

Examining the Association Between Insomnia and Bowel Disorders in Canada: Is There a Trend?

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ABSTRACT

OBJECTIVE: Sleep is critical for one's health and well-being, including the prevention and/or management of certain chronic health conditions. If one suffers from insomnia (trouble falling asleep or staying asleep), he/she may be at risk of developing bowel disorders such as irritable bowel syndrome. To our knowledge, there is little information in Canada linking insomnia to bowel disorders. Our goal was to employ a population-based study to ascertain the association between insomnia and bowel disorders as well as to determine if a trend exists in the relationship.

METHODS: The data originated from the Canadian Community Health Survey Cycle 1.1. The outcome variable was whether an individual has a bowel disorder (yes/no response). The primary explanatory variable was individuals who reported having trouble sleeping most of the time (insomnia). Odds ratios were calculated to determine the association of suffering from a bowel disorder if one has insomnia.

RESULTS: We found there was a strong relationship between insomnia and bowel disorders (unadjusted odds ratio 3.73; 95% CI: 3.37 to 4.12). This association remained statistically significant (adjusted odds ratio 2.79; 95% CI: 2.51 to 3.10) even when adjusted for sex, age, self-perceived stress and the presence of chronic fatigue syndrome in our multivariate logistic regression model. We demonstrated a stepwise trend such that an increase in frequency of trouble sleeping was associated with a greater incidence of bowel disorder.

CONCLUSION: We found a strong association between insomnia and the likelihood of suffering from a bowel disorder in the Canadian population.

KEYWORDS: *insomnia, bowel disorders, Canadian Community Health Survey (CCHS), Crohn's disease, irritable bowel syndrome*

INTRODUCTION

Sleep is vital from both a physical and psychological perspective. However, some individuals chronically suffer from poor quality of sleep. Insomnia, defined in laymen's terms as trouble falling asleep or staying asleep, affected nearly a quarter of the Canadian population aged 15 and older in a 1991 study.^{1,2} A recent North American study suggests that the current prevalence of insomnia may be as high as 40% and that this level is likely to increase in the future.³ A person with insomnia experiences reduced daily functioning and suffers from psychomotor impairment, which adversely affects both personal and professional activities.⁴ It is also hypothesized that insomnia is a contributing factor in the development of various adverse health outcomes. Bowel disorders, such as Crohn's disease and irritable

bowel syndrome (IBS), are believed to be partially caused by insomnia due to disruptions to the autonomic nervous system.^{5,6} Both Crohn's disease and IBS are chronic bowel disorders that can cause severe and disabling abdominal pain. With respect to Crohn's disease among Canadians, recent evidence suggests the incidence rate and prevalence are 13.4/100,000 and 233.7/100,000 respectively, reflecting some of the highest figures in the world.⁷ According to Thompson *et al.*,⁸ 12.1% of Canadians suffer from IBS. As a result, the estimated annual cost of IBS to Canada is almost \$1.4 billion, which includes both direct and indirect costs.⁹ This approximation is even more disturbing given there is currently no cure for either disease.

Our review of the literature suggests although there is evidence linking insomnia with bowel disorders, it is relatively limited. Goldsmith and Levin were the first to find that sleep deprivation among healthy volunteers elicited irritable bowel-like symptoms.¹⁰ However, with only 23 subjects, drawing

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generalizations from their results is restricted. In their study consisting only of women, Jarrett *et al.*¹¹ concluded that poor sleep leads to more reported gastrointestinal symptoms, even when controlling for psychological distress and stress. Working shifts has also been shown to affect sleep patterns – the level of sleep disturbance has been likened to that of clinical insomnia.¹² Not surprisingly, nurses who worked rotating shifts were found to experience more functional bowel disorders than those who worked non-rotating shifts.¹³ However, the study was limited by a small sample size and examined a specific cohort of workers, which is not necessarily representative of the general population. To our knowledge, there are only two population-based studies available on the topic of insomnia and its relationship to bowel disorders. In one study, the authors found a positive and statistically significant association between sleep disturbance and IBS (OR 1.6; 95% CI: 1.1 to 2.2).¹⁴ In a follow-up study involving the same cohort, the authors found as sleep disturbances increased, so did the frequency of reported gastrointestinal symptoms.¹⁵ However, both these studies were restricted to a small county in Minnesota, therefore limiting their external validity.

Given the burden of bowel disorders in Canada as well as the dearth of information on this matter, we conducted an investigation to test the hypothesis that insomnia increases the likelihood of suffering from bowel disorders among Canadians. To our knowledge, a population-based study examining such an association has not been conducted in Canada. The objectives of our study are to: 1) determine the prevalence of both insomnia and bowel disorders in Canada using a recent health survey database; 2) identify the characteristics of those who have self-reported bowel disorders; 3) ascertain if there is a relationship between insomnia and bowel disorders for Canadians aged 12 and older; and 4) should a relationship exist, establish if there is a trend.

MATERIALS AND METHODS

Data Source

Our data is from the Canadian Community Health Survey (CCHS), Cycle 1.1, conducted by Statistics Canada.¹⁶ The CCHS is a cross-sectional survey collecting responses from persons aged 12 or older, living in private occupied dwellings with questions related to health status, health care utilization, and health determinants for the Canadian population. Excluded from the sampling frame are individuals living on Indian Reserves and on Crown Lands, institutional residents, full-time members of the Canadian Armed Forces, and residents of certain remote regions. The CCHS Cycle 1.1 covered approximately 98% of the Canadian population aged 12 or older representing 136 health regions across the country.

Study-specific ethics approval was covered by the publicly available data clause (Item 1.3.1) governing the use of public release data set under the University of British Columbia's Policy #89 – Research and Other Studies Involving Human Subjects.

Collection for CCHS Cycle 1.1 took place between September 2000 and November 2001. In this time frame, a total of 136,937 households were approached to participate in the CCHS Cycle 1.1. Of these, a response was obtained for 125,159, which resulted in an overall household-level response rate of 91.4%. Among these responding households, 142,421 individuals were asked to participate in the interviews (conducted using computer-assisted interviewing). Excluded from our analysis were respondents with missing or unknown values for the six variables of interest in our study (outlined below). As a result, our analytic sample contained a total of 110,752 respondents.

Outcome Variable

Survey respondents were asked, “Do you have a bowel disorder such as Crohn’s Disease or colitis?” A dichotomous response (yes/no) was recorded.

Independent Variables

Primary Explanatory Variable

Survey respondents were asked, “How often do you have trouble going to sleep or staying asleep?” Available response categories were “most of the time”, “sometimes”, “never”, and “don’t know”. For the purposes of our study, those who answered that they had trouble going to sleep “most of the time” were deemed to be suffering from insomnia. This definition is similar to what has been used in the past for other epidemiological studies measuring insomnia.²

Potential Confounders

Age, sex, self-perceived stress, and chronic fatigue syndrome were selected as potential confounders in the statistical analyses.

Stress was included in the analysis as a possible confounder since Sutton *et al.*² observed an association between stress and insomnia. Stress has also been reported to affect the gastrointestinal system resulting in changes in bowel pattern and abdominal pain or discomfort.¹⁷ For CCHS Cycle 1.1, the question employed in our analysis was related to self-perceived stress in an individual’s life. Respondents were asked to answer this question using the following five options provided in the survey: 1) not at all stressful; 2) not very stressful; 3) a bit stressful; 4) quite a bit stressful; and 5) extremely stressful.

Another potential confounder is if an individual suffers from chronic fatigue syndrome. In their review article, Afari and Buchwald¹⁸ found that chronic fatigue syndrome patients report more difficulty falling asleep. The authors also found that this syndrome often co-occurs with other functional illnesses such as irritable bowel disorder. Survey respondents were asked “Do you have chronic fatigue syndrome?” with a response choice of either yes or no.

Statistical Analysis

The prevalence of insomnia and bowel disorders in the Canadian population (aged 12+) was determined by frequency tabulations. The data set was stratified by the presence or absence of bowel disorders and was subsequently characterized by study variables including age, sex, and other health related questions e.g. self-perceived health and activity level. Chi square analyses were conducted to ascertain an association between the outcome variable and each of the various explanatory variables.

We calculated bivariate odds ratios to estimate the probability of suffering from bowel disorders associated with insomnia. Unadjusted models were also created for each of the independent variables to investigate their association with bowel disorder. All the independent variables were then entered into a multivariate logistic regression model to obtain odds estimates of experiencing bowel disorders if suffering from insomnia adjusted for the presence of the other independent variables in the model. An *a priori* decision was made to include all explanatory variables in the final multivariate logistic regression model as these variables were selected for analysis based on literature findings.

In order for the data from the survey responses to be representative of the household population of Canada (aged 12+), a survey weight was applied to each person who responded to the survey to provide an estimate of who they represented

Table 1. Profile of Study Participants Overall and by the Presence of Bowel Disorder, CCHS Cycle 1.1 (N = 110,752).

Characteristic	% Overall*	Bowel Disorder		p-value
		Yes	No	
Sex				
Male	47.53	30.10	47.94	<0.0001
Female	52.47	69.90	52.06	
Age				
12 to 19	3.35	0.95	3.41	<0.0001
20 to 29	17.55	12.54	17.67	
30 to 39	20.52	16.05	20.63	
40 to 49	22.13	22.72	22.11	
50 to 59	15.78	19.76	15.68	
60 to 69	10.26	11.62	10.23	
70 to 79	7.40	11.28	7.31	
80+	3.00	5.08	2.95	
Self-perceived stress				
Not at all	12.75	9.02	12.84	<0.0001
Not very	21.76	18.08	21.85	
A bit	39.73	38.58	39.75	
Quite a bit	21.13	26.65	21.00	
Extremely	4.63	7.68	4.56	
Chronic fatigue syndrome				
No	99.16	95.96	99.23	<0.0001
Yes	0.84	4.04	0.77	
Frequency – trouble sleeping				
Never	51.96	31.08	52.45	<0.0001
Sometimes	34.01	38.75	33.89	
Most of the time (insomnia)	14.03	30.17	13.55	

*Weighted percentage according to Statistics Canada

p<0.05 was considered statistically significant for examining the correlation of each listed characteristic with the study's outcome variable (bowel disorder).

at a population level and to account for unequal probability of selection into the survey. This weight adjusted for the number of telephones in the household, the number of individuals in the household aged 12+, non-response, and seasonality. As such, our analytic sample size of 110,752 reflects a Canadian household population (aged 12+) of 21,520,586. Probability weights were used in the logistic models to provide weighted effect estimates and precise estimates of variance around these point estimates. All statistical analyses were conducted using SAS software (version 9.1) (SAS Institute Inc., 2002). All p-values were two-sided, and a p<0.05 was considered statistically significant.

RESULTS

Profile of Study Population

Based on our analytic sample, the prevalence of insomnia and bowel disorders was calculated to be 14.03% and 2.30%, respectively. Table 1 presents the overall frequency distribution for our dataset as well as for those who have bowel disorders and those who do not.

A review of Table 1 shows those who have a bowel disorder are more likely to: be women, have the disorder with advancing age, have more stress in their lives, suffer from chronic fatigue syndrome, and report having trouble going to sleep more frequently. Bivariate analysis using the Chi-square test showed a statistically significant association between each of the explanatory variables and the outcome variable.

With respect to characterizing those with bowel disorders, our analysis also suggests this cohort is more likely to: view themselves as having poorer health; have a regular medical doctor; consult an alternative health care provider; attend a self-help group; report decreases in activity at home, work or school, as well as in other leisure activities; and use sleeping pills (results not shown).

Association between Insomnia and Bowel Disorders

Table 2 presents the odds of having a bowel disorder based on the independent variables examined. The unadjusted odds ratios for the association between bowel disorders and the frequency of trouble sleeping are: a) Never: 1.00 (reference); b) Sometimes: 1.93 (95% CI: 1.76-2.12); and c) Most of the time: 3.73 (95% CI: 3.37-4.12). When adjusted for age, sex, self-perceived stress and chronic fatigue syndrome, the odds ratio for this same relationship is: a) Never: 1.00 (reference); b) Sometimes: 1.71 (95% CI: 1.55-1.88); and c) Most of the time: 2.79 (95% CI: 2.51-3.10). (The correlation between the variables in the adjusted model was 0.50 or less). These results suggest the probability of having a bowel disorder increases if the individual has trouble sleeping (either sometimes or most of the time). In fact, a trend exists such that the probability of suffering from a bowel disorder increases along with the frequency of trouble sleeping. The odds of having a bowel disorder is also elevated: 1) if the individual is female; 2) as one advances in age; 3) if there is a higher degree of self-perceived stress; and 4) if the individual suffers from chronic fatigue syndrome.

Table 2. Odds Ratios (95% Confidence Intervals) of the relationship between insomnia and bowel disorder, adjusted for covariates and confounders, CCHS Cycle 1.1 (N = 110,752).

Variable	Unadjusted	Adjusted*
Sex		
Male	1.00	1.00
Female	2.14 (1.97 – 2.33)	1.85 (1.70 – 2.02)
Age		
12 to 19	1.00	1.00
20 to 29	2.56 (1.69 – 3.87)	2.57 (1.70 – 3.90)
30 to 39	2.80 (1.86 – 4.23)	2.71 (1.79 – 4.10)
40 to 49	3.70 (2.46 – 5.57)	3.36 (2.23 – 5.06)
50 to 59	4.54 (3.01 – 6.84)	4.09 (2.71 – 6.17)
60 to 69	4.09 (2.70 – 6.21)	3.93 (2.59 – 5.97)
70 to 79	5.56 (3.67 – 8.44)	5.24 (3.44 – 7.96)
80+	6.20 (4.00 – 9.60)	5.63 (3.63 – 8.74)
Self-perceived stress		
Not at all	1.00	1.00
Not very	1.18 (1.00 – 1.38)	1.18 (1.01 – 1.39)
A bit	1.38 (1.20 – 1.60)	1.42 (1.22 – 1.64)
Quite a bit	1.81 (1.55 – 2.10)	1.67 (1.43 – 1.96)
Extremely	2.40 (1.97 – 2.91)	1.81 (1.48 – 2.22)
Chronic fatigue syndrome		
No	1.00	1.00
Yes	5.45 (4.42 – 6.71)	3.04 (2.45 – 3.77)
Frequency – trouble sleeping		
Never	1.00	1.00
Sometimes	1.93 (1.76 – 2.12)	1.71 (1.55 – 1.88)
Most of the time (insomnia)	3.73 (3.37 – 4.12)	2.79 (2.51 – 3.10)

*Adjusted for age, sex, self-perceived stress, and chronic fatigue syndrome.

DISCUSSION

With respect to the main research question, our results suggest insomnia is strongly associated with an increased probability of suffering from a bowel disorder even when controlled for sex, age, self-perceived stress, and chronic fatigue syndrome. Our findings support the results of the other population-based study conducted by Vege *et al.*¹⁴ Both studies reported statistically significant results; however, our adjusted odds ratio of 2.79 was slightly higher than the 1.6 reported by Vege *et al.*¹⁴ In addition, we found a stepwise trend in that the more difficulty one has falling asleep, the more likely they were to suffer from a bowel disorder. Not only does this support the findings by Cremonini *et al.*,¹⁵ but this trend also confirms our hypothesis that the more a Canadian suffers from insomnia, the greater the probability of experiencing bowel disorders. This is noteworthy as many studies have suggested the reverse relationship – that bowel disorders cause sleep disturbances.¹⁹⁻²¹ Given the fact that we employed an overarching health survey asking questions on a number of health-related issues, bias is minimized because respondents were not simply asked questions related to our hypothesis. As such, we believe there is evidence to suggest that insomnia corresponds to an increased probability of suffering from bowel disorders.

However, the actual mechanism by which lack of sleep induces bowel disorders remains unclear. In their recent review

article on sleep and chronic inflammatory disorders, Ranjbaran *et al.*²² found sufficient evidence proving changes in immune system function are caused by sleep disruptions. As there is an association between immune function and the sleep-wake cycle, the authors hypothesize sleep disruption plays a significant role in immunoinflammatory responses that cause or contribute to chronic inflammatory conditions such as IBS. The finding of a stepwise trend in association between insomnia and gastrointestinal disorders has been supported by animal studies.^{23,24}

The characteristics of those individuals in our dataset with bowel disorders mirror the findings of previous studies.^{25,26} Our study also confirms those with bowel disorders have a reduction in their health-related quality of life. This is not surprising given the myriad of symptoms associated with bowel disorders as well as the range in severity of such symptoms.

We calculated the prevalence of insomnia and bowel disorders to be 14.03% and 2.30% amongst adult Canadians respectively. Both of these figures are below the population estimates suggested in the literature. Sutton *et al.*² calculated the prevalence of insomnia in Canada (aged 15+) to be 24%. A reason for this discrepancy likely lies in how insomnia is ascertained among respondents – both in the way the question is worded as well as the available response options found in the survey. In their questionnaire, Sutton asked respondents, “Do you regularly have trouble going to sleep or staying asleep?” with a dichotomous (yes/no) response option. Recall that the question in the CCHS Cycle 1.1 survey inquired about the frequency of having trouble falling asleep with three response options. It should be noted that variations in the prevalence of insomnia are not uncommon as the literature has found levels from as low as 5% to as high as 50%, depending on the definition employed in the study.²⁷ In fact, combining those who reported trouble sleeping “most of the time” and “sometimes” in the current study make up 48% of the study sample.

Thompson *et al.*⁷ determined the prevalence of IBS to be 12.1% in Canada. One possible explanation for our lower figure is that the CCHS survey asked for medically-diagnosed bowel disorders whereas Thompson *et al.* utilized the Rome criteria.²⁸ This is of importance as the majority of people that experience bowel disorder symptoms do not seek medical attention.^{29,30} As such, using a list of symptoms to identify subjects with a bowel disorder will likely elicit a higher prevalence among respondents as compared to identifying only respondents medically-diagnosed with bowel disorder. Also, due to the nature of the question “Do you have a bowel disorder such as Crohn’s Disease or colitis?” in the CCHS survey, it was not necessarily specific for IBS. In other words, it encompasses individuals with Crohn’s Disease or colitis or IBS, but we are unable to differentiate between disorders. Further, individuals with IBS may know that they do not have



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either Crohn's Disease or colitis, and therefore our results likely underestimate the prevalence of IBS. Nevertheless, our findings were in agreement with Thompson *et al.*⁸ in that women have higher prevalence of bowel disorders in Canada.

One of the strengths of our study is that it was based on a population representative of Canadians. This resulted in less bias overall and gave our findings a great deal of external validity. Our study also had a very large sample size which provided sufficient power. Based on our sample size of 110,752 respondents, we obtained a power of >0.999 in order to detect a difference in the event rate of the proportion of people who do not sleep well versus those individuals who do sleep well (0.05 vs. 0.014, respectively).³¹ Our study is not without limitations, however. We relied on self-reported information which is subject to recall bias as well as subjective interpretation of questions. In particular, there were no definitions for the three response options available for the question related to sleeping difficulty in the CCHS survey ("most of the time", "sometimes", and "never"). In addition, there may be other possible confounders, such as caffeine consumption, not factored into the model. However, this variable was not measured in the survey, and we are not certain if this is a true confounder in the relationship between insomnia and bowel disorders given the current evidence. Lastly, our study was cross-sectional in nature and therefore may be affected by those limitations associated with this particular study design.

In summary, our population-based study indicates there is a stepwise association between insomnia and bowel disorders in Canada. However, given the limited amount of population-based data, more studies are warranted to examine this relationship further. Future studies should consider having clinical definitions and/or criteria for both insomnia and bowel disorders to minimize the subjectivity of responses. Also, case-control studies are suggested to clearly demonstrate that insomnia results in an increased risk of experiencing bowel disorders. Nevertheless, the results of our study lend evidence that the frequency of trouble sleeping is associated with the likelihood of suffering from a bowel disorder among Canadians. 

ACKNOWLEDGEMENTS

The authors wish to thank the following individuals from the School of Population and Public Health at the University of British Columbia who helped to review the manuscript: M. Koehoorn, W. Zhang, M.J. Milloy, and A. Harris.

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