



Original Article

Association between sleep problems and health-related quality of life in Canadian adults with chronic diseases

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ABSTRACT

Objectives: This study aimed to explore the association between sleep problems and health-related quality of life (HRQoL) in Canadian adults with chronic diseases, and whether mental illness can mediate the association.

Methods: Data were drawn from the Canadian Community Health Survey, 2015. A total of 10,900 participants aged ≥ 18 years and diagnosed with chronic diseases were enrolled in this study.

Results: Of these participants, 23.6% (95% CI 22.1, 25.2) suffered from severe impairment of HRQoL. Extreme sleep durations, including both short (<5 , 5 to <6 , and 6 to <7 h) and long (9 to <10 , and ≥ 10 h) sleep durations, were significantly associated with severe impairment of HRQoL (compared to 7 to <8 h). Insomnia was also independently associated with severe impairment of HRQoL when compared to those without insomnia. In the mediation analyses, mental illness was shown to partly mediate the associations of extreme sleep durations and insomnia with severe impairment of HRQoL.

Conclusions: In conclusion, both extreme sleep durations and insomnia were independently associated with severe impairment of HRQoL in adults with chronic diseases, and mental illness partly mediated the association.

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1. Introduction

The emergence of chronic diseases as the predominant challenge to global health is undisputed [1,2]. In Canada, chronic diseases affect over half of the general population, and its prevalence is still increasing as a result of considerable lifestyle changes, medical technology improvements and population aging [3]. Health-related quality of life (HRQoL) is an important indicator of a person's comprehensive health status [4], and a poorer HRQoL is well documented in adults with chronic diseases [5,6]. As chronic diseases are usually characterized by extended (even lifelong) duration and no clear-cut disposition, identifying and addressing the determinants of HRQoL have been recognized as the key concern in adults with chronic diseases.

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Sleep is a fundamental behavior, with unhealthy sleep habits becoming a growing trend in modern society [7,8]. Numerous studies have established robust association between sleep problems and some chronic diseases, such as coronary heart disease, stroke, diabetes, and cancer [9–12]. However, whether intervention should be focused on sleep problems to improve HRQoL in patients already suffering from chronic diseases is still uncertain. In addition, since mental illness can be impacted by sleep problems and it has a causal effect on HRQoL in adults with chronic diseases [13–16], it is critically important to have data-driven inference to determine whether mental illness could be a potential explanation for the association between sleep problems and impaired HRQoL.

In this study, we used a representative Canadian data to: (1) determine whether sleep problems were associated with an increased risk of impaired HRQoL in adults with chronic diseases; and (2) explore whether and to what extent mental illness can explain the association between sleep problems and risk of impaired HRQoL in adults with chronic diseases.

2. Materials and methods

2.1. Data source and sample

Data were drawn from the Canadian Community Health Survey, 2015. This survey, conducted by Statistics Canada, was a cross-sectional study designed to be representative of 98% of the Canadian population aged 12 or over. Using a multistage stratified cluster design, information on health status, health determinants and health system utilization were collected from the representative respondents through telephone and in-person interviews. Details about the survey have been described elsewhere [17]. All participants were informed about privacy, confidentiality and the voluntary nature of the survey, and gave their consent to Statistics Canada. Ethical approval was granted by the relevant policy committees at Statistics Canada.

In this study, participants from three provinces (Ontario, Manitoba, and Saskatchewan) who selected the optional survey module on sleep were included. Exclusion criteria: (1) less than 18 years (because sleep patterns in adolescents and adults are very different); (2) without any common chronic disease, including diabetes, hypertension, hyperlipidemia, heart disease, stroke, cancer, arthritis, scoliosis, fibromyalgia, osteoporosis, back problems, asthma, chronic obstructive pulmonary disease, migraine headaches, chronic fatigue syndrome, multiple chemical sensitivities, and Alzheimer's disease or any other dementia; and (3) had missing data on main study variables, including sleep problems, HRQoL, and mental illness. As a result, 10,900 participants were enrolled in the final analytic sample.

2.2. Variables of interest

Sleep problems referred to extreme sleep duration and insomnia in this study. Sleep duration was collected from the question: “How long do you usually spend sleeping each night?” Participants were instructed not to include time spent resting, and responses were recorded in hourly intervals. To capture possible non-linear relationships, sleep duration was divided into seven categories: <5, 5 to <6, 6 to <7, 7 to <8, 8 to <9, 9 to <10, and ≥ 10 h, with 7 to <8 h as the reference [18].

Insomnia was estimated using the question, “How often do you have trouble going to sleep or staying asleep?” [19,20]. Responses options included “never”, “rarely”, “sometimes”, “most of the time”, and “all of the time”. Consistent with previous studies, participants who reported “most of the time” or “all of the time” were considered to have insomnia [20].

HRQoL was assessed using the Health Utilities Index mark 3 (HUI3) [21]. The HUI3 is defined by a standardized health status classification system that includes eight attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain/discomfort. All attribute scores are aggregated into a single measure (global utility score) ranging from -0.36 to 1.0 (-0.36 = worst possible health, 0.0 = dead, and 1.0 = perfect health; negative values are allowed for some health status considered worse than death). Differences of ≥ 0.03 in HUI3 scores are considered to be clinically important [21]. The HUI3 has been proved valid and reliable in Canadians with chronic diseases [22]. Severe impairment of HRQoL was defined as the HUI3 scores <0.70 [23,24].

Mental illness was defined as the presence of a self-reported mood or anxiety disorder [25,26]. Participants were considered to have a mood disorder if they responded “yes” to the question “Do you have a mood disorder such as depression, bipolar disorder, mania or dysthymia?”, and considered to have an anxiety disorder if they responded “yes” to the question “Do you have an anxiety disorder such as a phobia, obsessive–compulsive

disorder or a panic disorder?”. This definition was reliable given its similarity with administrative data [27] and has been widely used [28,29].

2.3. Covariates

Sociodemographic and lifestyle variables included as covariates in the models were as follows: age, sex, visible minority, body mass index, marital status, education, household income, smoking status, physical activity, illicit drug use, number of chronic diseases, and province of residence. Smoking status was grouped into three types: current smoker (includes daily and occasional smoker), former smoker (at least one whole cigarette, non-smoker now), and never. Physical activity was divided into three categories according to the Canadian Physical Activity Guidelines (CPAG) [30]: active (at/above recommended level from CPAG), moderately active (below recommended level from CPAG), and inactive (no physical activity minutes reported). Illicit drug use referred to any kinds of illicit drug use in the past 12 months.

2.4. Statistical analysis

Characteristics of the participants were summarized as percentages for categorical variables and as mean for continuous variables. Comparisons across different sleep categories were assessed using Pearson's χ^2 test for categorical variables and one-way ANOVA for continuous variables. To obtain a deeper understanding of the relationship between sleep problems and HRQoL, we first explored the association between sleep problems and continuous HRQoL scores using generalized linear models. Then, we used logistic regression models to evaluate the association between sleep problems and severe impairment of HRQoL. Each sleep problem was entered in the models separately.

Mediation analyses were conducted following the Baron and Kenny's steps (Fig. 1) [31]: (1) the independent variable is significantly associated with the potential mediator; (2) the mediator is significantly associated with the dependent variable when the independent variable is controlled for; and (3) the association between the independent variable and the dependent variable is significantly attenuated on addition of the mediator to the multivariate regression model. The analyses were tested utilizing the generalized structural equation modelling (gsem) command, which allows for a dichotomous mediator. After generating the model with gsem, the total effect, indirect effect, and proportion of total effect represented by indirect effect can be examined directly with a product-of-coefficients test using the nlcom (nonlinear combination of estimators) command [32].

All analyses were performed in STATA 15.0 (Stata Corp., College Station, TX, USA). Sampling weights were applied to provide population estimates. Bootstrap methods were used to account for the complex survey design. Two-sided P values <0.05 were considered

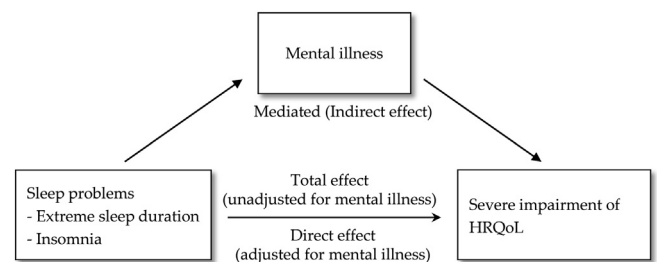


Fig. 1. Hypothesized mediation models predicting severe impairment of HRQoL.

to indicate statistical significance. Multiple comparisons were adjusted using Bonferroni method.

3. Results

3.1. Characteristics of study participants

Participants included in the final sample represented 6,372,800 Canadian adults with chronic diseases. Of these, 23.6% (95% CI 22.1, 25.2) suffered from severe impairment of HRQoL. The percentages of sleeping <5, 5 to <6, 6 to <7, 7 to <8, 8 to <9, 9 to <10, and ≥ 10 h were 8.3% (95% CI 7.5, 9.2), 13.1% (95% CI 12.0, 14.2), 28.1% (95% CI 26.6, 29.6), 30.1% (95% CI 28.6, 31.7), 16.2% (95% CI 15.0, 17.5), 2.6% (95% CI 2.1, 3.1), and 1.7% (95% CI 1.3, 2.1), respectively. Furthermore, the percentage of insomnia was 19.9% (95% CI 18.6, 21.3). Detailed characteristics of study participants are displayed in Table 1.

Table 1
Characteristics of study participants.

	% (95% CI)
Sample size ^a	10,900
Weighted population ^a	6,372,800
Age, years	
18 to 44	31.0 (29.6, 32.4)
45 to 59	31.5 (30.1, 33.0)
60 to 74	28.0 (26.8, 29.3)
≥ 75	9.5 (8.8, 10.2)
Sex	
Male	45.3 (44.1, 46.5)
Female	54.7 (53.5, 55.9)
Visible minority	
Yes	25.3 (23.6, 27.0)
No	74.7 (73.0, 76.4)
Body mass index, kg/m ²	
<18.5	1.9 (1.5, 2.4)
18.5 to <25.0	36.7 (35.1, 38.4)
25.0 to <30.0	35.7 (34.1, 37.2)
≥ 30.0	25.8 (24.3, 27.3)
Marital status	
Married/common-law	64.7 (63.0, 66.3)
Separated/divorced/widowed	16.4 (15.3, 17.6)
Never married	19.0 (17.6, 20.4)
Education level	
Less than secondary school grad	12.8 (11.7, 14.0)
Secondary school grad	24.1 (22.8, 25.5)
Post-secondary certificate diploma or univ degree	63.1 (61.5, 64.7)
Household income, CAD\$	
$\leq 29\,999$	16.2 (15.0, 17.4)
30 000 to 49 999	17.8 (16.6, 19.0)
50 000 to 79 999	24.1 (22.7, 25.5)
$\geq 80\,000$	42.0 (40.3, 43.6)
Smoking status	
Current smoker	20.0 (18.8, 21.3)
Former smoker	40.6 (39.1, 42.2)
Never	39.4 (37.7, 41.0)
Physical activity	
Active	53.9 (52.2, 55.6)
Moderately active	23.4 (22.0, 24.8)
Inactive	22.8 (21.4, 24.1)
Illicit drug use	
Yes	8.2 (7.4, 9.2)
No	91.8 (90.8, 92.6)
Number of chronic diseases	
1	42.0 (40.3, 43.7)
2	24.5 (23.2, 25.9)
≥ 3	33.5 (32.0, 35.0)
Province of residence	
Ontario	86.0 (85.4, 86.5)
Manitoba	7.6 (7.2, 8.0)
Saskatchewan	6.5 (6.1, 6.8)

CI = confidence intervals.

^a Numbers are rounded to base 100 for confidentiality purposes according to Statistics Canada data release policies. Percentages are based on weighted numbers.

3.2. Association between sleep duration and HRQoL

As shown in Table 2, we firstly explored the association between sleep duration and continuous HRQoL scores. When compared to 7 to <8 h, the mean HRQoL scores progressively decreased in both short (0.830 for 6 to <7 h; 0.769 for 5 to <6 h; and 0.683 for <5 h) and long (0.836 for 8 to <9 h; 0.780 for 9 to <10 h, and 0.611 for ≥ 10 h) sleep duration. In the multivariate generalized linear model, the inverse U-shaped association persisted and significant reductions were found in <5, 5 to <6, 9 to <10, and ≥ 10 h (Table 2).

Next, we assessed the association between sleep duration and the odds of severe impairment of HRQoL. When compared to 7 to <8 h, the prevalence of severe impairment of HRQoL progressively increased in both short and long sleep duration. In the multivariate logistic regression model, the U-shaped association persisted and significant odd ratios (ORs) for severe impairment of HRQoL were found in <5, 5 to <6, 6 to <7, 9 to <10, and ≥ 10 h (Table 2).

3.3. Association between insomnia and HRQoL

Table 2 also showed the association between insomnia and HRQoL. When compared to those without insomnia, the mean HRQoL scores decreased in those with insomnia. In the multivariate generalized linear model, insomnia was associated with decreased HRQoL scores, and the coefficient was -0.205 (95% CI $-0.237, -0.173$). The prevalence of severe impairment of HRQoL increased in those with insomnia. In the multivariate logistic regression model, the OR for severe impairment of HRQoL in those with insomnia was 2.74 (95% CI 2.22, 3.37).

3.4. Mediation analyses

In order to explore whether mental illness mediated the association between sleep problems and severe impairment of HRQoL, we conducted mediation analyses. As shown in Table 3, the indirect effect of mental illness on the association between sleep duration and severe impairment of HRQoL was 0.097 (95% CI 0.031, 0.163) for <5 vs. 7 to <8 h; 0.040 (95% CI 0.004, 0.075) for 5 to <6 vs. 7 to <8 h; 0.109 (95% CI 0.002, 0.216) for 9 to <10 vs. 7 to <8 h; and 0.187 (95% CI 0.030, 0.343) for ≥ 10 vs. 7 to <8 h, respectively. The indirect effect of mental illness on the association between insomnia and severe impairment of HRQoL was 0.115 (95% CI 0.072, 0.157). These results indicated that the associations of extreme sleep durations and insomnia with severe impairment of HRQoL can be partly mediated by mental illness.

4. Discussion

Our study showed that 23.6% (95% CI 22.1, 25.2) of Canadian adults with chronic diseases suffered from severe impairment of HRQoL. As more than half of the general Canadian population live with chronic diseases, it is imperative that more public health interventions should be focused on impaired HRQoL. In addition, our study demonstrated that sleep problems, including both extreme sleep durations and insomnia, were independently associated with severe impairment of HRQoL in adults with chronic diseases, and mental illness was shown to partly mediate the association.

The association between sleep duration and HRQoL has been gaining increasing attention. For example, Saku et al. [33], studied a middle-aged and older sample in Finnish, and found that sleeping <6.5 and >10 h were associated with higher probability of having low HRQoL as measured by 15D instrument. Faubel et al. [34], found that extreme sleep duration was a marker of worse HRQoL in older population. However, these studies conducted in general population couldn't provide direct evidence for the management of

Table 2

Association between sleep problems and health-related quality of life.

	HRQoL (Continuous)			HRQoL (Severe)		
	Mean (SE)	Coefficient (95% CI)	P value	% (95% CI)	OR (95% CI)	P value
Sleep duration, hours						
<5	0.683 (0.016) ^{##}	−0.171 (−0.221, −0.121)	<0.001	44.3 (38.7, 50.0) ^{##}	2.69 (1.90, 3.79)	<0.001
5 to <6	0.769 (0.012) ^{##}	−0.067 (−0.098, −0.036)	<0.001	31.0 (26.6, 35.4) ^{##}	1.79 (1.32, 2.44)	<0.001
6 to <7	0.830 (0.008)	−0.021 (−0.047, 0.006)	0.122	21.2 (18.5, 24.0)	1.32 (1.01, 1.73)	0.042
7 to <8	0.850 (0.007)	Ref	—	16.9 (14.4, 19.4)	Ref	—
8 to <9	0.836 (0.009)	−0.006 (−0.033, 0.022)	0.686	20.2 (16.9, 23.5)	1.05 (0.77, 1.42)	0.776
9 to <10	0.780 (0.021) [#]	−0.049 (−0.095, −0.002)	0.040	31.7 (22.6, 40.8) [#]	1.70 (1.02, 2.83)	0.040
≥10	0.611 (0.055) ^{##}	−0.306 (−0.528, −0.085)	0.007	45.1 (33.5, 56.7) ^{##}	2.91 (1.63, 5.21)	<0.001
Insomnia						
No	0.843 (0.005)	Ref	—	18.7 (17.2, 20.4)	Ref	—
Yes	0.685 (0.010) ^{**}	−0.205 (−0.237, −0.173)	<0.001	43.3 (39.8, 46.9) ^{**}	2.74 (2.22, 3.37)	<0.001

HRQoL = health-related quality of life; SE = standard error; OR = odds ratio; CI = confidence interval; Ref = reference group. Mean and percentages are based on weighted numbers.

^{##} $P < 0.001$ and [#] $P < 0.05$, in comparison with the reference group (7 to <8 h). P values were corrected using Bonferroni method due to multiple comparisons.

^{**} $P < 0.001$, in comparison with the reference group (no insomnia).

HRQoL (Severe) refers to severe impairment of HRQoL, which is defined as the Health Utilities Index mark 3 scores < 0.70.

All analyses are adjusted for age, sex, visible minority, body mass index, marital status, education, household income, smoking status, physical activity, illicit drug use, number of chronic diseases, and province of residence.

Table 3

Mental illness as a mediator in the association between sleep problems and severe impairment of health-related quality of life.

	Total effect		Indirect effect		% Mediated
	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value	
Sleep duration, hours					
<5 vs. Ref	1.081 (0.706, 1.457)	<0.001	0.097 (0.031, 0.163)	0.004	9.0%
5 to <6 vs. Ref	0.645 (0.348, 0.941)	<0.001	0.040 (0.004, 0.075)	0.029	6.2%
6 to <7 vs. Ref ^a	—	—	—	—	—
8 to <9 vs. Ref ^b	—	—	—	—	—
9 to <10 vs. Ref	0.595 (0.058, 1.132)	0.030	0.109 (0.002, 0.216)	0.046	18.3%
≥10 vs. Ref	1.235 (0.614, 1.857)	<0.001	0.187 (0.030, 0.343)	0.019	15.1%
Insomnia					
Yes vs. No	1.028 (0.813, 1.244)	<0.001	0.115 (0.072, 0.157)	<0.001	11.2%

CI = confidence interval; Ref = reference group (7 to <8 h).

All analyses are adjusted for age, sex, visible minority, body mass index, marital status, education, household income, smoking status, physical activity, illicit drug use, number of chronic diseases, and province of residence.

^a Indicates a non-significant relationship between sleep duration and mental illness; therefore, mediation analyses were not conducted.

^b Indicates a non-significant relationship between sleep duration and severe impairment of health-related quality of life; therefore, mediation analyses were not conducted.

chronic diseases. Recently, several studies have reported the relationship between sleep duration and HRQoL in patients with a specific physical disease, such as predialysis CKD [35], diabetes [36], and chronic liver disease [37]. But due to a limited range of study diseases, small sample sizes, and inconsistent results, we couldn't apply the conclusions to inform policy development of chronic diseases. Therefore, more evidence documented from adults with chronic diseases is really needed. In this study, using a large representative Canadian data with more detailed categories of sleep duration, we demonstrated a reliable and robust association between extreme sleep durations and impaired HRQoL in adults with chronic diseases.

Our study also established a robust association between insomnia and severe impairment of HRQoL in adults with chronic diseases. The finding was a valuable complement to such studies in other population (eg, studies in German adults [38], Chinese adults [39], Wisconsin older population [40], nationally representative sample of American adults [41,42], and etc.) Although the methods regarding insomnia diagnosis and HRQoL measurement were various, the main conclusions derived from these studies were quite similar. What our present study adds was a large representative sample of Canadian adults, and a standpoint of chronic disease management.

The mechanism links the association between sleep problems and severe impairment of HRQoL is unclear. To the best of our

knowledge, this is the first study to investigate the mediating role of mental illness on the association between sleep problems and severe impairment of HRQoL. Our finding suggested that intervention on mental illness may mitigate the impact of sleep problems on severe impairment of HRQoL in adults with chronic diseases.

There are some limitations to the present study. First, this cross-sectional study was unable to draw causal conclusions; thus, further prospective cohort studies and intervention trials should be undertaken to conduct causal results. Second, both sleep duration and insomnia were assessed by one single item. Although the method has been widely used, it was still considered to be less valid than more extensive measures. Third, our analyses were based on data that were self-reported rather than measured; however, the ascertainment of chronic diseases and mental illness was considered to be less biased because they are based on a diagnosis by health professionals, and the assessment of HRQoL using self-reported HUI3 has been proved valid and reliable in adults with chronic diseases [22].

5. Conclusions

Our study indicated that severe impairment of HRQoL was prevalent in Canadian adults with chronic diseases. Both extreme sleep durations and insomnia were independently associated with

severe impairment of HRQoL in adults with chronic diseases, and the association can be partly explained by mental illness. Future studies should focus on whether sleep problems or mental illness interventions improve HRQoL in adults with chronic diseases.

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Conflict of interest

The authors declare no conflict of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <https://doi.org/10.1016/j.sleep.2019.04.015>.

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