defecation were also worse in IBS-associated FI than in both constipation-associated FI and isolated FI. This observation is consistent with the findings of Atarodi et al.[7] on the British population.

For the mechanism of IBS-associated FI, abnormal stool consistency is often seen in IBS,[46] which may be a causative factor.[3,47–49] Chronic diarrhea due to IBS is well-known to correlate with liquid stool leakage.[47] At the same time, hard stools due to IBS can also cause overflow FI.[3,48,49] Based on the diagnosis of the different subtypes of IBS, the treatment should be personalized, especially regarding the use of anti-diarrhea medicine. Although we could not distinguish the constipation-predominant, diarrhea-predominant, and mixed-IBS forms of IBS in our study, it is clinically relevant to diagnose these forms in patients with FI-associated IBS.

Furthermore, we also showed that in the non-patient population, constipated respondents are more prone to FI than non-constipated people. This is consistent with the previous findings of co-occurrence of constipation and FI in Western populations.[14–17] Specifically, 36% of the FI respondents experienced constipation, and this is comparable to the report that 38% of patients with FI in America had co-occurrence of constipation[14] but slightly lower than the value of 44% in the Dutch population.[15] In our study, the constipation-associated FI respondents frequently reported symptoms such as straining, defecation blockage, and anal pain,[50] that is, obstructive defecation symptoms. We have also shown that the Renzi score, used in evaluating obstructive defecation severity, is positively correlated with FI severity in the respondents with constipation-associated FI. This is consistent with the study by Rajindrajith et al.,[51] which also showed that most FI respondents had obstructive defecation symptoms. Furthermore, Cauley et al. also showed that patients with constipation-associated FI had more difficulty with the balloon expulsion test and more paradoxical electromyography (EMG) than those with isolated FI,[17] indicating a possible higher incidence of obstructive defecation in constipation-associated FI. The possible association between obstructive defecation and FI in our study can be explained by the fact that these patients experience constipation, leading to fecal overflow incontinence. Untreated obstructive defecation results in severe, chronic constipation. It also contributes to the development of megarectum and other anatomical or physiological impairments, such as rectocele[1] or even pudendal neuropathy.[12,13,20,52] These impairments are present and diagnosed in subjects who have already been referred to a medical specialist, as these cannot be diagnosed by the general practitioner. This, in turn, means that such patients suffer from severe forms of constipation-associated FI. Otherwise, they would not be subjected to MRI or other procedures enabling the diagnosis of megarectum, rectocele, or pelvic organ prolapse.

This study also showed that respondents with constipation-associated FI had a more extended history of constipation than constipated respondents without FI. This finding indicates that even mild constipation should not be considered a trivial problem. Instead, constipation should be treated in time as it can progress to more severe forms with irreversible consequences, such as pudendal nerve neuropathy and urge FI.

It is also important to note that more than 50% of the respondents with constipation-associated FI used anti-diarrhea medicine in our study. It appears that more of the subjects were given inappropriate treatment. The anti-diarrhea medication solidified the stools in these subjects with constipation-associated FI, possibly making defecation even more difficult. This did not treat constipation and could have even increased its severity. In these respondents, FI was caused by constipation. In other words, more than 50% of patients with constipated FI seem to be brought into the vicious circle because of inappropriate treatment, which may lead to even more severe FI. For constipation-associated FI, cause-oriented treatment would be more efficient. For example, an enema or rectal irrigation program may indirectly relieve FI by treating the cause, that is, hard stools.[53] Laxatives could also be used to treat FI by softening the hard stools, which might cause constipation. However, this effect still needs to be validated with clinical trials.[54]

This study provides several clinical implications. First, in the non-patient population, we observed that FI could occur with IBS and constipation, similar to FI in the patient population with pelvic organ prolapse,[55,56] rectocele,[1] rectal prolapse, high-grade intussusception,[2] or megarectum.[3,4] Second, we confirmed that FI coexists with urine incontinence and is significantly associated with this symptom (data not shown), which corroborates existing

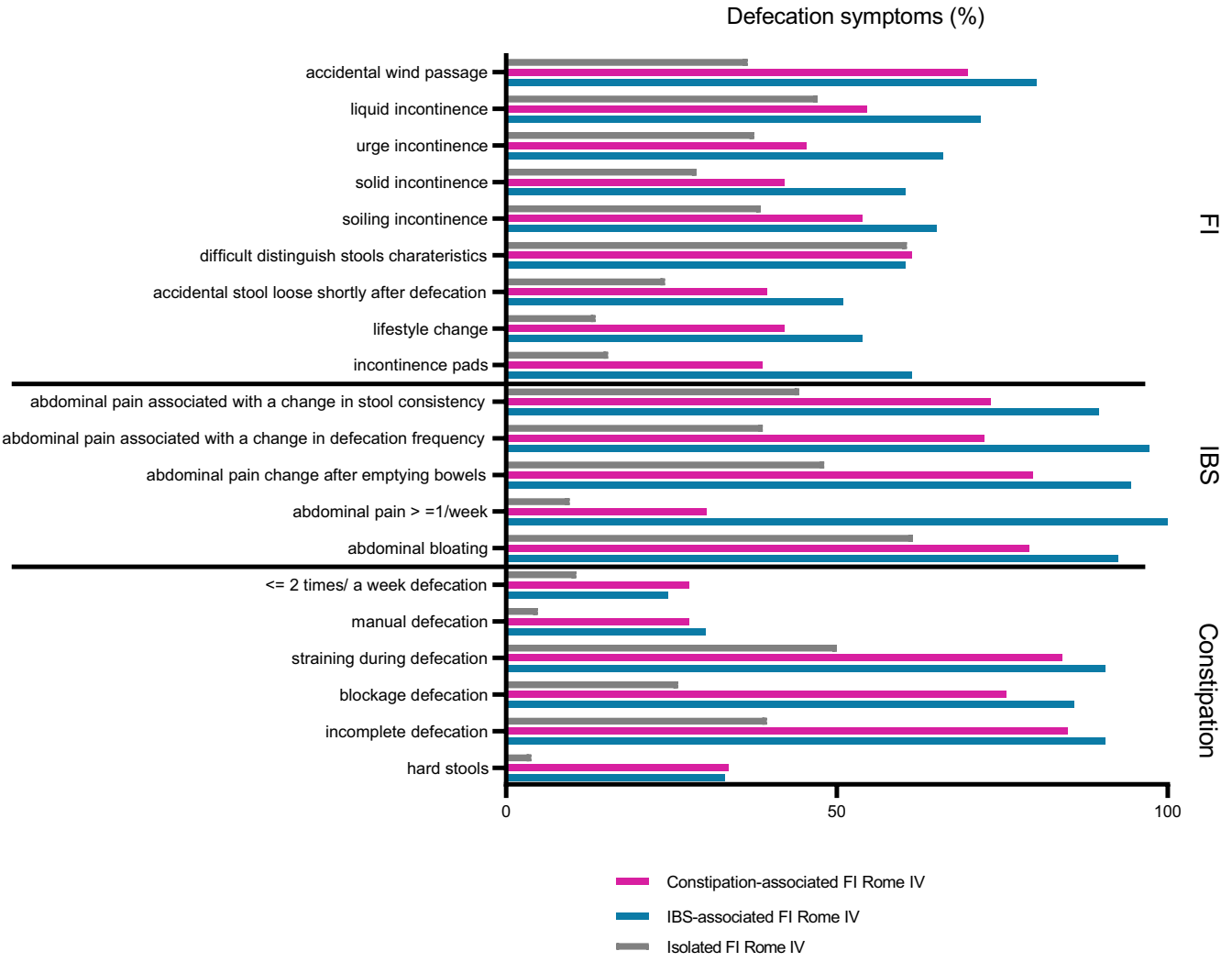

FIGURE 3 The defecation symptoms in fecal incontinent respondents included normal fecal incontinence symptoms as well as constipation and irritable bowel syndrome symptoms.

literature.[55–57] Third, our findings indicate that before initiating treatment, doctors should comprehensively evaluate the defecation disorder and perform an anamnesis to know whether FI coexists with either IBS or constipation or is isolated in the patient with FI. Finally, we revealed that constipation-associated FI is also present in subjects with milder constipation-associated FI, with a Renzi score of seven and a Wexner score of 7.7, which are not recognized as clinically relevant.[31,43] At the same time, diagnoses with the Rome IV criteria indicated that the subjects have coexisting FI and constipation. Therefore, we emphasize the need for awareness, as approximately 3.8% (119/3145) of subjects without organic problems or without already recognized anorectal alterations experienced constipation-associated FI. Importantly, these subjects should be provided with treatment on time to prevent the development of more severe forms of constipation-associated FI, which, in some cases, can even be irreversible. Furthermore, consultation might take much time to evaluate the defecation symptoms comprehensively. Since time is limited for each patient in the consulting room, patients are asked to fill in the digital DeFeC questionnaire before the consultation for FI or chronic constipation at the anorectal physiology laboratory at the University Medical Center Groningen. Using the DeFeC questionnaire could help diagnose FI and comprehensively evaluate its symptoms and possible causes. Furthermore, in the case of an isolated FI, the questionnaire results could indicate a direction for further diagnostic steps aiming to point out the cause of FI.

The current study has some limitations. Some of the patients with FI had taken treatment for FI; as a result, the reported FI symptoms may not be accurate for the actual clinical situation. Thus, our study's FI prevalence and severity may have been underestimated. On the other hand, people with defecation problems were more interested in answering the questionnaire, which may have led to overestimating the FI prevalence. The data were collected online, and one might doubt the data's accuracy, especially if compared to the face-to-face investigation performed by a medical specialist. However, it is known that FI is a taboo subject, and a comprehensive face-to-face interview does not guarantee that a patient will honestly share all the embarrassing details with the

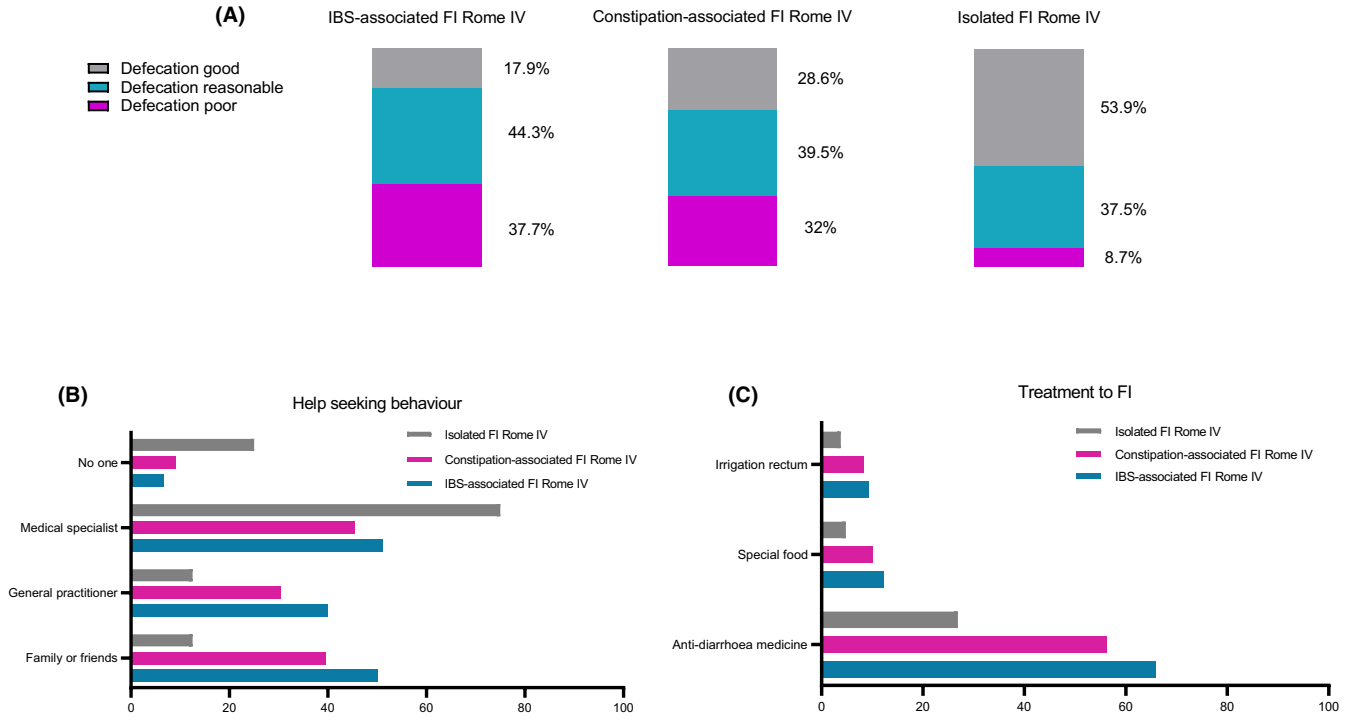

FIGURE 4 (A) Self-evaluation of health concerning defecation. (B) Help-seeking behavior. (C) Treatment for fecal incontinence.

doctor. We know that physical examination, particularly in combination with anorectal physiology tests, would provide objective information regarding anorectal physiology. However, it would be impossible to objectively test all the respondents from our study due to the large sample size we included. Such objective tests are, however, not required to meet the Rome IV criteria, as these are purely based on symptoms. Therefore, the digital method of data collection contributed to the comfort of the respondents and a higher level of honesty in their answers than in the case of a face-to-face interview.

5 | CONCLUSION

The prevalence of IBS-associated FI, constipation-associated FI, and isolated FI is comparably high. More than half of constipation-associated FI respondents use anti-diarrheal medicines, indicating the importance of diagnosing and targeting the cause of FI to provide personalized care instead of addressing only the FI symptoms. This knowledge provides the fundament for future research on treatment efficacy when the cause of FI, instead of only the symptom, is treated.

AUTHOR CONTRIBUTIONS

Ge Sun, Monika Trzpis, Paul Broens, and Wei Zang contributed to the study's conception and design. Material preparation and data collection were performed by Ge Sun and Monika Trzpis. Data analysis was performed by Ge Sun. The first draft of the manuscript was written by Ge Sun. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

ACKNOWLEDGMENTS

We acknowledge Wenbo Zang, MSc, and Judith Vonk, Ph.D. from the Department of Epidemiology, as well as Dion Groothof, MSc, and Mostafa al Moumni, M.D., Ph.D. from the Department of Surgery, University Medical Center Groningen for their support in the statistical analyses of this study. We would like to thank Editage (www.editage.cn) for English language editing.

FUNDING INFORMATION

This study was supported by the National Natural Science Foundation of China (#82072750, #81572332), Shanghai Pujiang Program (#2019PJD052), Natural Science Fund of Shanghai (20ZR1457200), 234 Subject Climbing Plan of Changhai Hospital (#2020YXK022). The contribution of Ge Sun to this study was supported by a joint fellowship from the University Medical Center Groningen and the China Scholarship Council (grant number CSC 2018 0831 0226 to G. S.).

CONFLICT OF INTEREST STATEMENT

The authors have no competing interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Ayabaca SM, Zbar AP, Pescatori M. Anal continence after rectocele repair. *Dis Colon Rectum*. 2002;45(1):63-69.
2. Collinson R, Cunningham C, D'Costa H, Lindsey I. Rectal intussusception and unexplained faecal incontinence: findings of a proctographic study. *Colorectal Dis*. 2009;11(1):77-83.

3. Rao SS. Pathophysiology of adult fecal incontinence. *Gastroenterology*. 2004;126:S14-S22.
4. Gattuso JM, Kamm MA. Clinical features of idiopathic megarectum and idiopathic megacolon. *Gut*. 1997;41(1):93-99.
5. Alavi K, Chan S, Wise P, Kaiser AM, Sudan R, Bordeianou L. Fecal incontinence: etiology, diagnosis, and management. *J Gastrointest Surg*. 2015;19(10):1910-1921.
6. Simren M, Palsson OS, Heymen S, Bajor A, Tornblom H, Whitehead WE. Fecal incontinence in irritable bowel syndrome: prevalence and associated factors in Swedish and American patients. *Neurogastroenterol Motil*. 2017;29(2):e12919.
7. Atarodi S, Rafieian S, Whorwell PJ. Faecal incontinence-the hidden scourge of irritable bowel syndrome: a cross-sectional study. *BMJ Open Gastroenterol*. 2014;1(1):e000002.
8. Bharucha AE, Zinsmeister AR, Schleck CD, Melton LJ. Bowel disturbances are the most important risk factors for late onset fecal incontinence: a population-based case-control study in women. *Gastroenterology*. 2010;139(5):1559-1566.
9. Read N, Abouzekry L. Why do patients with faecal impaction have faecal incontinence. *Gut*. 1986;27(3):283-287.
10. Read NW, Abouzekry L, Read MG, Howell P, Ottewell D, Donnelly TC. Anorectal function in elderly patients with fecal impaction. *Gastroenterology*. 1985;89(5):959-966.
11. Scott SM, Lunniss PJ. *Risk Factors in Faecal Incontinence*. Fecal Incontinence. Springer; 2007:43-66.
12. Kiff E, Barnes P, Swash M. Evidence of pudendal neuropathy in patients with perineal descent and chronic straining at stool. *Gut*. 1984;25(11):1279-1282.
13. Snooks SJ, Barnes P, Swash M, Henry M. Damage to the innervation of the pelvic floor musculature in chronic constipation. *Gastroenterology*. 1985;89(5):977-981.
14. Menees SB, Almario CV, Spiegel BMR, Chey WD. Prevalence of and factors associated with fecal incontinence: results from a population-based survey. *Gastroenterology*. 2018;154(6):1672-1681.e3.
15. Meinds RJ, van Meegdenburg MM, Trzpis M, Broens PMA. On the prevalence of constipation and fecal incontinence, and their co-occurrence, in The Netherlands. *Int J Colorectal Dis*. 2016;32(4):475-483.
16. Brochard C, Chambaz M, Ropert A, et al. Quality of life in 1870 patients with constipation and/or fecal incontinence: constipation should not be underestimated. *Clin Res Hepatol Gastroenterol*. 2019;43(6):682-687.
17. Cauley CE, Savitt LR, Weinstein M, et al. A quality-of-life comparison of two fecal incontinence phenotypes: isolated fecal incontinence versus concurrent fecal incontinence with constipation. *Dis Colon Rectum*. 2019;62(1):63-70.
18. Vollebregt PF, Wiklendt L, Dinning PG, Knowles CH, Scott SM. Coexistent faecal incontinence and constipation: a cross-sectional study of 4027 adults undergoing specialist assessment. *Eclinicalmedicine*. 2020;27:27.
19. Ouizeman DJ, Marine-Barjoan E, Hastier-De Chelles A, et al. The severity of symptoms is insufficient to predict major alterations to quality of life of patients with fecal incontinence or chronic constipation. *Int J Colorectal Dis*. 2020;35(11):2041-2048.
20. Amselem C, Puigdollers A, Azpiroz F, et al. Constipation: a potential cause of pelvic floor damage? *Neurogastroenterol Motil*. 2010;22(2):150-e48.
21. Burgell RE, Bhan C, Lunniss PJ, Scott SM. Fecal incontinence in men: coexistent constipation and impact of rectal hyposensitivity. *Dis Colon Rectum*. 2012;55(1):18-25.
22. Rao SS, Bharucha AE, Chiarioni G, et al. Functional anorectal disorders. *Gastroenterology*. 2016;150:1430-1442.e4.
23. Lacy BE, Mearin F, Chang L, et al. Bowel disorders. *Gastroenterology*. 2016;150(6):1393-1407. e5.
24. Meinds RJ, Timmerman MEW, van Meegdenburg MM, Trzpis M, Broens PMA. Reproducibility, feasibility and validity of the Groningen defecation and fecal continence questionnaires. *Scand J Gastroenterol*. 2018;53(7):790-796.
25. Palsson OS, Whitehead WE, van Tilburg MAL, et al. Development and validation of the Rome IV diagnostic questionnaire for adults. *Gastroenterology*. 2016;150(6):1481-1491.
26. Gagnier JJ, Lai JY, Mokkink LB, Terwee CB. COSMIN reporting guideline for studies on measurement properties of patient-reported outcome measures. *Qual Life Res*. 2021;30(8):2197-2218.
27. Verkuijl SJ, Meinds RJ, Trzpis M, Broens PM. The influence of demographic characteristics on constipation symptoms: a detailed overview. *BMC Gastroenterol*. 2020;20:1-9.
28. Communique of the seventh national population census [Internet]. National Bureau of Statistics of China; 2021 Available from: http://www.stats.gov.cn/english/StatisticalCommuniqu/.
29. Simren M, Palsson OS, Whitehead WE. Update on Rome IV criteria for colorectal disorders: implications for clinical practice. *Curr Gastroenterol Rep*. 2017;19(4):15.
30. Vaizey CJ, Carapeti E, Cahill JA, Kamm MA. Prospective comparison of faecal incontinence grading systems. *Gut*. 1999;44(1):77-80.
31. Renzi A, Brillantino A, Di Sarno G, d'Aniello F. Five-item score for obstructed defecation syndrome: study of validation. *Surg Innov*. 2013;20(2):119-125.
32. Lewis SJ, Heaton KW. Stool form scale as a useful guide to intestinal transit time. *Gut*. 1997;41:A122-A123.
33. de Wild N, Herrmann F, Bos GJFJ, Trzpis M, Broens PMA. Anorectal dysfunction in adults with spina bifida and associated socio-emotional factors-a retrospective, cross-sectional cohort study. *Spinal Cord*. 2022;60(7):679-686.
34. Zhou BF. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults – study on optimal cut-off points of body mass index and waist circumference in Chinese adults. *Biomed Environ Sci*. 2002;15(1):83-96.
35. Yuan Y, Qiu L, Li Z-Y, et al. An epidemiology study of fecal incontinence in adult Chinese women living in urban areas. *Chin Med J (Engl)*. 2020;133(3):262-268.
36. Rockwood TH. Incontinence severity and QOL scales for fecal incontinence. *Gastroenterology*. 2004;126(1):S106-S113.
37. Bharucha AE, Zinsmeister AR, Locke GR, et al. Prevalence and burden of fecal incontinence: a population-based study in women. *Gastroenterology*. 2005;129(1):42-49.
38. Bordeianou L, Rockwood T, Baxter N, Lowry A, Mellgren A, Parker S. Does incontinence severity correlate with quality of life? Prospective analysis of 502 consecutive patients. *Colorectal Dis*. 2008;10(3):273-279.
39. Pares D, Vial M, Bohle B, et al. Prevalence of faecal incontinence and analysis of its impact on quality of life and mental health. *Colorectal Dis*. 2011;13(8):899-905.
40. Mundet L, Ribas Y, Arco S, Clave P. Quality of life differences in female and male patients with fecal incontinence. *J Neurogastroenterol Motil*. 2016;22(1):94-101.
41. Khanijow KD, Pahwa AK, Newman DK, Arya LA, Andy UU. Barriers to exercise among women with urgency urinary incontinence: patient and provider perspectives. *Female Pelvic Med Reconstr Surg*. 2018;24(4):301-306.
42. Bedard K, Heymen S, Palsson OS, Bharucha AE, Whitehead WE. Relationship between symptoms and quality of life in fecal incontinence. *Neurogastroenterol Motil*. 2018;30(3):e13241.
43. Rothbarth J, Bemelman WA, Meijerink WJHJ, et al. What is the impact of fecal incontinence on quality of life? *Dis Colon Rectum*. 2001;44(1):67-71.
44. Pahwa AK, Khanijow KD, Harvie HS, Arya LA, Andy UU. Comparison of patient impact and clinical characteristics between urgency and

passive fecal incontinence phenotypes. *Female Pelvic Med Reconstr Surg*. 2020;26(9):570-574.
45. Pucciani F. Faecal soiling: pathophysiology of postdefaecatory incontinence. *Colorectal Dis*. 2013;15(8):987-992.
46. Grad S, Dumitrascu D. Irritable bowel syndrome subtypes: new names for old medical conditions. *Dig Dis*. 2020;38(2):122-127.
47. Schiller LR. Evaluation of chronic diarrhea and irritable bowel syndrome with diarrhea in adults in the era of precision medicine. *Am J Gastroenterol*. 2018;113(5):660-669.
48. Nurko S, Scott SM. Coexistence of constipation and incontinence in children and adults. *Best Pract Res Clin Gastroenterol*. 2011;25(1):29-41.
49. Crane SJ, Talley NJ. Chronic gastrointestinal symptoms in the elderly. *Clin Geriatr Med*. 2007;23(4):721-734.
50. Rao SS, Patcharatrakul T. Diagnosis and treatment of dyssynergic defecation. *J Neurogastroenterol Motil*. 2016;22(3):423-435.
51. Rajindrajith S, Devanarayana NM, Benninga MA. Constipation-associated and nonretentive fecal incontinence in children and adolescents: an epidemiological survey in Sri Lanka. *J Pediatr Gastroenterol Nutr*. 2010;51(4):472-476.
52. van Meegdenburg MM, Heineman E, Broens PM. Pudendal neuropathy alone results in urge incontinence rather than in complete fecal incontinence. *Dis Colon Rectum*. 2015;58(12):1186-1193.
53. Christensen P, Bazzocchi G, Coggrave M, et al. A randomized, controlled trial of transanal irrigation versus conservative bowel management in spinal cord-injured patients. *Gastroenterology*. 2006;131(3):738-747.
54. Norton C, Whitehead WE, Bliss DZ, Harari D, Lang J. Management of fecal incontinence in adults. *NeurourolUrodyn*. 2010;29(1):199-206.
55. Nygaard I, Barber MD, Burgio KL, et al. Prevalence of symptomatic pelvic floor disorders in US women. *JAMA*. 2008;300(11):1311-1316.
56. Lawrence JM, Lukacz ES, Nager CW, Hsu JWY, Luber KM. Prevalence and co-occurrence of pelvic floor disorders in community-dwelling women. *Obstet Gynecol*. 2008;111(3):678-685.
57. Botlero R, Bell RJ, Urquhart DM, Davis SR. Prevalence of fecal incontinence and its relationship with urinary incontinence in women living in the community. *Menopause*. 2011;18(6):685-689.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Sun G, Trzpis M, Ding H, Gao X, Broens PMA, Zhang W. Co-occurrence of fecal incontinence with constipation or irritable bowel syndrome indicates the need for personalized treatment. *Neurogastroenterology & Motility*. 2023;35:e14633. doi:10.1111/nmo.14633