



Relationship between Neuroticism and Gastrointestinal Symptoms in Irritable Bowel Syndrome: The Mediating Role of Sleep

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(Received 15 Nov 2021; accepted 21 Jan 2022)

Abstract

Background: We aimed to explore the relationship between the sleep and gastrointestinal symptoms in patients with irritable bowel syndrome (IBS) from the perspective of personality factors.

Methods: Overall, 167 patients with IBS— from First Affiliated Hospital of Nanjing Medical University in Jiangsu Province of China in 2019 were included. Gastrointestinal Symptom Score (GIS), Chinese version of Pittsburgh Sleep Quality Index (PSQI) and Eysenck Personality Questionnaire (EPQ) were used to assess gastrointestinal symptoms, sleep and personality. We use mediator variables analyze to explore the relationship between sleep, neurotic personality and gastrointestinal symptoms in IBS patients.

Results: 48.5% of IBS patients had sleep disorders. IBS patients with high neuroticism had higher total PSQI scores, longer sleep latency, worse sleep persistence, more nocturnal sleep disturbances and daytime dysfunctions, and more use of sleep medication ($P<0.05$). Stomach distention, cramping epigastric pain, loss of appetite, and epigastric pain were more prominent in IBS patients with high neuroticism ($P<0.05$). In addition, neurotic personality was significantly predictive of sleep and some gastrointestinal symptoms, and sleep was a complete mediator of neurotic personality and gastrointestinal symptoms in IBS patients.

Conclusion: High neurotic personality in IBS patients leads to more prominent gastrointestinal symptoms by causing sleep disturbance.

Keywords: Irritable bowel syndrome; Neuroticism; Gastrointestinal symptom; Sleep; Mediation effect

Introduction

Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder characterized by recurrent abdominal pain, abdominal discomfort accompanied by bowel behavior or change in bowel habits. The duration of the disease is at least six months, and the symptoms occur at least one day a week in the last three months (1).

IBS currently affects about one tenth of the global population, bringing a huge disease burden (2),

but its pathological mechanism is not completely clear. Patients with IBS have brain-enteric circulation disorders, leading to intestinal movement disorders, visceral hypersensitivity and central nervous system changes (3), among which sleep problems are an important factor affecting brain-enteric circulation (4). Sleep disorders are very common in patients with IBS (5,6), and about 74% of patients with IBS complain of "poor



sleep" (7). Gastrointestinal symptoms of patients with IBS will worsen after a poor night's sleep (5,8). The sleep problems of IBS patients could not be explained by psychological pain (9), and the susceptibility to sleep disorders was related to certain personality traits, insomniacs showed more "neurotic" traits (10). Patients with high neuroticism have IBS symptoms every day, and patients with low neuroticism have IBS symptoms once a month (11), suggesting that the level of neuroticism may be related to gastrointestinal symptoms of IBS.

Therefore, this study explored the relationship between gastrointestinal symptoms, sleep problems, and personality factors in patients with IBS from the perspective of personality factors.

Methods

Participants and setting

Adult outpatients with IBS who visited the department of Gastroenterology and the Department of Clinical Psychology of First Affiliated Hospital of Nanjing Medical University from February 2018 to February 2019 were recruited.

The study was approved by the Ethics Committee of the university (Ethical Approval Number: 2019-NT-06). Inclusion criteria: 28-65 years of age, meeting the Roman IV (1) diagnostic criteria for IBS, and receiving upper gastrointestinal endoscopy. Exclusion criteria: history of gastrointestinal surgery; malignant tumor or ulcerative disease; Use of non-steroidal anti-inflammatory drugs; Have liver and bile disease or pancreatitis; pregnant women; Unable to complete the questionnaire due to serious physical or mental illness. A total of 167 people completed the survey.

Gastrointestinal Symptom Score questionnaire

Gastrointestinal Symptom Score (GIS) (12) was used to assess the severity of IBS symptoms. Likert 5-point scoring method was used, grading from "asymptomatic" to "very severe", with a total Score of 40. The higher the Score, the more severe the Gastrointestinal symptoms. GIS has

high reliability and validity in evaluating functional gastrointestinal diseases.

Psychological evaluation

The psychological evaluator were all masters in psychology and had been engaged in psychological assessment for a long time. They did not participate in the study design and did not understand the specific situation of patients.

Sleep quality assessment: The Chinese version of Pittsburgh Sleep Quality Index (PSQI) was used to evaluate the sleep of patients in the last month. The scale consists of 19 self-rated items, including 7 parts: Subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disorders, sleep drug use and daytime dysfunction. In addition, there were 5 questions which were helpful for the evaluation of clinical sleep condition, but do not participate in scoring. The score for each component ranges from 0 to 3, and the sum of the seven component scores is the PSQI total score, which ranges from 0 to 21. The higher the score, the worse the sleep quality. The Cronach α coefficients of 7 components and each item were 0.84 and 0.85, the half-reliability coefficients of odd-even component were 0.87, and the correlation coefficients between the two-week retest and the pre-test were 0.83. This indicates that the scale has high internal consistency and retest reliability (13).

Assessment of Personality dimension: The Chinese version of Eysenck Personality Questionnaire (EPQ) revised by Gong Yaodian was used for assessment of adult version (14). The Questionnaire included 88 items, and the subjects were asked to answer yes or no according to their own situation and score on three Personality dimensions: E, N and P: E was introverted and extroverted, with high scores representing extroversion and sociability, and low scores representing introversion and introspection; N Neuroticism, high scores may be prone to strong emotional reactions, or even irrational behavior, reflecting behavior patterns; P psychosis, not psychosis, everybody has it, but it varies in degree, high scores can be lonely, cold, like doing strange

things. In this study, $N > 65$ was defined as high neuroticism.

Data analysis

Data were assessed with Statistical Package for the Social Sciences (SPSS) for Windows, version 26.0. Mean \pm standard deviation (SD) was used for demographic data and overall sleep status. Mann-Whitney test was used for comparison of gastrointestinal symptoms and sleep quality between high and low neuroticism groups. Spearman correlation analysis was used to analyze the correlation between sleep quality, personality factors and gastrointestinal symptoms. The variables with $P < 0.05$ were included in the regression anal-

ysis of the mediation model to obtain the mediation analysis model of sleep quality, personality factors and gastrointestinal symptoms. $P < 0.05$ indicates statistically significant difference.

Results

Demographics

Demographic data is presented in Table 1. Overall, 167 patients with IBS were collected, 14.4% were male and 85.6% were female, with an average age of 43 years. Among all IBS patients, 48.5% had sleep disturbances.

Table 1: Basic information and sleep status of IBS patients ($\bar{x} \pm s$) (n=167)

Items	IBS patients n (%)
Age (yr)	42.65 \pm 11.77
Gender	
Male	24 (14.40%)
Female	143 (85.6%)
Education (year)	12.44 \pm 3.65
PSQI	
Without sleep disturbance (≤ 7)	86 (51.5%)
Sleep disturbance (>7)	81 (48.5%)
Male	10
Female	71

Comparison of sleep and gastrointestinal symptoms between high and low neuroticism in IBS patients

As shown in Table 2, the total PSQI score of IBS patients with high neuroticism was significantly higher than low neuroticism, indicating the worse sleep of high neuroticism group. Significant differences were also found in sleep latency, sleep persistence, sleep disturbance, use of sleep drugs, and daytime dysfunction scores between two groups. IBS patients with high neurotic personali-

ty had longer sleep latency, worse sleep persistence, more nighttime sleep disturbances and daytime dysfunction, and more use of sleep medication. However, there was no significant difference in subjective sleep quality and habitual sleep efficiency between the two groups. In addition, gastrointestinal symptoms, such as bloating, spasmodic epigastric pain, loss of appetite, and epigastric pain were more prominent in IBS patients with high neuroticism.

Table 2: Comparison of sleep and gastrointestinal symptoms in IBS patients between high and low neurologic groups ($\bar{x}\pm s$)

<i>Variable</i>	<i>high neuroti- cism</i>	<i>low neuroti- cism</i>	<i>Z</i>	<i>P value</i>
PSQI	(<i>n</i> =57)	(<i>n</i> =110)		
Subjective sleep quality	1.74±0.70	1.81±0.86	-1.113	0.266
Sleep latency	2.35±0.99	1.81±1.11	-3.531	0.000
Sleep persistence	1.54±1.16	0.86±0.91	-3.643	0.000
Habitual sleep efficiency	1.56±1.45	1.03±1.21	-1.748	0.080
Nighttime sleep disturb- ance	1.84±0.41	1.34±0.88	-3.563	0.000
Use of sleep drugs	0.74±1.17	0.25±0.65	-2.957	0.003
Daytime dysfunction	0.70±0.76	0.39±0.59	-2.681	0.007
PSQI total points	10.49±3.66	7.69±3.38	-4.388	0.000
GIS				
Nausea	2.11±1.06	2.11±0.92	-0.656	0.512
Vomit	1.23±1.20	1.27±1.07	-0.283	0.777
Stomach bloating	2.19±1.23	1.70±1.32	-2.400	0.016
Spasmodic epigastric pain	1.82±1.47	1.23±1.24	-2.173	0.030
Early satiety	2.02±0.67	2.06±1.04	-0.649	0.516
Heartburn	1.11±1.32	1.04±1.31	-0.355	0.722
Upset stomach	2.77±0.87	2.47±1.16	-1.873	0.061
Loss of appetite	2.21±1.10	1.87±1.10	-1.998	0.046
Retrosternal discomfort	1.89±1.37	1.70±1.22	-1.008	0.313
Epigastric pain	2.04±0.65	2.29±0.93	-1.984	0.047
GIS total points	19.39±5.42	17.75±4.99	-1.816	0.069

Analysis of the mediating effect of sleep

The study examined the mediating effect of sleep by analyzing the correlation and regression among neurotic personality (independent variable X), sleep (mediating variable M) and gastrointestinal symptoms (dependent variable Y) in stomach bloating (Y1), spastic epigastric pain (Y2), loss of appetite (Y3), and epigastric pain (Y4).

Neurotic personality and gastrointestinal symptoms (Y1-Y4) were examined significantly correlated. At the same time, neurotic personality and sleep were significantly correlated, and both sleep and gastrointestinal symptoms were significantly ($P<0.05$) correlated (Table 3). The results satisfy the conditions of mediation analysis.

Table 3: Correlation between sleep and neurotic personality and gastrointestinal symptoms in IBS patients (r value)

<i>Variable</i>	<i>Neurotic personality</i>	<i>PSQI</i>
Neurotic personality	1	0.328**
Gastrointestinal symp- tom		
Stomach bloating	0.206**	0.212**
Spastic epigastric pain	0.197*	0.511**
Loss of appetite	0.162*	0.163*
Epigastric pain	-0.154*	-0.220**

Notes: * $P<0.05$, ** $P<0.01$

The mediating effect test of sleep in the relationship between neurotic personality and gastrointestinal symptoms are shown in Table 4. The first step regression analysis suggested that the neurotic personality of IBS patients was significantly predictive to gastrointestinal symptom including stomach bloating ($c=0.020$), spastic epigastric pain ($c=0.019$), loss of appetite ($c=0.013$) and epigastric pain ($c=-0.009$). The second step regression results showed that neurotic personality of IBS patients also had a significant predictive effect on sleep status ($a=0.088$). As we can see from the third step, a significant c became an insignificant c' ($c'=0.015$, $P=0.057$) when the de-

pendent variable was stomach bloating, showing a complete mediating effect ($b=0.057$, $P=0.045$). Likewise, neurotic personality was unable to directly predict epigastric pain of IBS patients ($c'=0.003$, $P=0.643$), but completely predicted epigastric pain of IBS patients through sleep under the mediation of sleep ($b=0.181$, $P=0.000$). However, the mediating effect of sleep did not exist when the dependent variable was anorexia ($b=0.037$, $P=0.131$). When the dependent variable was epigastric pain, neurotic personality also predicted epigastric pain symptoms in IBS patients entirely by sleep ($c'=-0.006$, $P=0.258$, $b=-0.044$, $P=0.019$).

Table 4: Regression analysis of mediation models

<i>Viable</i>	<i>Regression equation</i>	<i>Standard error</i>	<i>t</i>	<i>P</i>
First step	Y1=0.020X	0.007	2.708	0.007
	Y2=0.019X	0.007	2.584	0.011
	Y3=0.013X	0.006	2.108	0.037
	Y4=-0.009X	0.005	-1.997	0.047
Second step	M=0.088X	0.020	4.463	0.000
Third step	Y1=0.015X	0.008	1.918	0.057
	+0.057M	0.028	2.023	0.045
	Y2=0.003X	0.007	0.465	0.643
	+0.181M	0.026	7.048	0.000
	Y3=0.010X	0.006	1.501	0.135
	+0.037M	0.024	1.518	0.131
	Y4=-0.006X	0.005	-1.135	0.258
	+0.044M	0.018	-2.370	0.019

The mediating effect test showed that sleep had a mediating effect on the relationship between neurotic personality and stomach distention, spastic epigastric pain and epigastric pain, with standard

errors less than 0.05. The c' was not significant. The confidence interval did not contain 0. As results, it was a complete mediation effect (Table 5).

Table 5: Bootstrap test for mediating effects

<i>PSQI</i>	<i>B</i>	<i>Standard error</i>	<i>P</i>	<i>95% confidence interval</i>	
				upper limit	lower limit
Y1	0.057	0.027	0.038	0.008	0.110
Y2	0.181	0.025	0.001	0.132	0.230
Y3	0.037	0.024	0.122	-0.011	0.082
Y4	-0.044	0.018	0.015	-0.079	-0.007

Discussion

The study used mediator variables to analyze the relationship between neurotic personality, sleep, and gastrointestinal symptoms in IBS patients and found that IBS patients with high neuroticism had worse sleep, more severe stomach bloating, spastic epigastric pain, loss of appetite and epigastric pain. Our study further showed that sleep presented a complete mediating effect in the impact of neurotic personality on partial gastrointestinal symptoms in IBS patients.

Among all IBS patients, sleep disorders accounted for 48.5%. IBS patients are more prone to sleep abnormalities, such as poor sleep quality, nighttime disturbances, and daytime dysfunction (15). Patel and his colleagues found that IBS patients sleep longer but feel less comfortable during the day (5). Our study also found that female IBS patients had a higher proportion of sleep disorders, which was consistent with previous studies showing women were more prone to sleep problems when they were stressed (16).

Previous study had shown that the neuroticism score of IBS patients was significantly higher than that of normal people (17). Eysenck pointed out that people with a high level of neuroticism is emotionally unstable, moody and easily excited. Neuroticism is related to the function of the autonomic nervous system, especially the sympathetic nervous system. The present study confirmed that patients with high neuroticism were also more prominent in stomach bloating, spastic epigastric pain, loss of appetite, and epigastric pain. It also suggested that epigastric pain was associated with gastrointestinal-specific anxiety and neurotic personality (18), which was consistent with our findings, but no relationship between anorexia and neuroticism was found in this study. Neurotic personality also has a greater impact on sleep, with high levels of neuroticism predicting worse sleep quality (19). Sleep problems in high neurotic IBS patients were further found mainly reflected in prolonged latency, poor persistence and more daytime dysfunction in the present study. In addition, gastrointestinal dys-

function and sleep disturbances were conformed significantly correlated in IBS patients (20). The severity of gastrointestinal symptoms in IBS patients was significantly positively correlated with sleep disturbances (21). Therefore, neurotic personality, sleep, and gastrointestinal symptoms interact with each other in IBS patients.

Mediation analysis was used to explore further the role of sleep in neurotic personality and gastrointestinal symptoms in IBS. Neurotic personality was confirmed to have a significant predictive effect on sleep and some gastrointestinal symptoms in our study. Liu Qiqin et al also found that neurotic personality is a risk factor for sleep problems and IBS among middle school students (22). The predictive effect of neurotic personality on gastrointestinal symptoms disappeared when sleep was introduced as a mediating variable, indicating that sleep was a complete mediating factor between neurotic personality and gastrointestinal symptoms. It suggested that neurotic personality in IBS patients predicted more severe stomach bloating and epigastric pain completely through sleep disorders. The higher the level of neuroticism, the more severe the sleep disturbance, and the more prominent stomach bloating and epigastric pain in IBS patients. Poor sleep in IBS patients may be due to increased nocturnal voluntary arousal and prolonged REM sleep, which has arousing and stimulating effects on colonic motility and may lead to sleep disturbances (23). Fass et al also found that 57.2% of IBS patients were awakened by abdominal pain or discomfort during sleep, leading to sleep disruption (24). Lack of sleep has also been shown to cause upregulation of the immune system and increased microscopic inflammation in gut, leading to gastrointestinal symptoms (25). Buchanan et al demonstrated that self-reported poor sleep quality significantly predicted next day abdominal pain, anxiety, and higher levels of fatigue (8). In contrast, IBS patients also reported a significant reduction in gastrointestinal symptoms following the use of melatonin for sleep (26). However, no differences were found in sleep quality under polysomnography in IBS patients and normal controls. The number of awakenings, slow-wave

sleep and REM sleep were similar between the two groups, suggesting that sleep disturbances in IBS patients are not related to changes in sleep structure, and may be related to overreaction to normal stimuli and neurotic personality (25).

Several limitations should be considered in our study, such as a small sample size and a single evaluation method. The sample size can be further expanded in the future. Methods that are more objective such as gastrointestinal endoscopes and polysomnography can be used for evaluate gastrointestinal symptoms and sleep in the future.

Conclusion

High neurotic personality in IBS patients leads to more prominent gastrointestinal symptoms by causing sleep disturbance. Therefore, for IBS patients with high neuroticism scores, sleep quality should be actively improved to relieve gastrointestinal symptoms.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

This study was funded by: 511 Tengfei Project of Jiangsu Province Hospital (JSPH-511B-2018-3).

Conflict of interest

The authors declare that there is no conflict of interest.

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