Original Research

Tracing the Relationships between Sleep Disturbances and Symptoms of Irritable Bowel Syndrome

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Abstract

Background and Objective: Irritable bowel syndrome (IBS) is a functional gastrointestinal disorder. Sleep disturbances are known to be common among individuals with this syndrome. This study aimed to determine the relationship between sleep quality and severity of intestinal symptoms in irritable bowel syndrome.

Materials and Methods: This cross-sectional study was carried out among 201 subjects who met the Rome III criteria for irritable bowel syndrome with no organic gastrointestinal or mental disease. Demographic data was recorded; Pittsburgh Sleep Quality Index (PSQI) and Irritable Bowel Syndrome Severity Scoring System (IBS-SSS) questionnaires were employed to measure the sleep quality, hours of sleeping in darkness and severity of intestinal symptoms. The Hospital Anxiety and Depression Scale (HADS) questionnaire was also used to measure the anxiety and depression among the subjects.

Results: Among 201 subjects, 67.2% were poor sleepers (PSQI > 5), and the average time for sleeping in darkness was 5.51 ± 1.45 hours. Anxiety and depression were significantly related to the sleep quality. Besides, the subjects with more hours of sleeping in darkness tended to have lower PSQI scores. The correlation between the global IBS-SSS and PSQI score indicated a strong relationship (P = 0.02), which became weaker after adjusting the effects of anxiety and depression (P = 0.05). Subjects with depression spent fewer hours to sleep in darkness and the mean hours of sleeping in darkness were lower in subjects with IBS symptoms compared to the group in remission.

Conclusion: There is an inverse relationship between the severity of symptoms of irritable bowel syndrome and sleep quality.

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Keywords: Irritable bowel syndrome; Sleep quality; Anxiety; Depression; Sleeping in darkness

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Introduction

One third of a human's life is spent in sleep. During sleep, the body systems more than any time in rest, are in repair and recovery. Sleep-wake cycles are regulated by the circadian clock. The circadian clock, located in the suprachiasmatic nucleus, is coordinated with the light-dark cycle over a 24-hour period. Melatonin, a hormone secreted from the pineal gland in the brain, plays an important role in the sleep-wake cycle via induction of sleepiness at the beginning of the darkness (1, 2). Melatonin is a derivative of serotonin, one of the most important neurotransmitters in sleep regulation (3, 4), and its rhythmic secretion is regulated by the suprachiasmatic nucleus. In modern life, some of sleep disturbances are associated with dysregulation of body's biological clock as a human can be continuously exposed to artificial light.

Gastrointestinal (GI) tract is the most important source of the chemicals melatonin and serotonin beyond central nervous system (CNS). Both of these chemicals play important role in GI motility (5,

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6). In some GI motility disorders such as irritable bowel syndrome (IBS) altered serotonin signaling (7) and lower melatonin metabolites are reported (8). IBS is a common functional gastrointestinal disorder which affects 3%-20% of populations worldwide (9). There is not any pathophysiological explanation for IBS and just chronic abdominal pains mostly relieving with defecation, diarrhea, constipation, and bloating are its main characteristics.

As IBS and sleep disturbances are in common in serotonin and melatonin regulation disorders (10-13), an implication comes along that these two important phenomena could have a common biochemical pathway independent of the confounding effects of other factors. Furthermore, many studies have shown that sleep has an altered architecture in patients with IBS [increase in rapid eye movement sleep (REM)] in comparison to the normal population (14-16). According to previous researches, IBS cases have a low sleep quality and more sleep disturbances in parallel with the severity of their IBS symptoms (17-20). Besides, both sleep disorders and IBS are reported to be connected with psychological disorders such as anxiety and depression (21-23).

To date no significant research is conducted to study the relation between duration of sleeping in darkness and IBS symptoms and Middle Eastern literature has not been focused on the relation between IBS severity symptoms and sleep quality among adults. The aim of this study was to assess the sleep quality of patients with IBS and correlation among sleeping in darkness, IBS severity and sleep quality in these patients.

Materials and Methods

Subjects

This cross-sectional study was carried out enrolling all 201 patients with IBS referred to the gastrointestinal clinic of Shariati Hospital, Tehran, Iran, from October 2013 to August 2014. All the participants including 131 women and 70 men (median age: 36 years, range: 16-87 years) satisfied the Rome III criteria for IBS (24): Recurrent abdominal pain or discomfort at least 3 days/month in the last 3 months associated with two or more of the following:

1) Improvement with defecation,

2) Onset associated with a change in frequency of stool,

3) Onset associated with a change in form (appearance) of stool.

These diagnostic criteria were fulfilled for the last 3 months with symptoms onset at least 6 months prior to diagnosis. Subjects were excluded if they had any chronic disease that could have interference with normal sleep or could induce any kind of pain, history of pathological disease or surgery of the GI tract or the pelvic area during the past six months, pregnancy, night works and shift works, use of opioids, use of any drugs that could interfere with normal sleep rhythm (anti-depressants, benzodiazepines, serotonergic drugs related to the GI system, etc.) and drugs that cause constipation or diarrhea.

Written informed consent was obtained from all the subjects. The study was approved by the Ethics Committee of Tehran University of Medical Sciences for clinical studies.

Questionnaire

Demographic characteristics were recorded for each patient: age, sex, body mass index (BMI), education, marital status, duration of IBS symptoms and medication.

In order to evaluate the patients' sleep quality, type of IBS, symptomatic severity of IBS, anxiety and depression, validated questionnaires were used.

The IBS type was ascertained on the basis of IBS module (Rome III criteria) and was categorized as diarrhea predominant IBS (IBS-D), constipation predominant IBS (IBS-C), alternative type with diarrhea and constipation (IBS-A).

The severity of IBS symptoms was measured using Irritable Bowel Syndrome Severity Scoring System (IBS-SSS) questionnaire (25). Our severity scoring questionnaire which had been already validated in the Iranian population (26) consisted of four components in a structure composed of five questions: 1) severity of abdominal pain or discomfort, 2) frequency of abdominal pain or discomfort, 3) severity of abdominal distension, 4) satisfaction of bowel habits, 5) the effect of IBS symptoms on quality of life. Each of the five questions generated a score from 0 to 100 leading to a total possible score of 500. Mild, moderate, and severe cases were indicated by scores of 75 to 175, 175 to 300 and > 300, respectively.

The Pittsburg Sleep Quality Index (PSQI) (27) measures self-described sleep quality over the prior month based on seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications and daytime dysfunction. Each component is scored

from 0 to 3 and the PSQI total index is calculated by summing these scores. A total score equal to 5 or higher identifies poor sleepers. In this study, a validated Iranian version of PSQI (with sensitivity of 94% and specificity of 72%) was used (28).

As an arbitrary decision to compute the duration of the subject's sleeping in darkness, we considered 8:00 p.m. as the start and 6:00 a.m. as the end of darkness; and based on the sleeping and waking times, the duration of sleeping in darkness for each individual was calculated.

The Hospital Depression and Anxiety Scale (HADS) questionnaire was used as an anxiety and depression scale (29). This questionnaire was validated among the Iranian population (30) and consisted of two "seven-component" scales for anxiety and for depression, each question with a score from 0 to 3 and consequently, each component with a score from 0 to 21. For the purpose of analysis, both of the anxiety and depression total scores were divided into four consecutive intervals: normal (0 to 7), mild (8 to 10), moderate (11 to 14), and severe (15 to 21).

Statistical analysis

Descriptive statistics including frequencies, means, and standard deviation (SD) were calculated for all components of the questionnaires.

Two independent sample t test was used to compare the means between variables have two levels and one-way ANOVA was used to compare the means between variables have more than two levels.

Multiple linear regressions were used for adjusting confounder effect of some variables. Pearson's correlation coefficient was used to measure the strength of linear correlation between variables. P-value of less than 0.05 was considered to be statistically significant. All statistical analysis was performed via the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, United States).

Results

Of 201 patients, 131 participants (65.2%) were women. The mean ± SD age of the patients was 36.67 ± 13 years. The mean ± SD of the subjects' BMI was 24.49 ± 4.34 kg/m^2. 92 subjects (45.8%) had academic education while 109 (54.2%) had education in the level of diploma and lower (Table 1).

Furthermore, 76 subjects (37.8%) suffered from constipation (IBS-C) while 52 (25.9%) suffered from diarrhea (IBS-D) and the 72 (35.8%) had alternative symptoms of diarrhea and constipation (IBS-A). According to IBS severity scoring system (25), the most frequent symptoms reported by the patients were moderate followed by severe and mild symptoms, respectively (Table 1).

The mean PSQI score of the patients was 8.19 ± 4.7, with the median of 7 and mode of 8. Poor sleepers (PSQI > 5) included 135 subjects (67.2%). The average estimated time for sleeping in darkness was 5.51 ± 1.45 hours.

Those with poor sleep quality were more likely to report severe symptoms of IBS and a significant relationship was observed between the PSQI and IBS-SSS scores (P = 0.02). Using univariate analysis, poor sleep quality was more frequent among women, and those with more severe IBS symptoms, anxiety and depressive symptoms (Table 1).

There was no significant relationship between the sleep quality scored by PSQI and IBS types, age, BMI, and marital status of the study participants (Table 1).

Assessment of the relationship between PSQI score and IBS-SSS subtypes (mild, moderate, and severe) showed that participants with severe symptoms had the highest PSQI scores (P < 0.05).

Among PSQI components, disturbing factors during night were the less frequently reported one by the participants with remission subtype (P = 0.01, mean difference < 0). Sleep latency (P = 0.02), sleep disturbances (P = 0.01), use of sleeping medications (P < 0.01), and daytime dysfunction (P = 0.04) were the PSQI components which showed significant differences between IBS severity levels.

There was no statistically significant relationship between IBS severity and sex, age, BMI, marital status, educational level, and IBS subtypes among study participants (P > 0.05).

With multiple linear regressions, we also evaluated the relationship between IBS severity and sleep quality adjusting on potential confounders (anxiety and depression), which IBS severity became weaker after adjusting for the effects of anxiety and depression (Beta: 0.13, 95% CI: -0.03-1.40) (Table 2).

Table 1. Relationship between characteristics of study participants and PSQI score

Patient features		n (%)	PSQI score*	95% CI	P value	F (df)
Total			8.19			
Age (Year)	Total	201 (100)		7.54-8.85	0.120	2.14 (2)
	≤ 35	99 (49.3)	8.16	7.31-9.00		
	35-50	71 (35.3)	7.59	6.46-8.71		
	50 <	31 (15.4)	9.68	7.55-11.79		
Sex	Total	201 (100)		7.53-8.85	< 0.001	12.3 (1)
	Male	70 (35.0)	6.64	5.74-7.54		
	Female	131 (65.0)	9.00	8.16-9.87		
BMI (kg/m^2)	Total	201 (100)		7.43-8.79	0.900	0.2 (3)
	≤ 25	105 (52.3)	8.19	7.30-9.00		
	> 25	91 (47.3)	8.32	6.90-9.17		
Education	Total	201 (100)		7.54-8.85	0.120	2.54 (1)
	Diploma and lower	109 (54.2)	8.67	7.71-9.64		
	Academic	92 (45.8)	7.61	6.75-8.48		
Marriage status	Total	201 (100)		7.54-8.85	0.490	0.7 (2)
	Married	128 (64.0)	8.33	7.47-9.19		
	Single	61 (30.0)	7.68	6.61-8.75		
	Die or depart	12 (6.0)	9.25	6.14-12.35		
IBS type	Total	201 (100)		7.45-8.75	0.250	1.4 (2)
	Diarrhea	72 (35.8)	9.00	7.69-10.38		
	Constipation	76 (37.8)	7.80	6.72-8.90		
	Alternative	52 (25.9)	7.73	6.69-8.77		
IBS severity symptoms	Total	201 (100)		7.44-8.76	0.020	3.43 (3)
	Remission	9 (4.5)	6.44	3.27-9.61		
	Mild	47 (23.0)	7.00	5.86-8.22		
	Moderate	76 (38.0)	7.73	6.67-8.79		
	Severe	66 (33.0)	9.50	8.28-10.74		
Anxiety	Total	201 (100)		7.54-8.85	< 0.001	9.88 (3)
	Normal	89 (44.5)	6.58	5.72-7.44		
	Mild	66 (33.0)	8.80	7.62-9.98		
	Moderate	28 (14.0)	9.20	7.38-11.18		
	Severe	18 (9.0)	12.22	10.30-14.14		
Depression	Total	201 (100)		7.54-8.85	< 0.001	9.72 (3)
	Normal	122 (61.0)	7.00	6.23-7.79		
	Mild	58 (29.0)	9.24	7.97-10.50		
	Moderate	16 (8.0)	12.56	10.50-14.62		
	Severe	5 (2.5)	10.80	6.73-14.86		

* Data are presented as mean.
Two independent sample t test was used to compare means between variables have two levels and one-way ANOVA was used to compare means between variables have more than two levels.
PSQI: Pittsburg Sleep Quality Index; BMI: Body mass index; IBS: Irritable bowel syndrome

Table 2. Relationship between IBS severity and sleep quality adjusting on potential confounders (anxiety and depression)

Variable	PSQI score		
	Beta	95% CI	P value
Depression	0.21	0.38–2.23	0.01
Anxiety	0.22	0.36–1.81	< 0.01
IBS severity	0.13	-0.03–1.40	0.05

PSQI: Pittsburg Sleep Quality Index; IBS: Irritable bowel syndrome

A significant reciprocal negative correlation found between duration of sleeping in darkness and sleep quality was found (Pearson correlation = -0.51, P < 0.001) (Figure 1). There was also a significant negative correlation between depression and duration of sleeping in darkness (Table 3). Patients with IBS symptoms, especially the diarrheal subtype, slept less in darkness in comparison to the patients with remission; but the observed association was not significant (Table 3).

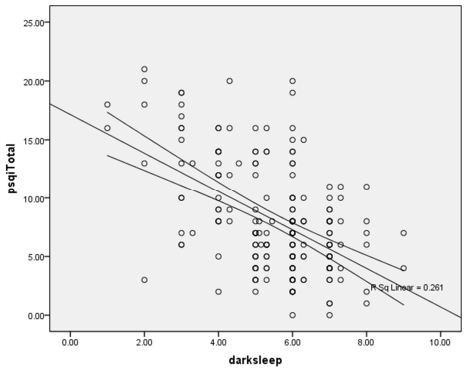

Figure 1. Scatter plot of the hours of sleeping in darkness vs. sleep quality

Table 3. Relationship between hours of sleeping in dark and clinical characteristics of study participants

Clinical Characteristic		n (%)	Sleeping in darkness (hour)*	95% CI	P value	F (df)
IBS symptoms	Total	201 (100)	5.51	5.31-5.72	0.53	0.73 (3)
	Remission	9 (4.5)	6.12	5.23-7.01		
	Mild	47 (23)	5.61	5.28-5.93		
	Moderate	76 (38)	5.4	5.03-5.77		
	Severe	66 (33)	5.49	5.11-5.87		
Anxiety	Total	201 (100)	5.51	5.30-5.72	0.41	0.94 (3)
	Remission	89 (44.5)	5.55	5.26-5.83		
	Mild	66 (33)	5.54	5.14-5.94		
	Moderate	28 (14)	5.66	5.13-6.18		
	Severe	18 (9)	5.98	4.24-5.71		
Depression	Total	201 (100)	5.51	5.31-5.71	0.03	3.02 (3)
	Remission	122 (61)	5.69	5.46-5.91		
	Mild	58 (29)	5.45	4.98-5.91		
	Moderate	16 (8)	4.7	3.89-5.52		
	Severe	5 (2.5)	4.6	3.18-6.00		

* Data are presented as mean.
Two independent sample t test was used for compare means between variables have two levels and one-way ANOVA used to compare means between variables have more than two levels.
IBS: Irritable bowel syndrome

Discussion

Current study confirmed that poor sleep quality has a significant association with the severity of IBS symptoms (according to the IBS-SSS scoring tool). This relation was distinct from the influences of anxiety and depression on the sleep quality and IBS symptoms (21-23) as high prevalence of anxiety and psychological disorders has been shown to increase intestinal response to psychological distress (31). Bellini et al. study (18) also showed latent links between IBS severity symptoms and sleep quality in patients with IBS without any psychological distress. However, they showed a weak relationship between the total IBS-SSS and PSQI scores at first (r = 0.2 and 95% CI: -0.03-0.35, P = 0.18); so the item response theory (IRT) model was used to find the links between the two variables. In this study, we found a strong relationship between the total IBS-SSS and PSQI scores by analyzing the variances and adjusting the effects of potential confounders.

The higher rate of daytime dysfunction among patients with IBS and more severe symptoms in this study confirms the results of a study in Japan (19) which showed a higher rate of daytime sleepiness in patients with IBS in contrast with asymptomatic subjects.

Moreover in the study of Wu et al., (17) the scores of three components of PSQI (sleep quality, sleep disturbances and daytime dysfunction) were higher among patients with IBS without anxiety and depression compared with control subjects; whereas the scores of six components of PSQI (sleep quality, sleep latency, sleep efficiency, sleep disturbances, sleep duration and daytime dysfunction) were higher among patients with IBS and with anxiety and depression in comparison with control subjects. These results can imply a relationship between the three components (sleep latency, sleep efficiency, and sleep duration) and psychological factors. In this study the component "sleep latency" was one of the four components having a significant relationship with IBS severity which could be a reason for the weakening of relationship between IBS severity symptoms and PSQI scores after adjusting the effects of anxiety and depression.

Considering demographic characteristics, there was a sex-related sleep quality issue in patients with IBS; poorer sleep quality among women which was similar to the results of other studies organized among normal populations (32, 33). These studies stated that women are more likely than men to have trouble falling asleep and staying so, and to frequently wake up feeling not well-rested. Findings from clinical and basic research studies strongly implicate a role for sex steroids in sleep modulation.

Some studies provided conclusions that altered serotonin and melatonin metabolism and signaling were found in the GI tract of patients with IBS (7, 10). Besides, melatonin had the effect of lowering GI motility (8) while patients with IBS had a lower serum level of melatonin (34). As brain melatonin is a substance secreted by the beginning

of darkness and sleeping in darkness had a significant relationship with the sleep quality of the subjects, in this study we considered the duration of sleeping in darkness as a parameter to find out its relations with the other characteristics of patients with IBS.

One of our observations was the higher rate of depression among the subjects with shorter duration of sleeping in darkness; the reason could be explained by the result of a study stating that misalignment between the timing of sleep and the circadian pacemaker is linked to depression symptoms (35). This could also lead to the lower production of melatonin during the short period of sleeping in darkness, as it is seen that nocturnal serum levels of melatonin in the patients with depression are lower than the normal population (36). While melatonin is a modifier of the GI motility which improves the IBS symptoms (37), it was expected that the severity of IBS symptoms would be worse in the depressed population with shorter durations of sleeping in dark. The results of this research did not show any relation between the dark sleep duration and IBS symptoms neither in the group with signs of depression, nor in the whole population, which could be due to the inadequate sample size of the research.

Our study had two advantages. This study considered the hours of sleeping in darkness in patients with IBS to find a correlation with the severity of IBS, based on the fact that melatonin is a chemical functioning on both the GI tract and brain, reducing bowel movements and inducing sleepiness during the darkness. The other advantage was measuring the patient's anxiety and depression in order to rule out their confounding effects.

As a limitation of this study, it was a cross-sectional study, performed in a tertiary care center, so it might has not provided a realistic view about the population and it could not be able to find any causation between the variables. The inadequate sample size of the research might have prevented observing the true relation between IBS severity symptoms and duration of sleeping in the darkness. Using the PSQI scoring system to assess the sleep quality as a whole, without focusing on any specific aspect of the sleep was another limitation while there are other tools such as Epworth Sleepiness Scale (ESS) (38) or Insomnia Severity Index (ISI) (39) can evaluate the outpatient's sleepiness and insomnia severity separately and detect the effects of sleep disturbances on daily life. Therefore, additional studies employing various parameters to evaluate sleep disturbances and abdominal symptoms are needed to confirm and expand our findings. Furthermore, in this study, we did not investigate several factors, such as the mental state, environmental conditions or drinking and smoking habits of our participants, which have been demonstrated to affect sleep (40-44). Either case control or interventional studies are needed to be utilized in order to find the causal effects between IBS symptoms, sleep quality and sleeping in darkness.

Conclusion

In conclusion, we found that there might be an inverse relationship between the severity of IBS symptoms and sleep quality. Sleep quality was directly related to the hours of sleeping in dark. Subjects with depression spent less hours of sleeping in darkness and the mean hours of sleeping in darkness were lower in the group with IBS symptoms in comparison with the group in remission. The findings of this study may indicate that improving sleep habits can have a role in ameliorating IBS symptoms and psychological distress.

Conflict of Interests

Authors have no conflict of interests.

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