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The Impact of Rotating Shift Work on the Prevalence of Irritable Bowel Syndrome in Nurses

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Abstract

OBJECTIVES—Shift work has been associated with gastrointestinal symptoms such as abdominal pain, constipation, and diarrhea. These symptoms overlap with those reported by patients with functional bowel disorders. Because shift work will lead to misalignment between the endogenous circadian timing system and the external 24 h environment, we hypothesized that nurses participating in shift work will have a higher prevalence of functional bowel disorders when compared with nurses participating in day shifts.

METHODS—Nurses engaged in patient care were invited to complete Rome III, irritable bowel syndrome–quality of life measure (IBS-QOL) and modified Sleep-50 questionnaires. Respondents were classified as working day, night, or rotating shifts. The prevalence of IBS, functional constipation, functional diarrhea, and individual gastrointestinal symptoms was determined.

RESULTS—Data were available for 399 nurses (214 day shift, 110 night shift, and 75 rotating shift workers). Rotating shift nurses had a significantly higher prevalence of IBS compared to day shift nurses (48% vs. 31%, $P < 0.01$). Multivariable logistic regression correcting for age, gender, and sleep quality proved this association robust. IBS-QOL scores among groups were similar. Prevalence of functional constipation and functional diarrhea was similar between groups. Rotating shift nurses had a significantly higher prevalence of abdominal pain compared to day shift (81% vs. 54%, $P < 0.0001$) and night shift workers (61%, $P = 0.003$).

CONCLUSIONS—Participation in shift work, especially rotating shift work, is associated with the development of IBS and abdominal pain that is independent of sleep quality. Circadian rhythm disturbances may have a function in the pathogenesis of IBS and abdominal pain.

INTRODUCTION

Functional bowel disorders are symptom-based gastrointestinal disorders that are commonly encountered in the general population (1). The most common functional bowel disorder is

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CONFLICT OF INTEREST

Guarantor of article: Willemijntje A. Hoogerwerf, MD.

Specific author contributions: William D. Chey and Willemijntje A. Hoogerwerf conceptualized the study; Borko Nojkov collected the data; and Joel H. Rubenstein analyzed the results. Borko Nojkov, Joel H. Rubenstein, William D. Chey, and Willemijntje A. Hoogerwerf made substantial contributions to the intellectual content of the paper (design, interpretation of the data, writing of the paper).

Potential competing interests: Borko Nojkov, Joel H. Rubenstein, and Willemijntje A. Hoogerwerf have no conflicts of interest relevant to this paper. William D. Chey is a consultant to Albireo, Aryx, Axcan, AstraZeneca, Ironwood, Proctor & Gamble, Prometheus, Salix, SmartPill, Takeda, and XenoPort, and is on the speaker's bureau for Axcan, Prometheus, Salix, and Takeda.

irritable bowel syndrome (IBS), which is defined by the presence of abdominal pain or discomfort in association with altered bowel habits (1). The etiology of IBS is unknown but alterations in motility, visceral sensitivity, intestinal barrier function, genetics, and psychological makeup have been implicated in its pathogenesis (2–6). In addition, although controversial, IBS has been associated with sleep disorders (7–9).

The aim of this study was to determine whether disruption of biological rhythms through the participation in shift work was associated with functional bowel disorders. The basis for this study was formed by several observations. First, disruption of biological rhythms secondary to shift work, travel across different time zones, or space flights has been associated with gastrointestinal symptoms such as abdominal discomfort, constipation, or diarrhea (10–15). These symptoms overlap with those reported by patients with functional bowel disorders. Second, chronic disruption of biological rhythms due to shift work has been associated with the development of serious gastrointestinal disease. For example, data from the Nurses Health Study showed that women who worked at least three rotating nights per month for 15 or more years had a significantly greater risk of developing colorectal cancer when compared to women who never worked rotating night shifts (16). Third, a recent clinical study showed that melatonin, a known regulator of circadian rhythms, can improve IBS symptoms (17). To better understand the association between disruptions in circadian rhythms and functional bowel disorders, we conducted a cross-sectional observational study to determine the prevalence of IBS, functional constipation, functional diarrhea, and individual gastrointestinal symptoms among nurses participating in shift work. To assess whether functional bowel disorders result from disruption in biological rhythms (chronodisruption (18)), we also assessed sleep quality to control for the possible confounding function of sleep. We hypothesized that the prevalence of functional bowel disorders would be greatest in nurses participating in rotating shifts (as opposed to permanent day or permanent night shift workers) as those individuals are most likely to develop a chronic misalignment of the endogenous circadian timing system with the external 24 h environment. We also hypothesized that the effect of shift work on the prevalence of functional bowel disorders would be independent of the quality of sleep.

METHODS

Study subjects

All nurses employed within the University of Michigan Health System Nursing Department were contacted by e-mail (approximately 2,500 nurses). Subjects were incentivized to participate by automatic enrollment into a drawing for one of four gift certificates. Nurses interested in participating in the study were directed to the web-based study surveys. All survey materials were collected without identifying information. The study protocol was reviewed and approved by the institutional review board of University of Michigan. The study recruitment period was between November 2007 and February 2008.

Enrolled subjects were classified into three groups: (i) nurses working permanent day shifts, (ii) nurses working permanent night shifts, and (iii) nurses rotating between day and night shifts. This classification was based on each subject's response to the following question: "What best describes your work schedule?"

Subjects with a self-reported organic gastrointestinal disorder (peptic ulcer disease, inflammatory bowel disease, malignancy, gallbladder disorder, pancreatitis, or liver disease), previous surgery of the gastrointestinal tract, current pregnancy, or breast-feeding were excluded from the analyses. Subjects who were not involved in direct patient care or who did not complete all required study questionnaires were also excluded from the final analysis.

Questionnaires

All subjects completed the following surveys:

1. General demographic form, including questions on age, sex, race, height, weight, chronic medical conditions, medical history, and medications used. In addition, data were gathered on specific work schedules, length of particular shift–work schedule, and specific job description.
2. IBS modules from the Rome III questionnaire (available at http://www.romecriteria.org/criteria/). This validated survey was used to identify subjects with IBS and classify them into the following subgroups: constipation-predominant IBS, diarrhea-predominant IBS, mixed IBS, or unsubtyped IBS subgroups. Questionnaires were also used to establish the prevalence of functional constipation and functional diarrhea.
3. Irritable bowel syndrome–quality of life measure (IBS-QOL). This is a validated 34-item survey developed to assess the impact of IBS symptoms on disease-specific quality of life (19). A higher score on this scale correlates with a better quality of life.
4. Modified Sleep-50 questionnaire. This questionnaire is designed to detect sleep disorders as listed in the *Diagnostic and Statistical Manual of Mental Disorders*. Three items from the Sleep-50 were used to assess overall sleep quality ("Generally, I sleep badly," "I feel sleepy during the day and struggle to remain alert," and "I have difficulty falling asleep").

Statistical analysis

On the basis of an assumed IBS prevalence of 15% in nurses working permanent day shifts, we calculated a required sample size of at least 213 day shift participants and 71 participants in each of the other shift work groups to detect an odds ratio of 2.5 with a power of 80 %. Comparisons of continuous variables were made with analysis of variance. Comparisons of categorical variables between groups were made with χ^2-test or Fisher's exact test. For the comparison of items of the Sleep-50 questionnaire with bowel symptoms, the Bonferroni correction was used to assess statistical significance due to the multiple comparisons ($P \leq 0.00017$ was considered significant). Multivariate logistic regression was also performed for IBS and individual symptoms.

RESULTS

General information

Of 2500 nurses, 552 (22.0 %) completed the surveys online. Following application of exclusion criteria as defined in the method section, 399 nurses were included in the final analyses. Of the 399 nurses, 214 reported working day shift, 110 reported working night shifts, and 75 reported working rotating shifts. Table 1 summarizes demographic characteristics of the nurses in the three groups. More than 85% of respondents were women. Night shift and rotating shift nurses were younger than day shift nurses. Day shift nurses had significantly longer work experience compared to night shift and rotating shift nurses. There were no significant differences in body mass index between groups.

There were no differences in the use of medications for gastrointestinal symptoms, antidepressants, sedatives/hypnotics, thyroid replacement, medications for diabetes mellitus, hormone replacement therapy, or vitamins/minerals.

Prevalence of functional bowel disorders and individual bowel symptoms

The prevalence of IBS, functional constipation, and functional diarrhea in the three groups of nurses are summarized in Table 2. The prevalence of IBS was significantly higher in rotating shift nurses when compared with day shift nurses. When IBS subtypes were assessed, the prevalence of mixed IBS in rotating shift nurses was significantly higher when compared with nurses working day or night shift s. Diarrhea-predominant IBS was more common in nurses working night shifts when compared with nurses working day shifts. There was a trend toward a statistically significant difference in the prevalence of diarrhea-predominant IBS between night shift nurses and rotating shift nurses (P=0.06). Three nurses fit into the category of unsubtyped IBS (two day shift workers and one night shift worker). Due to the small number of individuals with unsubtyped IBS, this group was excluded from the subgroup analysis. The prevalence of functional constipation and functional diarrhea defined by the Rome III criteria was similar between the three groups of nurses.

In patients fulfilling criteria for IBS, the specific impact of IBS on quality of life was assessed using the IBS-QOL instrument. There were no significant differences in mean total scores on IBS-QOL between nurses with IBS working day, night, or rotating schedules (IBS-QOL mean scores were 84.3, 87.2, and 85.6 for each of the three groups, respectively, P=NS).

We also assessed the prevalence of individual IBS and bowel-associated symptoms among the three shifts. The presence of abdominal pain or discomfort was reported significantly more frequently in rotating shift nurses compared with day (81% vs. 54%, P<0.0001) and night shift nurses (61 %, P<0.003 vs. rotating nurses). There was no significant difference in the prevalence of any other individual gastrointestinal symptoms examined, including the presence of loose, mushy or watery stools, hard or lumpy stools, less then three bowel movements per week, difficulty to evacuating stools, sensation of incomplete stool emptying, or feeling that the stool could not be passed.

Sleep disturbances and bowel symptoms

The occurrence of IBS and individual bowel symptoms was examined for association with the presence of disturbed sleep. Positive answers to three items from the modified Sleep-50 instrument assessing sleep quality (“Generally, I sleep badly,” “I feel sleepy during the day and struggle to remain alert,” and “I have difficulty falling asleep”) were compared with the presence of IBS. There were significant associations between each of the three sleep quality indicators and the presence of IBS regardless of responder’s work shift schedule (Table 3). Similar findings were shown for the presence of abdominal pain (data not shown).

Multivariate logistic regression analysis

Table 4 shows the association between type of shift work and sleep quality with IBS, adjusted for each other, age, and gender. Participation in rotating shift work is significantly associated with having IBS, even after adjustment for sleep quality. Night shift work was not associated with IBS compared with day shift. Poor sleep quality is associated with IBS. Similar associations for abdominal pain were also shown (Table 5). Adjusting for years of nursing experience rather than age resulted in similar estimates of the effects of shift work.

There was no association between the number of years, adjusted for age, for which nurses participated in night or in rotating shifts and IBS. Similarly, there was no association between the number of years, adjusted for age, for which nurses participated in night or in rotating shifts and abdominal pain.

DISCUSSION

Our findings suggest that nurses participating in shift work, particularly those that participate in rotating shift work, have a higher prevalence of IBS and abdominal pain. This association is independent of quality of sleep.

Previous work has reported a higher prevalence of gastrointestinal symptoms among persons working non-daytime shifts when compared to those working days (10,12,13,15). Only one previous study specifically looked at the prevalence of functional bowel disorders among persons working rotating shifts (14). Our results are similar to this smaller study from Singapore (118 participants — 60 day vs. 58 rotating shifts), which found the prevalence of functional bowel disorders to be 38% in nurses working rotating shifts vs. 20 % in day shift nurses (P=0.04).

To our knowledge, this is the first study to use the Rome III criteria to identify the prevalence of IBS, functional diarrhea, and functional constipation among shift workers. The use of the Rome III criteria, which require 3 days of symptoms in the past month, likely explains the relatively high prevalence of IBS identified in our study. In a *post hoc* analysis of our data using a more stringent symptom threshold of greater than 2 days per week of abdominal pain or discomfort, the prevalence of IBS decreased substantially (day shift 13%, night shift 19%, rotating shifts 21%). Though trends remained apparent using this more stringent symptoms threshold, differences between groups were no longer statistically significant (day vs. rotating shifts P = 0.09), perhaps due to limited statistical power for discerning differences at those lower prevalence.

There was no significant difference in IBS-related quality of life between rotating, night, and day shift nurses with IBS. It should be noted that responders from the three groups had relatively high overall scores on the IBS-QOL survey, suggesting that they all reported low impact of their IBS symptoms on disease-specific quality of life. This may, again, be related to the use of the less-restrictive Rome III criteria that are more likely to capture individuals with milder IBS symptoms.

Older studies that attempted to assess the association between sleep disturbances and IBS yielded conflicting results (7–9). Results from our study suggest that sleep disturbances do not provide a complete explanation for the association between IBS or abdominal pain and shift work. In a logistic regression analysis, we found an association between IBS or abdominal pain and shift work even after controlling for sleep quality. This finding supports our hypothesis that the increased prevalence of IBS in rotating shift workers may be representative of circadian disruption rather than the consequence of sleep disturbance.

Our results suggest that the presence of pain was forcing the increased prevalence of IBS in rotating shift workers. Interestingly, a recent study showed significant circadian variations in the perception of rectal distension in healthy volunteers (20). Furthermore, a recent clinical study showed that the administration of melatonin, a known regulator of circadian rhythms, can improve IBS symptoms by decreasing pain without altering colonic motility (17). Thus, it is conceivable that disruption of circadian rhythms, to which rotating shift workers are particularly prone, will lead to alterations in circadian physiology that modulate visceral sensitivity. Improvement in pain symptoms after the administration of melatonin may result from the restoration of circadian rhythmicity.

At a molecular level, circadian rhythms are controlled by clock genes. Recent studies have shown that clock genes are expressed within mouse epithelial cells and myenteric plexus, suggesting a potential function for clock genes in coordination and modulation of cell proliferation, differentiation, motility, and nociception (21–23). We therefore speculate that

disruptions of this molecular clock may lead to alterations in colonic physiology and, ultimately, to gastrointestinal symptoms. The mechanism responsible for the higher prevalence of pain (and not diarrhea or constipation) in those individuals participating in rotating shift work remains to be determined. However, melatonin (a regulator of circadian rhythms) has been shown to improve abdominal pain in patients with IBS without altering stool transit time (17). This effect of melatonin is independent of its effect on sleep patterns. In addition, visceral sensitivity in response to rectal balloon distention differs over the time of day (20). Taken together, these findings suggest that visceral pain sensation follows a circadian rhythm that is mediated through melatonin. Some studies have suggested that colonic motility follows a circadian rhythm as well (24). Thus, one would expect constipation and diarrhea to be more prevalent in rotating shift workers as well. This "dichotomy" in terms of the selective effect of shift work on pain but not bowel frequency and/or consistency may be reflective of the ability of the colon to respond to abrupt changes in environmental conditions without compromise of colonic motility whereas nociceptive mechanisms are more easily compromised for reasons that are yet to be determined.

When interpreting our results, a number of limitations should be taken into consideration. First, our study population consisted of a convenience sample of nurses that might influence the generalizability of our results to the population at large. Second, the overall response rate was relatively low, which raises concerns about how representative the respondents were of the total population of nurses invited to participate. Third, it is conceivable that individuals with higher degree of anxiety or psychological distress, or those with other co-morbidities (including IBS) require more time off work, and are therefore more likely to participate in night or rotating shift work. This could relate to our results as such individuals might have had IBS symptoms before their participation in night or rotating shift work. We were reassured to find that the gender distribution, mean age, and years of experience of study respondents were similar to the overall population of nurses employed at our medical center. In terms of a potential participation bias of rotating shift workers with IBS, the nature of the surveys, with its focus on gastrointestinal symptoms, is such that it is conceivable that the percentage of those responding to the surveys were more likely to suffer from gastrointestinal symptoms, regardless of the shift they worked.

As in any observational study, there may have been unmeasured confounders. For instance, the presence of psychological distress and/or anxiety was not formally assessed in our study population. However, indirect measures of stress and/or anxiety were assessed by reviewing self-reported use of antidepressants and sedatives in each of the three study groups. No major differences were identified in the reported usage of antidepressants (19% day, 21% night, and 18.7% rotating shift nurses) or sedatives (4.5% day, 2% night, and 5% rotating shift workers) between the groups. Still, different shifts may produce different levels of work-related stress, or may be associated with variations in dietary habits or physical activity, all of which could impact on IBS symptoms.

In summary, our findings suggest that nurses participating in shift work and in particular, those working rotating shifts, are at significantly increased risk of developing IBS and abdominal pain compared to persons working a standard daytime schedule. Practicing gastroenterologists should be aware of this association and educate patients with IBS on the possible impact of their work schedule on their symptoms. As the United States has become increasingly dependent upon shift workers to meet the demands of globalization and our 24 h society, the impact of shift work on gastrointestinal health and disease will require further studies at both a clinical and basic science level.

Study Highlights

WHAT IS CURRENT KNOWLEDGE

- Irritable bowel syndrome (IBS) is the most common of functional bowel disorders, and its etiology, although not completely understood, is likely multifactorial.
- IBS has been associated with sleep disorders, although this relationship remains controversial.
- Disruption of biologic rhythms secondary to night shift work has been associated with gastrointestinal symptoms.

WHAT IS NEW HERE

- IBS and abdominal pain (but not functional diarrhea and functional constipation) are more common in nurses participating in rotating shift work as opposed to permanent night or day shift work.
- The association between IBS and night/rotating shift work is independent of sleep quality.
- This is the first study to use the Rome III criteria to examine the relationship between shift work and functional bowel disorders in a large US cohort.

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Table 1

Study population demographics

	Permanent day shift workers (*n* =214)	Permanent night shift workers (*n*=110)	Rotating shift workers (*n*=75)	*P* value
Age (years)	45.6±9.3	41.5±11.0	37.3±10.8	<0.0001
Male/female (% males)	20/194 (9.4%)	11/98 (10.1%)	10/65 (13.3%)	NS
BMI	27.6±6.7	28.9±7.2	27.5±6.6	NS
Nursing experience (years)	19.6±10.3	12.9±11.2	11.0±10.3	<0.0001

BMI, body mass index.

Table 2

Prevalence of functional gastrointestinal disorders stratified by work schedule

	Permanent day shift workers (*n*=214)	Permanent night shift workers (*n*=110)	Rotating shift workers (*n*=75)	*P* value
IBS	66 (31.3%)	44 (40.0%)	36 (48.0%)	NS for day vs. night <0.01 for day vs. rotate NS for night vs. rotate
IBS-M	46 (21.5%)	25 (21.8%)	26 (34.7%)	NS for day vs. night 0.02 for day vs. rotate 0.05 for night vs. rotate
IBS-D	10 (4.7%)	13 (11.8%)	3 (4.0%)	0.02 for day vs. night NS for day vs. rotate 0.06 for night vs. rotate
IBS-C	9 (4.2%)	5 (4.6%)	6 (8.0%)	NS between each of the groups
Functional constipation	29 (13.6%)	15 (13.6%)	10 (13.3%)	NS between each of the groups
Functional diarrhea	4 (1.9%)	6 (5.5%)	3 (4.0%)	NS between each of the groups

IBS, irritable bowel syndrome; IBS-C, constipation-predominant IBS; IBS-D, diarrhea-predominant IBS; IBS-M, mixed IBS.

Table 3

Associations between sleep quality and IBS stratified by shift status

	Day shift			Night shift			Rotating shift		
	No IBS (*n*=147)	**IBS (*n*=67)**	***P* value**	**No IBS (*n*=66)**	**IBS (*n* =44)**	***P* value**	**No IBS (*n*=39)**	**IBS (*n*=36)**	***P* value**
"I feel sleepy during the day and struggle to remain alert"	22.2% (32)	52.4% (33)	<0.0001	37.5% (24)	79.1% (34)	<0.0001	22.2% (8)	55.6% (20)	0.003
"Generally I sleep badly"	30.0% (40)	51.6% (33)	0.001	20.3% (13)	51.2% (22)	<0.001	16.7% (6)	47.2% (17)	0.005
"I have difficulty falling asleep"	34.5% (50)	50.8% (32)	0.03	26.6% (17)	58.4% (25)	0.001	30.4% (17)	68.8% (11)	0.005

IBS, irritable bowel syndrome.

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Table 4

Multivariate logistic regression for presence of IBS

Effect	Odds ratio	95% Confidence interval
Shift (rotating vs. day)	2.14	1.14 –3.03
Shift (night vs. day)	1.18	0.67 –2.07
“Generally I sleep badly” (yes vs. no)	1.53	0.87 –2.67
“I feel sleepy during the day and struggle to remain alert” (yes vs. no)	3.64	2.19 –6.05
“I have difficulty falling asleep” (yes vs. no)	2.05	1.22 –3.45
Age (per 1 year increment)	0.99	0.97 –1.02
Gender (male vs. female)	0.88	0.41 –1.92

Table 5

Multivariate logistic regression for abdominal pain

Effect	Odds ratio	95% Confidence interval
Shift (rotating vs. day)	2.80	1.35 –5.80
Shift (night vs. day)	0.97	0.56 –1.69
“Generally I sleep badly” (yes vs. no)	2.00	1.09 –3.64
“I feel sleepy during the day and struggle to remain alert” (yes vs. no)	1.85	1.08 –3.17
“I have difficulty falling asleep” (yes vs. no)	2.18	1.28 –3.70
Age (per 1 year increment)	0.94	0.92 –0.96
Gender (male vs. female)	0.59	0.28 –1.23