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GENERAL GYNECOLOGY

Neuropsychological function is related to irritable bowel syndrome in women with premenstrual syndrome and dysmenorrhea

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Abstract

Background There is increasing evidence demonstrating the co-occurrence of primary dysmenorrhea (PD), premenstrual syndrome (PMS), and irritable bowel syndrome (IBS) in women. This study aimed to investigate whether women who have symptoms of IBS in addition to PD and PMS also report more severe or frequent menstruation-associated symptoms and psychological complications compared to women with PD and PMS alone.

Methods The study group included 182 female University students aged 18–25 years. IBS was diagnosed using the Rome III criteria. The severity of PMS and PD was determined using a 10-point visual analog scale and PSST (Premenstrual Syndrome Screening Tool), respectively. Neuropsychological functions including cognitive function, depression score, anxiety score, stress, insomnia, daytime sleepiness, quality of life and personality were assessed using standard questionnaires.

Results Of the 182 young females, 31 (17.0%) had IBS. Average days of bleeding during the menstrual cycle and mean pain severity on the PSST scale were significantly greater in the group with IBS compared to the non-IBS group ($p<0.01$). The non-IBS individuals scored more favorably than the women with IBS with respect to severity of depression, insomnia, daytime sleepiness ($p<0.05$). The PSST scores were significantly correlated with scores for depression ($r=0.29$; $p<0.001$), anxiety ($r=0.28$; $p<0.001$), stress ($r=0.32$; $p<0.001$), insomnia ($r=0.34$; $p<0.001$) and daytime sleepiness ($r=0.31$; $p<0.001$); while, they were negatively correlated with cognitive abilities ($r=-0.20$; $p=0.006$) and quality of life ($r=-0.42$; $p<0.001$). Linear regression analysis showed that the PSST scores were possibly significant factors in determining the scores for depression, anxiety, stress, quality of life, insomnia and daytime sleepiness ($p<0.05$).

Conclusion IBS is related to psychological comorbidities, in particular depression, sleep problems and menstrual-associated disorders. IBS may exacerbate the features of PMS which should be taken into account in the management of PMS.

Keywords Cognitive abilities · Anxiety · Depression · Insomnia · Quality of life

Introduction

Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder characterized by abdominal pain or discomfort together with alteration of bowel habits in the

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lack of structural abnormalities [1]. Epidemiologic studies have reported that the prevalence of IBS is approaching 11% globally [2] and 1.1% to 25% in Iranian populations [3, 4].

The pathogenesis of IBS involves the interactions of several factors, i.e., abnormal gastrointestinal motility, visceral hypersensitivity, and elevated pain perception [5, 6], dietary intolerance [7], disturbance of brain–gut axis function [8, 9], chronic inflammation, changing gut immune induction [10], intestinal permeability and reorganization of microbiota [11], psychosocial stressors and psychiatric comorbidities [12]. Patients with IBS endure high levels of psychological distress; these have been reported to be at intermediate levels between psychiatric cases and healthy individuals [13]. Psychiatric comorbidities such as depression may also be involved in the negative effect of IBS on the quality of life [14]. The large intestine is partly regulated via the autonomic nervous system and reacts to stress. Stress is associated with increased pain sensation and increased motility of the large intestine [15].

Sex hormones may also contribute to the etiology of IBS. This is supported by the fact that IBS is more prevalent in women compared to men [16]. Menarche defines the beginning of menstruation and it is one of the most impactful events in a women's life; women of reproductive age are often negatively affected by symptoms corresponding to menstrual dysfunction such as premenstrual syndrome (PMS) and primary dysmenorrhea (PD) [17].

PD can be defined as a presence of spasmodic-like pain in the lower abdomen, without any pelvic pathology, at shortly before or the onset of menstruation, which occur in up to 90% of woman [18]. Some days prior to menstruation, prostaglandins act on the uterine muscle where they increase the speed of onset of menstruation and smooth muscle contraction [19]. Premenstrual syndrome (PMS) is a set of physiological and affective symptoms happening within the one week prior to menses, after which there is an attenuation over a few days following the onset of menstrual bleeding, or shortly thereafter [20]. The frequency and intensity of PMS symptoms differ considerably between women [21, 22]. Between 70 and 90% of women experience one or more signs of physical discomfort or psychological symptoms during the luteal phase of their menstrual cycle [23, 24].

The presentation of IBS symptoms and the associated changes in bowel habit may vary over the phases of the menstrual cycle, indicating a potential effect of gonadal hormones on gastrointestinal symptoms [23, 25]. We have previously reported that among 448 adolescent girls, the prevalence of IBS was significantly higher in the individuals with PD (19.9%), cases with PMS (13.6%), and individuals with both PMS and PD (17.4%) compared to health controls (8.1%) [26]. In spite of the documented co-occurrence of PD and PMS with IBS, these conditions have generally been explored as separate entities and so, there is scarce existing information on their combined impact. It remains unknown whether women with concurrent PMS and PD who report IBS have elevated levels of physiological and psychological distress. This study aimed to investigate that women who report IBS in addition to PD and PMS will also report more severe or frequent menstruation-associated symptoms and psychological complications compared to women with PD and PMS alone.

Materials and methods

Study design and participants

This study was performed on female university students suffering from PMS and PD during November–December 2019 from 5 universities in Birjand city, Khorasan Province, Iran. The sample size was determined to achieve 80% power and $\alpha' = 0.05$ according to a previous study [26] and it was determined that 173 cases would be needed for sufficient power. The inclusion criteria of study were: a natural menstrual cycle, being single civil status (unmarried), having both PMS and PD which had started within 2 years of menarche. The exclusion criteria were any acute or chronic systemic diseases; and any history of pelvic or abdominal surgery. We also excluded girls with any endocrinopathy, endometriosis and/or adenomyosis, fibroids, secondary dysmenorrhea and other gynecological complications which were diagnosed by expert gynecologist or self-reported. Girls, who were using any medication and hormone therapy over the past year, were also elided. The study was approved by the Ethics Committee of Birjand University of Medical Sciences (BUMS) and informed consent was obtained from each participant.

Diagnosis of IBS, premenstrual syndrome and dysmenorrhea

Dysmenorrhea

These following criteria were used to define PD: pain beginning within 6–12 h of menstruation, lower abdominal pain related with onset of menarche and extended over 8–72 h, as well as low back pain or anterior thigh during menses [27].

The dysmenorrheal pain severity was measured in each participant using a visual analog scale (VAS), with scores from 1 to 10. Pain was defined as "mild" when a female rated 1–3, "moderate" when rated 4–5, "severe" when rated 6–7, or "extreme severe" with a score of 8–10 [28].

Premenstrual syndrome

PMS was determined using the PSST (Premenstrual Syndrome Screening Tool) questionnaire [29], which consists of 19 items in three section (physical, behavioral and psychological symptoms) in the 5 days prior to menstruation of the previous 3 months. The severity of each symptom was graded from 0 to 3 based on 4-option Likert scale (0: none, 3: severe), covering the lowest and highest range of 0 and 57. The individuals who obtained scores greater than 20 were enrolled to the present study. This scale was validated in Iran. Notably, the reliability, internal consistency, and the validity of the questionnaire for Iranian population were 0.9, 0.8, and 0.7, respectively [30].

Menstrual pattern

Menstrual patterns of participants were evaluated by standard questionnaires which included the menarcheal age, menstrual cycle length, duration and amount of flow [31].

IBS

This part of questionnaire consisted of questions about various gastrointestinal disorders, described on the basis of Rome III criteria translated into Persian. IBS was defined as repeated abdominal pain/discomfort at least 3 days per month in the last 2 months accompanied with $2 \geq$ of the following criteria: (1) relief with defecation, (2) the beginning related with an alteration in frequency and (3) alteration in appearance of stool [1]. IBS and four subtypes including constipation-predominant (IBS-C), diarrhea predominant (IBS-D), mixed bowel habit (IBS-M), and unclassified IBS, were diagnosed based on the Rome III criteria and explanation of recent symptoms. The validity and reliability of this questionnaire in Iranian individuals have been reported previously [32].

Anthropometric measurements and blood collection

Demographic information was gathered by face-to-face interview. Anthropometric indices (waist and hip circumference, weight, height) and cardiac measurements were assessed using validated instruments and standard procedure in our health centers by expert paramedic. Body mass index (BMI) was also calculated using this formula: weight (kg)/height (m^2).

5-mL EDTA blood samples were collected from each participant in morning and hematological indices immediately were measured using the SysmexK-800.

Neuropsychological assessment

Cognitive abilities were evaluated using the Cognitive Abilities Questionnaire (CAQ). The CAQ consists of 30 questions, each of which is scored on 1–5 and, thus, a total score obtaining from 30 to 150. Higher scores indicated superior cognition performances [33]. The CAQ measures memory, inhibitory control and selective attention, decision-making, planning, sustained attention, social cognition and cognitive flexibility [34].

Depression Anxiety and Stress Scale (DASS-21) [35] is commonly used, and has been well validated for measuring negative emotions. This 21-question scale has 3 subscales (each contains 7 items) measuring depression, anxiety and stress, respectively. All items are scored on a zero to 3. Since DAS-21 is the short version of DAS-42, the final score of each sub-class must to be doubled. Higher score presents more severe negative symptoms. The valid and reliable Persian revision of DASS-21 scale was used in this survey [36].

The insomnia severity index (ISI) is a reliable tool which quantitatively measures a severity of insomnia [37]. The questionnaire involves 7 questions dealing on sleep disorder intensity, sleep-associated satisfaction and anxiety-associated sleeping disorder. Each item is rated from zero to 4 to provide a total score ranging 0–28. Higher scores point out more degree of insomnia.

The Epworth sleepiness Scale (ESS) is an accepted and validated questionnaire which can be used to measure daytime sleepiness. It have eight items with 4-point Likert scale (0–3) which quantifies the frequent probability of fall asleep in most common daily living conditions. Total scores range from 0 to 24 and higher scores indicate worsen sleepiness [38].

The short form health survey (SF-12) is a widely accepted tool for measuring health-related quality of life [39]. The SF-12 is a shorter version of the SF-36, and composed of 12 questions creates normalized physical and mental health subscales included in the SF-36. The Iranian version of the SF-12 revealed good psychometrically reliability and validity [40].

Personality Type A/B Inventory developed by Rathus has a 25-item questionnaire and individuals concerning to their mood and states have to response: yes (score = 1) or no (score = 0) [41]. Type A personality describes a complex emotional individual who often have an aggressive mood, active, opponent, competitive, chivalrous and having different standards and activities. While, type B personality has features such as feeling less pressure, having regular rest/exercise, lower standard and slow working [42, 43]. This

instrument divides individual personality types into two classes: type A (> score 13) and type B (≤13). The validity and reliability of this instrument were confirmed for Iranian population [41, 44].

Statistical analysis

Statistical analyses were conducted using the SPSS for Windows version 16.0 (Statistical Package for Social Sciences Inc., Chicago, USA). Continuous variables are presented as mean ± SD and were compared between groups using independent sample *T* test. Categorical variables presented as number (percent) and compare between groups by Chi-square test. The correlation between PSST score and neuropsychological tests was evaluated using Pearson correlation analysis. Univariate linear regression analysis was used to assess the effects of PSST scores on neuropsychological performances. A p value < 0.05 was considered to be statistically significant.

Table 1 Demographic, anthropometrics and hematological characteristics of IBS and No-IBS women

Variable	No-IBS ($n=151$)	IBS ($n=31$)	P value[a]
Age (years)	20.7 ± 1.7	20.4 ± 4.0	0.48
BMI (kg/m^2)	20.9 ± 2.9	20.3 ± 2.8	0.32
SBP (mmHg)	10.6 ± 0.96	10.8 ± 0.99	0.44
DBP (mmHg)	7.1 ± 0.75	7.4 ± 0.77	0.56
WHR	0.73 ± 0.04	0.74 ± 0.03	0.46
Hematological indices			
WBC (10^9 cells/L)	6.8 ± 1.8	7.1 ± 1.9	0.46
RBC(10^{12} cells/L)	4.8 ± 0.5	4.8 ± 0.4	0.89
HCT (%)	41.6 ± 3.6	41.1 ± 3.3	0.46
Hb (g/dL)	13.9 ± 1.4	13.8 ± 1.6	0.67

Data presented as mean ± SD

BMI body mass index, *Hb* hemoglobin, *HCT* hematocrit, *IBS* irritable bowel syndrome, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *WHR* waist: hip ratio

[a]Using independent sample *T* test

Results

Of the 182 young females in the population sample, 31 (17.0%) were found to have IBS. IBS subtypes included IBS-D 12.9%, IBS-C 9.7%, IBS-M 64.7%, and unsubtyped IBS 9.7%. The most predominant symptoms of IBS were alterations in bowel frequency (96.8%), alterations in fecal consistency (90.3%), and abdominal pain which was alleviated by defecation (61.3%). Constipation was present in 41.9% of IBS subjects, diarrhea was found in 25.8%, and 22.6% presented with intermittent diarrhea and constipation. The clinical features of the participants are summarized in Table 1. No significant difference was found between IBS and Non-IBS groups in terms of age, BMI, SBP, DBP, waist: hip ratio and hematological indices (Table 1).

The distribution of menstrual pattern and common physiological symptoms of PMS between two groups are presented in Table 2. Average days of bleeding was significantly greater in the IBS group compared to non-IBS group ($p=0.002$). Also, in the non-IBS group, the mean pain severity of PSST scale was significantly lower than that in IBS groups ($p=0.001$). Among physiological symptoms of PMS, prevalence of muscular pain is statistically

Table 2 Relationship between menstrual pattern, PSST score and physiological symptoms with presence of IBS

Variable	No-IBS ($n=151$)	IBS ($n=31$)	P value[a]
Age of menstruation, years	13.1 ± 1.4	13.1 ± 1.2	0.77
Average days of bleeding	6.5 ± 1.1	7.8 ± 4.1	**0.002**
Duration of the menstruation cycle (day)	28.0 ± 3.9	27.4 ± 5.4	0.52
PSST sore	32.2 ± 9.8	38.7 ± 9.7	**0.001**
Dysmenorrhea pain score	7.2 ± 2.1	7.3 ± 2.6	0.92
Menstruation-associated physical symptoms, *n* (%)			
Tender breasts	94 (62.3)	22 (71)	0.36
Backache	142 (94.0)	31 (100)	0.16
Feeling of bloating	142 (94.0)	30 (96.8)	0.54
Weight gain	69 (45.7)	17 (54.8)	0.35
Swelling of the limbs	78 (51.7)	22 (71.0)	**0.049**
Joint or muscle pain	129 (85.4)	30 (96.8)	0.83
Gastrointestinal symptoms	122 (80.8)	27 (87.1)	0.40
Use of medicine for relieving pain	82 (54.3)	15 (48.4)	0.66

Significance of bold values are $P < 0.05$

Data presented as mean ± SD or number (%)

[a]Using independent sample *T* test or Chi-square test as appropriate

significant higher in group with IBS compared to No-IBS group ($p=0.049$).

Neuropsychological function in relation to IBS

The women with IBS did not perform worse than the non-IBS group for all of the cognitive abilities tasks ($p>0.05$). But, the non-IBS individuals scored more favorably than the women with IBS in the Dass-21 test (depressed mood), insomnia intensity, severity of daytime sleepiness, and nocturnal sleeping ($p<0.05$; Table 3). Personality type of 48.4% of IBS cases was type A, whereas 36.4% of No-IBS group had type A personality; the difference was not statistically significant ($p=0.16$).

Neuropsychological function in relation to PMS

The correlation between the PSST score and cognitive abilities, depression, anxiety, stress, quality of life, insomnia and daytime sleepiness scores using Pearson correlation analysis is shown in Table 4. The PSST score was significantly correlated with scores for depression ($r=0.29$; $p<0.001$), anxiety ($r=0.28$; $p<0.001$), stress ($r=0.32$; $p<0.001$), insomnia ($r=0.34$; $p<0.001$) and daytime sleepiness ($r=0.31$; $p<0.001$); while, they were negatively correlated with cognitive abilities ($r=-0.20$; $p=0.006$) and quality of life($r=-0.42$; $p<0.001$).

Univariate linear regression analysis was conducted to evaluate the association of PSST score and neuropsychological test scores in two, IBS and No-IBS groups (Table 5). PSST score appeared to be a significant factor in determining the scores of depression, anxiety, stress, quality of life, insomnia and daytime sleepiness in both groups ($p<0.05$).

Discussion

To the best of our knowledge, this work is the first study to show that women who report IBS in addition to PD and PMS have a significantly higher PSST score, the average days of bleeding and frequency of some physical symptoms of PMS compared to those without it. They also more suffer from more degree of some neuropsychological problems including depression, insomnia, daytime sleepiness compared to

Table 3 Association of cognitive ability, emotional performance, personality and sleep pattern with presence of IBS

Variable (score)	No-IBS ($n=151$)	IBS ($n=31$)	P value[a]
Test of cognitive abilities			
Memory	25.6 ± 3.1	24.5 ± 4.5	0.08
Inhibitory control and selective attention	22.0 ± 3.8	21.4 ± 4.6	0.45
Decision-making	19.0 ± 3.7	18.2 ± 3.7	0.28
Planning	11.1 ± 2.8	10.5 ± 3.0	0.26
Sustain attention	9.6 ± 2.4	8.7 ± 2.4	0.06
Social cognition	10.6 ± 2.1	11.2 ± 2.0	0.16
Cognitive flexibility	14.6 ± 2.8	14.1 ± 2.8	0.35
Total cognitive ability task	112.6 ± 14.0	108.6 ± 14.8	0.15
Dass-21			
Depression	10.5 ± 8.6	14.0 ± 10.2	**0.046**
Anxiety	8.5 ± 6.0	10.7 ± 7.4	0.078
Stress	17.0 ± 9.6	19.3 ± 11.4	0.26
Quality of life (SF-12)			
Physical health	15.9 ± 2.4	15.3 ± 3.0	0.25
Mental health	16.5 ± 3.6	15.7 ± 4.2	0.24
Total quality of life score	32.4 ± 5.0	31.5 ± 5.7	0.36
Test of sleep pattern			
Insomnia score (ISI)	5.7 ± 6.4	8.7 ± 8.3	**0.025**
Daytime sleepiness score (ESS)	5.8 ± 5.7	8.9 ± 6.2	**0.008**
Nocturnal sleep hours	7.4 ± 1.3	6.7 ± 1.5	**0.008**
Personality			
Type A	55 (36.4)	15 (48.4)	0.16
Type B	96 (63.6)	16 (51.6)	

Significance of bold values are $P < 0.05$

Data presented as mean ± SD or number (%)

[a]Obtained from independent sample T test or Chi-square tests as appropriate

Table 4 Correlation matrix between PSST score and neuropsychological tests in subjects with PMS and PD

Variables	PSST score	Cognitive abilities	Depression	Anxiety	Stress	Quality of life	Insomnia
Cognitive abilities							
r	− 0.20						
p	**0.006**						
Depression							
r	0.29	− 0.50					
p	**< 0.001**	**< 0.001**					
Anxiety							
r	0.28	− 0.46	0.57				
p	**< 0.001**	**< 0.001**	**< 0.001**				
Stress							
r	0.32	− 0.52	0.57	0.61			
p	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**			
Quality of life							
r	− 0.42	0.36	− 0.48	− 0.44	− 0.51		
p	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**		
Insomnia							
r	0.34	− 0.12	0.22	0.33	0.24	− 0.41	
p	**< 0.001**	0.11	**0.003**	**< 0.001**	**0.001**	**< 0.001**	
Daytime sleepiness							
r	0.31	− 0.32	0.30	0.37	0.23	− 0.32	0.52
p	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	0.002	**< 0.001**	**< 0.001**

Significance of bold values are $P < 0.05$

Table 5 Linear regression analysis the effect of PSST score on cognitive abilities, depression, anxiety, stress, quality of life, insomnia and daytime sleepiness scores as the dependent variables across IBS categories

Variables	No-IBS		IBS	
	B	*P* value	*B*	*P* value
Cognitive abilities	− 0.21	0.07	− 0.53	0.05
Depression	0.20	**0.004**	0.41	**0.032**
Anxiety	0.12	**0.014**	0.36	**0.008**
Stress	0.25	**0.002**	0.62	**0.002**
Quality of life	− 0.18	**< 0.001**	− 0.44	**< 0.001**
Insomnia	0.16	**0.002**	0.50	**0.001**
Daytime sleepiness	0.14	**0.003**	0.29	**0.010**

Significance of bold values are $P < 0.05$

IBS cases. In contrast to the previous studies, we have compared a group of affected patients (both PD and PMS) with women affected by both PD and PMS, and not with a healthy control group.

Identifying the co-occurrence of one or more physical or psychological complications is important. The reason is that this comorbidity can lead to difficulty in making a correct diagnosis because of the confounding manifestations of a patient's main problem; it can also affect the correct interpretation of research results, and causes worse health outcomes compared to the presence of a single problem.

Previous studies have indicated that PD and PMS co-occur in 25–50% of women with IBS [25, 45]. One the other hand, in one population-based, postal study, 26% of women with PD had IBS according to Rome III after a 10-year-follow-up [46]. In addition, female with IBS experience higher sensitivity to rectal distention than female without it, especially during menstruation [16], proposing elevated visceral sensitivity within the period of reducing ovarian hormone amounts [47]. Regarding the somatic, psychological and gastrointestinal symptoms across the menstrual cycle, individuals with IBS had serious manifestations compared to healthy controls [25]. Altman and co-workers reported that the presence of PMS alone or PMS plus PD in IBS patients is associated with an exacerbation of symptoms reported during the luteal and the menses phases [48]. This suggests that the symptoms of IBS are aggravated during menses and cyclical alterations in rectal sensitivity are closely variations in response to the sex hormonal environment [16]. Therefore, it is crucial to account for concomitant other conditions that may influence symptom intensity and menstrual cycle phase in assessing treatment response. For example, the treatment of PMS woman with antidepressants which have anticholinergic features may further worsen symptoms in women with IBS-C.

Altogether, a total 16 tests of cognitive abilities, emotional/behavioral factors, sleep pattern and personality were administered to the study population. For four of these tests including depressed mood, insomnia, daytime sleepiness, and nocturnal sleep, the non-IBS participants scored significantly more favorably compared to those with IBS. It has been shown that personality and affective characteristics are main elements of the IBS biopsychosocial model, being contributed in performance and dysregulation of the brain–gut connection, and involving the formation, recurrence and relapse of IBS [49].

It has been reported that an increased level of neuroticism, conscientiousness, lie score, psychoticism, openness; while decreased values of extraversion and crime were reported in IBS patients compared to healthy control [50, 51]. In a study among adolescents from Sri Lanka, IBS cases demonstrated higher hostility and aggression, negative self-esteem and self-adequacy, emotional unresponsiveness and instability as well as negative world view versus normal cases [52]. In Korean IBS patients, anxiety and depression trait that was evaluated using the Hospital Anxiety and Depression Scale (HADS) closely associated with the degree of IBS-related symptoms [53]. In longitudinal study among Taiwanese population, IBS patients had 2.7- and 2.4-times greater risk of developing depression and sleep complication, respectively, than healthy controls [54], indicating IBS as a causal risk factor for psychiatric disorders.

Patients with IBS are more vulnerable to stressful experiences, which generate gastrointestinal manifestations [55]. Psychiatric complications are linked with variations in the formation of visceral sensations in IBS patients, which could explain the symptoms of IBS [56]. In accordance with our results, the prevalence of insomnia and sleepiness in patients with IBS was greater than healthy individuals in previous reports [57–59].

Insomnia is found in up to 20% of adults and is characterized by difficult falling asleep, maintenance of sleep, early morning awaking, poor sleep quality and lower satisfaction with sleep pattern [60]. A recent meta-analysis of published data claimed that sleep impairment was found in 37.6% of IBS patients [61]. Interestingly, in a recent survey, the coexistence of both depression and insomnia is remarkably associated with higher risk of developing IBS in comparison to each individual occurrence [62]. Balikji et al. reported that IBS symptom severity was significantly correlated with insomnia, sleep quality, sleep onset latency as well as the frequency of night awakening [63].

The brain–gut connection contributed in the pathogenesis of IBS. Sleep disturbance causes alteration of the activation of the autonomic nervous system implicating that sleep problems may be related with autonomic dysregulation [64, 65]. Moreover, IBS complaints, particularly pain, frequently have an adverse effect on sleep. One the other hand, sleep has a critical role in the immune system, and insufficient or sleep difficulty could induce immune dysfunction, which could lead in the inflammatory mucosal alterations observed in IBS cases [66, 67]. Thus, the relationship of IBS and insomnia is of a reciprocal nature. Deprivation or insufficient sleep for any reason promotes pain. These evidences propose that the improvement of sleep will decrease IBS-related pain.

As we have found, results from several observational studies did not support the casual association between IBS disease process and cognitive impairments. IBS patients were not different from healthy controls regarding the executive function, absolute IQ and recognition scores, Spatial Working Memory tests, psychomotor speed, attention and interference tests, and intelligence tests [68–70].

The question that arises is whether the severity of IBS aggravates the patients' anxiety depression and sleep problems or do their anxiety, depression and sleep problems exaggerate their IBS severity? Since this was a cross-sectional survey and not a longitudinal design, it is not possible to establish causal relationships. It is obvious that PMS symptoms and anxiety/depression or sleep problems have bidirectional and feedback impacts on each other.

Nevertheless, there are several limitations to this study. Due to its cross-sectional design of study, we were not able to determine cause and effect associations. The subjects with IBS in current work were not sub-grouped to those with IBS-C, IBS-D, or IBS-M because of the small sample size of each subtype. Thus, further investigations are also needed to study IBS population in detail and described whether menstrual patterns and associated symptoms differ between IBS subtypes.

Conclusion

IBS may be related to several psychiatric comorbidities, in particular depression, sleep problems and menstrual-associated disorders. In particular, IBS can exacerbate PMS symptoms. Another implication of the current study is the close relationship between cognitive dysfunction, depression, anxiety, sleep disturbance and PMS symptom severity. It is most likely that the severity of gastrointestinal symptoms and psychological distress collectively cause the increased reporting of severe PMS symptoms in women. So, in PMS management, it is important to increase awareness among clinicians and gynecologists concerning to the relationships between PMS and IBS.

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Author contributions AB performed all analyses and drafted the manuscript. AB, SK, MA and SM coordinated the fieldwork of the study. MS, AA, MA, NZ and HR provided methodological feedback. AB, ZH, and GF supervised the overall research project and helped to draft the manuscript. All of the authors have read and confirmed the final manuscript. All authors state that they have no conflicts of interest.

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Data availability The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval Ethical approval was obtained from the Birjand University of Medical Sciences and informed written consent was completed by all participants (code:IR.BUMS.REC.1398.160).

Informed consent Informed consent was obtained from all individual participants included in the study.

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