Research

Self-reported sleep disturbances among people who have had a stroke: a cross-sectional analysis

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Abstract

Background: Sleep disturbances and their potential association with stroke remains understudied at a population level. We sought to determine the prevalence of sleep disturbances among people who have effects of stroke compared with the general population.

Methods: We used data from people aged 18 years or older who responded to the sleep and chronic disease modules of the 2017–2018 cycle of the Canadian Community Health Survey (CCHS). We measured sleep disturbances by self-reports of having trouble staying awake most or all of the time; either short (< 5 h) or long (> 9 h) nightly sleep duration; having trouble going to or staying asleep most or all of the time; and never, rarely or sometimes having refreshing sleep. We used log-binomial and multinomial regression to investigate prevalence of sleep disturbances among respondents who reported effects of stroke compared with others, adjusting for confounding factors.

Results: We included 46 404 CCHS respondents, 682 of whom reported effects of stroke. The prevalence of sleep disturbances for those with effects of stroke was higher than among others in the sample with regard to trouble staying awake (13.0% v. 6.1%; adjusted relative risk [RR] 2.16, 95% confidence interval [CI] 1.59–2.94), short or long duration sleep (28.9% v. 10.0%; adjusted RR 1.93, 95% CI 1.57–2.38), trouble going to or staying asleep, (28.1% v. 17.6%; adjusted RR 1.53, 95% CI 1.28–1.83) and lack of refreshing sleep (41.1% v. 37.1%; adjusted RR 1.30, 95% CI 1.14–1.49). The prevalence of at least 1 reported measure of sleep disturbance was 61.6% among those with effects of stroke, compared with 48.2% among others (adjusted RR 1.28, 95% CI 1.18–1.40).

Interpretation: Self-report of having effects of stroke was associated with increased prevalence of sleep disturbances compared with the general population. Sleep disturbances were reported by a high proportion of respondents with effects of stroke, indicating the importance of screening for related disorders.

Disturbance of normal sleeping patterns is a commonly reported, but understudied, condition among people who have had a stroke.[1] Sleep disturbances represent both a risk factor for and a consequence of stroke.[2–8] Sleep disturbances are thought to have a negative impact on functional recovery of activities of daily living, mood and levels of fatigue.[9,10] When interviewed, people who have had a stroke reported both reduced and excessive sleep afterward.[11] International consensus exists that cognitive and other nonmotor impairments are priority areas for stroke research.[12,13] Furthermore, understanding poststroke fatigue (and how to reduce it), to which sleep disruptions may be a major contributor,[14] is one of the top 10 patient priorities for stroke rehabilitation.[15]

Despite the known association between sleep disturbances and stroke, the prevalence of sleep disturbances among patients with stroke is not well defined. Studies of the prevalence of sleep disturbances are often limited by small sample size, providing estimates that range between 25%[16] and 80%,[17] with a wide variety of stroke characteristics and populations included across studies. Meta-analyses have estimated a prevalence of poststroke insomnia of 29%–54%, depending on the length of time after stroke, but this neglects those who have poststroke hypersomnia.[6]

Our aim was to determine the prevalence of sleep disturbances among people who have or have not had stroke; we hypothesized that the prevalence of sleep disturbances is higher among those who have effects of a stroke compared with the general population.

Methods

Study design

We conducted a cross-sectional, population-based study using data from adults who completed the 2017–2018 Canadian Community Health Survey (CCHS) including the module on sleep disturbances.

Data source and study population

The CCHS is a multistage, stratified cluster survey with data that represent 98% of the Canadian population aged 12 years or older. The 2017–2018 survey cycle (the most recent cycle available for public use at the time of study conduct) had 113 290 respondents.[18] We restricted analysis to adults (age ≥ 18 yr) living in Prince Edward Island, Quebec, Alberta, British Columbia, Yukon Territory and Nunavut, where the relevant sleep-related question module was administered. We excluded those with missing data on the primary exposure of interest (stroke status) or on any of the potential covariates.

Outcomes

We measured 4 types of sleep disturbances according to the following responses to questions in the CCHS: most or all of the time to, "How often do you find it difficult to stay awake when you want to?"; short (< 5 h) or long (> 9 h) self-reported sleep durations each night to, "How long do you usually spend sleeping each night?"; most or all of the time to, "How often do you have trouble going to sleep or staying asleep?"; and never, rarely or sometimes to, "How often do you find your sleep refreshing?". The full set of potential responses to scale questions were "never," "rarely," "sometimes," "most of the time" and "all of the time." The specific composition of the sleep-related question set in the CCHS has not been validated as a diagnostic tool; however, similar questions and 5-point scales are used as components of other sleep disorder questionnaires.[19–22] We selected thresholds to be consistent with methods used in other studies that have used the CCHS sleep module.[23–26] Previous studies using CCHS data have shown the association of both short and long sleep duration with chronic disease, which informed our rationale for selecting these cutoffs.[2,24]

Exposure

We determined stroke status from the CCHS question, "Do you suffer from the effects of a stroke?" This question has been shown to have moderate agreement ($\kappa = 0.58$) with physician claims data indicating presence of stroke.[27] Hereafter, we refer to respondents who said yes to this question as having had a stroke.

Confounders

We used previous CCHS analyses,[2,23–25] primary studies in the clinical setting,[10,11,14,16,17,28] meta-analyses,[6,9,29] literature reviews[8,30,31] and clinical expertise of the coauthors to select covariates with associations to both sleep disturbances and stroke. Model 1 used a set of confounders with a low likelihood of being colliders, namely diabetes status, age, sex, highest level of education, body mass index, physical activity level according to the Canadian Physical Activity Guidelines (moderate-to-vigorous activity ≥ 150 min/wk), frequency of alcohol use and frequency of smoking. Model 2 included all confounders in Model 1, with the addition of other self-reported chronic conditions, namely arthritis, asthma, cancer, heart disease, high blood cholesterol, high blood pressure, mood disorder (e.g., depression, bipolar disorder, mania, dysthymia) and anxiety disorder (e.g., phobia, obsessive–compulsive disorder, panic).[4,14,25,29,32,33] These factors have potential bidirectional relationships with our exposure and outcomes. Depending on the temporality of these factors (which is unknown, given the cross-sectional design) they could act as either confounders or colliders, leading to a more complete set of covariates, but a potential risk of overadjustment in Model 2. We recoded the original CCHS age variable into 6 age categories (18–39 yr, 40–49 yr, 50–59 yr, 60–69 yr, 70–79 yr, ≥ 80 yr) to better represent age ranges by which prevalence of insomnia has been previously found to vary and to provide a sufficient sample size of people who have had a stroke within each category, as stroke is relatively uncommon at younger ages.[23]

Statistical analysis

We adjusted all point and variance estimates using relative weights (individual sampling weight divided by average weight of all included respondents) and the average design effect for Canada (2.95) provided in the CCHS documentation.[18] We used these values to calculate an adjusted weight (relative weight divided by the square root of the design effect) that was incorporated into all analyses to account for the complex survey design of the CCHS. We tabulated frequencies using these adjusted weights to describe the prevalence of each type of sleep disturbance by stroke status and across covariates. We also calculated the risk of having at least 1 of the 4 sleep disturbances of interest. We used log-binomial regression to calculate relative risks (RRs) with 95% confidence intervals (CIs) of the association between sleep disturbances and stroke and covariates. For each type of sleep disturbance, we investigated sex and age as possible effect modifiers of stroke. We used multinomial logistic regression to compare the ratio of RRs of having increasing numbers of co-occurring sleep disturbances, compared with 0 sleep disturbances, by stroke status. We considered a p value of less than 0.05 to be statistically significant. We present prevalence data as absolute risks, and model outputs as RRs by stroke status. We have reported all results in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and *CMAJ* guidance for survey reports.[34,35] We performed all analyses using SAS version 9.4 (SAS Institute).

Ethics approval

Institutional ethics approval was not required for this study, as it solely used publicly accessible data sources.

Results

We included 46 404 respondents, 682 of whom reported that they suffered from the effects of a stroke (Figure 1). Differences between participants with and without stroke are provided in Table 1. After adjusting for survey weight and design effect, the prevalence of stroke was 1.1% and increased with age (18–39 yr: 0.2%; 40–49 yr: 0.3%; 50–59 yr: 1.1%; 60–69 yr: 2.1%; 70–79 yr: 2.8%; ≥ 80 yr: 5.4%). Overall, the prevalence of at least 1 type of sleep disturbance (61.6% v. 48.2%), as well as all 4 individual types of sleep disturbances (13.0%–41.1% v. 6.1%–37.1%) was higher among those who had a stroke than among others

(Table 2). Prevalence for each type of sleep disturbance, stratified by stroke status and all modelled covariates, is available in Appendix 1, Sections 1–5, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.221063/tab-related-content.

We did not observe any significant interactions of stroke with sex or age, but stratified RRs are provided in Section 6 and 7 of Appendix 1. Respondents who suffered from the effects of a stroke were more likely to report at least 1 type of sleep disturbance in the unadjusted model (RR 1.28, 95% CI 1.17–1.40) and in Model 1 (adjusted RR 1.28, 95% CI 1.18–1.40), but not in Model 2 (adjusted RR 1.06, 95% CI 0.98–1.15) (Table 3). This group also had an increased risk of difficulty staying awake (unadjusted RR 2.13, 95% CI 1.58–2.88; Model 1 adjusted RR 2.16, 95% CI 1.59–2.94; Model 2 adjusted RR 1.83, 95% CI 1.35–2.49), and of short or long sleep duration (unadjusted RR 2.88, 95% CI 2.40–3.47; Model 1 adjusted RR 1.93, 95% CI 1.57–2.38; Model 2 adjusted RR 1.50, 95% CI 1.22–1.85) (Appendix 1, Sections 8 and 9). People who reported a stroke had higher risk of difficulty going to sleep in both the unadjusted model (RR 1.60, 95% CI 1.33–1.92) and in Model 1 (adjusted RR 1.53, 95% CI 1.28–1.83), but this was attenuated and became nonsignificant when controlling for additional covariates in Model 2 (adjusted RR 1.11, 95% CI 0.91–1.35) (Appendix 1, Section 10). People who reported a stroke had a significantly higher risk of nonrefreshing sleep only in Model 1 (adjusted RR 1.30, 95% CI 1.14–1.49)

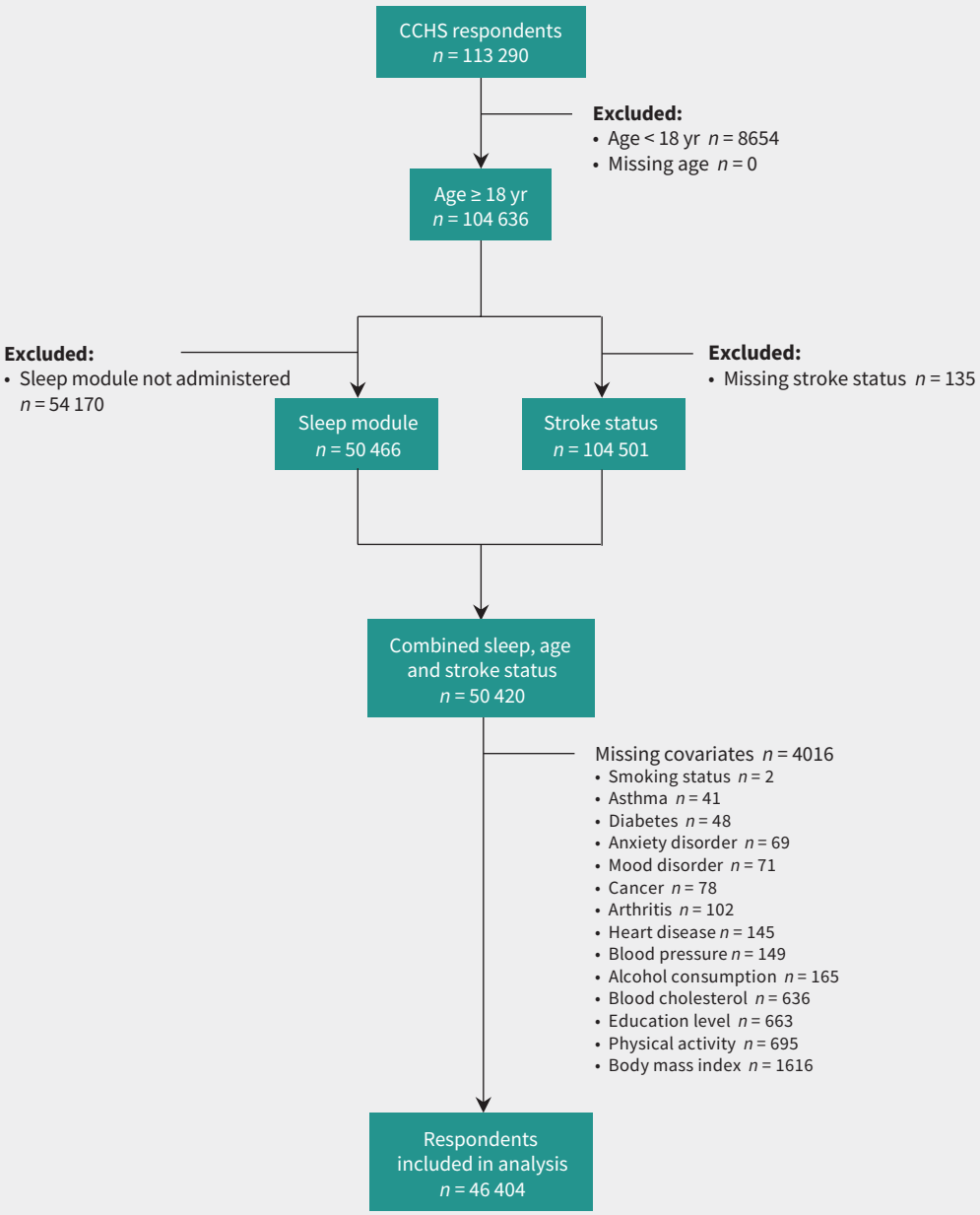

Figure 1: Study flowchart. Note: CCHS = Canadian Community Health Survey.

(Appendix 1, Section 11). The effects of extreme sleep duration were similar when short and long durations were considered separately, so we favoured combining these categories (Appendix 1, Section 12).

The proportion of respondents with 0, 1, 2, 3 or 4 types of sleep disturbances is provided in Table 4. The RR ratio of having either 3 or 4 types of sleep disturbances, compared with 0 disturbances, among respondents who reported a stroke was significantly higher than among those without stroke effects in all models (Table 4). The RR ratio for 2 co-occurring sleep disturbances was significantly higher for those who reported a stroke in the unadjusted model and in Model 1. The RR ratio for any 1 type of sleep disturbance was higher among people who reported a stroke only in Model 1 (adjusted RR 1.40, 95% CI 1.05–1.87).

Interpretation

All 4 types of sleep disturbances were more prevalent among people who reported a stroke than in the general population. The most common type of sleep disturbance among those who reported a stroke was nonrefreshing sleep, whereas the type of sleep disturbance with the highest RR for this group was difficulty staying awake. This group had a significantly greater risk of having more co-occurring sleep disturbances than those who did not report a stroke, reinforcing the potential association between stroke status and each type of sleep disturbance. Overall, the interaction between stroke and sex or age was not significant, indicating that the association of

Table 1 (part 1 of 2): Survey participant characteristics

Characteristic	No. (%) of respondents*		Standardized difference
	No stroke *n* = 45 722	Stroke† *n* = 682	
Sex			
Male	21 601 (50.1)	344 (55.1)	0.100
Female	24 121 (49.9)	338 (44.9)	
Age, yr			
18–39	13 984 (38.2)	25 (6.2)	1.149
40–49	6655 (16.8)	26 (5.3)	
50–59	7992 (17.7)	113 (18.2)	
60–69	9009 (15.5)	200 (30.7)	
70–79	5687 (8.7)	185 (23.5)	
≥ 80	2395 (3.1)	133 (16.1)	
Education			
Less than secondary school	6348 (10.9)	206 (25.3)	0.432
Secondary school	10 332 (23.4)	154 (27.1)	
Postsecondary certificate or degree	28 952 (65.8)	322 (47.6)	
Physical activity			
No physical activity minutes reported	9246 (17.8)	253 (33.0)	0.366
Active below recommended level	10 627 (23.2)	160 (22.1)	
Active at or above recommended level	25 849 (59.0)	269 (44.9)	
Frequency of alcohol consumption			
Did not drink in the previous 12 mo	7921 (16.7)	241 (27.1)	0.309
Occasional drinker (< 1/mo)	6984 (14.0)	135 (18.0)	
Regular drinker (≥ 1/mo)	30 817 (69.3)	306 (54.9)	
Frequency of smoking			
Not at all	37 236 (82.9)	536 (78.5)	0.181
Occasionally	2170 (5.4)	26 (3.8)	
Daily	6316 (11.7)	120 (17.7)	
Body mass index			
Underweight (< 18.50)	466 (1.1)	6 (0.4)	0.364
Normal weight (18.50–24.99)	16 148 (37.8)	192 (28.1)	
Overweight (25.00–29.99)	16 361 (35.7)	228 (29.6)	
Obese – class I, II, III (≥ 30.00)	12 747 (25.4)	256 (41.9)	

Table 1 (part 2 of 2): Survey participant characteristics

Characteristic	No. (%) of respondents*		Standardized difference
	No stroke *n* = 45 722	Stroke† *n* = 682	
Arthritis			
No	35 119 (82.5)	326 (54.8)	0.625
Yes	10 603 (17.5)	356 (45.2)	
Asthma			
No	41 982 (92.3)	596 (87.4)	0.162
Yes	3740 (7.7)	86 (12.6)	
Diabetes			
No	42 045 (93.6)	536 (77.7)	0.466
Yes	3677 (6.4)	146 (22.3)	
Cancer			
No	44 814 (98.5)	643 (95.2)	0.188
Yes	908 (1.5)	39 (4.8)	
Heart disease			
No	43 250 (96.1)	443 (68.7)	0.771
Yes	2472 (3.9)	239 (31.3)	
High blood cholesterol			
No	39 712 (89.0)	397 (57.9)	0.752
Yes	6010 (11.0)	285 (42.1)	
High blood pressure			
No	36 513 (83.9)	308 (50.1)	0.771
Yes	9209 (16.1)	374 (49.9)	
Mood disorder (depression, bipolar, mania, dysthymia)			
No	41 732 (92.1)	564 (82.9)	0.283
Yes	3990 (7.9)	118 (17.1)	
Anxiety disorder (phobia, obsessive compulsive, panic)			
No	41 873 (92.1)	585 (86.6)	0.179
Yes	3849 (7.9)	97 (13.4)	

*Numbers of participants are raw values present in the survey sample, whereas percentage values and standardized mean differences are weighted to the Canadian population.
†Defined by responding yes to the question, "Do you suffer from the effects of a stroke?"

sleep disturbances with stroke was similar for both sexes and across the lifespan.

We found that almost two-thirds of people who reported a stroke also had at least 1 type of sleep disturbance, with a risk of sleep disturbances 1.3–2.2 times higher than the general population, depending on the specific type of disturbance. The risk of having co-occurring sleep disturbances was 1.9–7.4 times higher. One CCHS study previously showed that people with excess sleep duration (≥ 10 hr) had a higher risk of stroke (adjusted hazard ratio 2.24, 95% CI 1.01–4.98) than those sleeping 7–9 hours per night, similar to our risk estimates for short or long sleep duration.[2] Others have identified associations between sleep duration and difficulty going to sleep with various chronic diseases, but not stroke specifically.[24,25] Our study advances this

Table 2: Prevalence of self-reported sleep disturbances in Canadian adults by stroke status*

Sleep disturbance	Prevalence*, %	
	No stroke *n* = 45 722	Stroke *n* = 682
Difficulty staying awake	6.1	13.0
< 5 hr or > 9 hr sleep	10.0	28.9
Difficulty going to sleep	17.6	28.1
Nonrefreshing sleep	37.1	41.1
At least 1 type of sleep disturbance	48.2	61.6

*Prevalence was weighted to the Canadian population.

Table 3: Associations between having at least 1 type of self-reported sleep disturbance, self-reported stroke and other covariates

Characteristic	Unadjusted RR (95% CI)	Model 1* Adjusted RR (95% CI)	Model 2* Adjusted RR (95% CI)
Stroke†	1.28 (1.17–1.40)	1.28 (1.18–1.40)	1.06 (0.98–1.15)
Sex, female	1.20 (1.17–1.23)	1.19 (1.16–1.22)	1.06 (1.04–1.09)
Age, yr			
18–39	Ref.	Ref.	Ref.
40–49	1.01 (0.97–1.04)	0.99 (0.96–1.03)	0.99 (0.96–1.02)
50–59	0.96 (0.93–0.99)	0.92 (0.89–0.95)	0.95 (0.92–0.98)
60–69	0.87 (0.84–0.91)	0.83 (0.80–0.86)	0.89 (0.86–0.92)
70–79	0.86 (0.82–0.90)	0.81 (0.77–0.85)	0.88 (0.84–0.91)
≥ 80	0.91 (0.85–0.98)	0.81 (0.75–0.87)	0.88 (0.82–0.94)
Education			
Less than secondary school	1.18 (1.14–1.22)	1.14 (1.10–1.19)	1.05 (1.02–1.09)
Secondary school	1.11 (1.08–1.15)	1.09 (1.06–1.12)	1.03 (1.01–1.06)
Postsecondary certificate or degree	Ref.	Ref.	Ref.
Physical activity			
No physical activity minutes reported	1.12 (1.09–1.16)	1.08 (1.04–1.11)	1.03 (1.00–1.06)
Active below recommended level	1.05 (1.02–1.08)	1.02 (0.99–1.05)	1.01 (0.98–1.03)
Active at or above recommended level	Ref.	Ref.	Ref.
Frequency of alcohol consumption			
Did not drink in the previous 12 mo	1.13 (1.10–1.17)	1.08 (1.05–1.11)	1.03 (1.00–1.06)
Occasional drinker (< 1/mo)	1.15 (1.11–1.19)	1.08 (1.04–1.12)	1.03 (0.99–1.09)
Regular drinker (≥ 1/mo)	Ref.	Ref.	Ref.
Frequency of smoking			
Not at all	Ref.	Ref.	Ref.
Occasionally	1.13 (1.07–1.19)	1.13 (1.07–1.18)	1.04 (0.99–1.09)
Daily	1.20 (1.16–1.24)	1.16 (1.12–1.20)	1.04 (1.01–1.08)
Body mass index			
Underweight (< 18.50)	1.26 (1.15–1.39)	1.16 (1.06–1.28)	1.07 (0.97–1.18)
Normal weight (18.50–24.99)	Ref.	Ref.	Ref.
Overweight (25.00–29.99)	1.03 (1.00–1.06)	1.07 (1.04–1.10)	1.02 (1.00–1.05)
Obese – class I, II, III (≥ 30.00)	1.13 (1.10–1.17)	1.13 (1.10–1.17)	1.03 (1.01–1.06)
Diabetes	1.11 (1.06–1.16)	1.11 (1.06–1.16)	1.03 (1.00–1.07)
Arthritis	1.19 (1.16–1.23)	NA	1.08 (1.05–1.11)
Asthma	1.28 (1.23–1.32)	NA	1.06 (1.02–1.10)
Cancer	1.16 (1.06–1.26)	NA	1.07 (1.00–1.15)
Heart disease	1.14 (1.08–1.20)	NA	1.04 (0.99–1.10)
High blood cholesterol	1.08 (1.04–1.12)	NA	1.02 (0.98–1.06)
High blood pressure	1.05 (1.02–1.08)	NA	1.02 (0.99–1.05)
Mood disorder	1.65 (1.61–1.70)	NA	1.16 (1.11–1.21)
Anxiety disorder	1.57 (1.52–1.61)	NA	1.11 (1.07–1.15)

Note: CI = confidence interval, NA = variable not included in model, Ref. = reference category, RR = relative risk.
*Model 1 controlled for the effects of age, diabetes, sex, education level, body mass index, physical activity level, alcohol consumption and smoking status. Model 2 controlled for the same factors as Model 1, with the addition of arthritis, asthma, cancer, heart disease, high blood cholesterol, high blood pressure, mood disorder and anxiety disorder.
†Defined by responding yes to the question, "Do you suffer from the effects of a stroke?"

Table 4: Proportions and relative risk ratios of co-occurring sleep disturbances, compared with 0 sleep disturbances, by stroke status*

No. of sleep disturbances	Stroke†	No. of respondents	Proportion‡, %	Unadjusted RR ratio (95% CI)	Model 1 RR ratio (95% CI)	Model 2 RR ratio (95% CI)
0	No	23 601	51.8	Ref.	Ref.	Ref.
	Yes	249	38.4			
1	No	13 284	30.4	1.31 (0.99–1.74)	1.40 (1.05–1.87)	1.29 (0.96–1.72)
	Yes	207	29.5			
2	No	6486	13.4	1.77 (1.27–2.47)	1.89 (1.35–2.66)	1.39 (0.98–1.99)
	Yes	127	17.6			
3	No	2071	3.9	3.96 (2.68–5.86)	3.77 (2.50–5.69)	2.53 (1.63–3.93)
	Yes	80	11.4			
4	No	280	0.5	8.35 (4.10–17.01)	7.42 (3.51–15.70)	4.51 (2.04–9.95)
	Yes	19	3.0			

Note: CI = confidence interval, Ref. = reference category, RR = relative risk.
*The proportion (%) of each type of sleep disturbance was weighted to the Canadian population. The risk of having a given number of sleep disturbances relative to 0 sleep disturbances, and the ratio of this risk among respondents who reported a stroke (compared with those who did not), was used to calculate RR ratios. Model 1 controlled for the effects of age, diabetes, sex, education level, body mass index, physical activity level, alcohol consumption and smoking status. Model 2 controlled for the same factors as Model 1, with the addition of arthritis, asthma, cancer, heart disease, high blood cholesterol, high blood pressure, mood disorder and anxiety disorder.
†Defined by responding yes to the question, "Do you suffer from the effects of a stroke?"
‡Of 45 722 respondents without effects of stroke and 682 with effects of stroke.

work by showing associations between all types of sleep disturbances measured in the CCHS, including both short and long sleep duration, as well as the increased risk of co-occurring sleep disturbances in those who have had a stroke. Other studies have shown that sleep disorders are highly prevalent among those who have had a stroke, and that prevalence decreases over time in this population, yet remains significantly elevated.[6,36] Even in the chronic (> 6 mo)[37] phase after stroke, sleep-disordered breathing and insomnia occur in 59%–72% and 32%–50% of people who have had a stroke, respectively.[6,36] Although we did not measure diagnosed sleep disorders, we found that related sleep disturbances, which could be self-reported as part of a screening tool during routine visits,[20] had a similar prevalence among people who reported a stroke.

Limitations

The cross-sectional nature of the CCHS prevents us from establishing whether reported sleep disturbances were present before stroke or developed after stroke. Symptoms related to sleep disturbances have been previously established as both risk factors for and consequences of stroke.[3,17] Data were self-reported and not objectively measured, given the nature of the survey. Although self-reported and objective measures of sleep disturbances may not correlate in the acute phase after stroke, they are correlated at 6 month follow-up.[38] However, we did not know the time between occurrence of stroke and survey completion.

Covariates adjusted in our models were limited by the data available within the CCHS questionnaire. Other potential confounders that may have important impacts on sleep disturbances and that are associated with stroke, such as sleep-disordered breathing, could be considered in future work.[8,17,39] Some covariates may have created an overadjustment bias from collider effects in the cross-sectional data. Despite this, we showed the effect of stroke on several types of sleep disturbances using a model that may have residual confounding but low risk of overadjustment (Model 1) and another that was more comprehensively controlled, but with greater risk of overadjustment (Model 2).

The module of sleep-related questions was administered only in 6 Canadian regions (not including Ontario, the most populous province in Canada). As such, readers should be cautious in generalizing the results beyond the provinces in which data were collected. Our results do not represent a pan-Canadian estimate.

Finally, the overall prevalence of stroke that we observed in CCHS data (1.08%) was lower than that observed in Canadian Chronic Disease Surveillance System (CCDSS) data (2.92%).[40] This lower prevalence of stroke in the CCHS was more pronounced with increasing age (e.g., 0.28% in CCHS v. 0.62% in CCDSS among people aged 35–49 yr, 5.41% in CCHS v. 17.07% in CCDSS among those aged ≥ 80 yr).[40] Data from the CCHS are self-reported by voluntary participants, whereas diagnoses in the CCDSS are based on information from hospital admissions and physician billing data, which are also subject to misclassification bias.[41–43] People who had severe strokes may have been less willing or able to participate in the survey than those with mild strokes or no strokes, which may have created a selection bias in our data. Individuals living in institutions are excluded from CCHS survey coverage,[18] so those who had very severe strokes that resulted in institutionalization would not have been captured. Conversely, the CCHS question, "Do you suffer from the effects of a stroke?" may have caused some people without residual impairments, or those who did not feel they "suffered" from their stroke, to answer "no" to this question. It is difficult to estimate how this incomplete ascertainment may have

biased our findings, as both those with the least and most severe levels of stroke impairment may be under-represented. Future studies could attempt to link CCHS data to other provincial health administrative data sets that include information on the time elapsed since stroke and stroke severity to explore associations with these factors, as well as a wider range of potential confounders and follow-up.

Conclusion

We estimated the prevalence and association of sleep disturbances with stroke, showing that almost two-thirds of people in several regions of Canada who reported having had a stroke also reported at least 1 type of sleep disturbance. The risk of having co-occurring sleep disturbances was also significantly elevated in this group. Sleep disturbances affect quality of life and are highly prevalent among people who have had a stroke. Family physicians and stroke specialists could consider screening for sleep disturbances during routine visits, as an addition to the ongoing care of this population. The adaptation of stroke-specific sleep interventions is an emerging area, and increased knowledge of the high prevalence of these disturbances will help physicians make the best care decisions for patients who have had a stroke.[44]

References

1. Sterr A, Herron K, Dijk D-J, et al. Time to wake-up: sleep problems and daytime sleepiness in long-term stroke survivors. *Brain Inj* 2008;22:575-9.
2. Joundi RA, Patten SB, Williams JVA, et al. Association between excess sleep duration and risk of stroke: a population-based study. *Can J Neurol Sci* 2023; 50:17-22.
3. Li W, Wang D, Cao S, et al. Sleep duration and risk of stroke events and stroke mortality: a systematic review and meta-analysis of prospective cohort studies. *Int J Cardiol* 2016;223:870-6.
4. Yin J, Jin X, Shan Z, et al. Relationship of sleep duration with all-cause mortality and cardiovascular events: a systematic review and dose-response meta-analysis of prospective cohort studies. *J Am Heart Assoc* 2017;6:e005947.
5. He Q, Sun H, Wu X, et al. Sleep duration and risk of stroke: a dose-response meta-analysis of prospective cohort studies. *Sleep Med* 2017;32:66-74.
6. Hasan F, Gordon C, Wu D, et al. Dynamic prevalence of sleep disorders following stroke or transient ischemic attack: systematic review and meta-analysis. *Stroke* 2021;52:655-63.
7. Gottlieb E, Landau E, Baxter H, et al. The bidirectional impact of sleep and circadian rhythm dysfunction in human ischaemic stroke: a systematic review. *Sleep Med Rev* 2019;45:54-69.
8. Duss SB, Brill A-K, Bargiotas P, et al. Sleep-wake disorders in stroke-increased stroke risk and deteriorated recovery? an evaluation on the necessity for prevention and treatment. *Curr Neurol Neurosci Rep* 2018;18:72.
9. Fulk GD, Boyne P, Hauger M, et al. The impact of sleep disorders on functional recovery and participation following stroke: a systematic review and meta-analysis. *Neurorehabil Neural Repair* 2020;34:1050-61.
10. Byun E, Kohen R, Becker KJ, et al. Stroke impact symptoms are associated with sleep-related impairment. *Heart Lung* 2020;49:117-22.
11. Byun E, McCurry SM, Kim B, et al. Sleep disturbance and self-management in adults with subarachnoid hemorrhage: a qualitative study. *Clin Nurs Res* 2022; 31:632-8.
12. McDonald MW, Black SE, Copland DA, et al. Cognition in stroke rehabilitation and recovery research: consensus-based core recommendations from the second Stroke Recovery and Rehabilitation Roundtable. *Int J Stroke* 2019;14:774-82.
13. Leitch S, Logan M, Beishon L, et al. International research priority setting exercises in stroke: a systematic review. *Int J Stroke* 2023;18:133-43.
14. Suh M, Choi-Kwon S, Kim JS. Sleep disturbances after cerebral infarction: role of depression and fatigue. *J Stroke Cerebrovasc Dis* 2014;23:1949-55.
15. Hill G, Regan S, Francis R; Stroke Priority Setting Partnership Steering Group. Research priorities to improve stroke outcomes. *Lancet Neurol* 2022;21: 312-3.
16. Fulk G, Duncan P, Klingman KJ. Sleep problems worsen health-related quality of life and participation during the first 12 months of stroke rehabilitation. *Clin Rehabil* 2020;34:1400-8.
17. Pasic Z, Smajlovic D, Dostovic Z, et al. Incidence and types of sleep disorders in patients with stroke. *Med Arh* 2011;65:225-7.
18. Canadian Community Health Survey: annual component (CCHS). Ottawa: Statistics Canada; 2022 Nov. 30. Available: https://www.statcan.gc.ca/en/survey/household/3226 (accessed 2022 Jan. 22).
19. Douglass AB, Bornstein R, Nino-Murcia G, et al. The Sleep Disorders Questionnaire. I: creation and multivariate structure of SDQ. *Sleep* 1994;17:160-7.
20. Management of chronic insomnia. Toronto: Centre for Effective Practice; 2017. Available: https://tools.cep.health/wp-content/uploads/2021/07/CEP_Management_of_Chronic_Insomnia_2017.pdf (accessed 2022 June 25).
21. Zhao J-L, Cross N, Yao CW, et al. Insomnia disorder increases the risk of subjective memory decline in middle-aged and older adults: a longitudinal analysis of the Canadian Longitudinal Study on Aging. *Sleep* 2022;45:zsac176.
22. Cross NE, Carrier J, Postuma RB, et al. Association between insomnia disorder and cognitive function in middle-aged and older adults: a cross-sectional analysis of the Canadian Longitudinal Study on Aging. *Sleep* 2019;42:zsz114.
23. Garland SN, Rowe H, Repa LM, et al. A decade's difference: 10-year change in insomnia symptom prevalence in Canada depends on sociodemographics and health status. *Sleep Health* 2018;4:160-5.
24. Dai H, Mei Z, An A, et al. Association between sleep problems and health-related quality of life in Canadian adults with chronic diseases. *Sleep Med* 2019;61:26-30.
25. Power JD, Perruccio AV, Badley EM. Pain as a mediator of sleep problems in arthritis and other chronic conditions. *Arthritis Rheum* 2005;53:911-9.
26. Rahim A, McIsaac MA, Aronson KJ, et al. The associations of shift work, sleep quality, and incidence of hypertension in Ontario adults: a population-based study. *Can J Cardiol* 2021;37:513-8.
27. Lix LM, Yogendran MS, Shaw SY, et al. Population-based data sources for chronic disease surveillance. *Chronic Dis Can* 2008;29:31-8.
28. Schuiling WJ, Rinkel GJE, Walchenbach R, et al. Disorders of sleep and wake in patients after subarachnoid hemorrhage. *Stroke* 2005;36:578-82.
29. Krittanawong C, Tunhasiriwet A, Wang Z, et al. Association between short and long sleep durations and cardiovascular outcomes: a systematic review and meta-analysis. *Eur Heart J Acute Cardiovasc Care* 2019;8:762-70.
30. Duss SB, Seiler A, Schmidt MH, et al. The role of sleep in recovery following ischemic stroke: a review of human and animal data. *Neurobiol Sleep Circadian Rhythms* 2016;2:94-105.
31. Khot SP, Morgenstern LB. Sleep and stroke. *Stroke* 2019;50:1612-7.
32. Garcia-Marcos L, Sanchez-Solis M. Does asthma cause sleep disorders … or the other way around? *J Pediatr (Rio J)* 2021;97:366-8.
33. Mogavero MP, DelRosso LM, Fanfulla F, et al. Sleep disorders and cancer: state of the art and future perspectives. *Sleep Med Rev* 2021;56:101409.
34. von Elm E, Altman DG, Egger M, et al.; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;370:1453-7.
35. Burns KEA, Kho ME. How to assess a survey report: a guide for readers and peer reviewers. *CMAJ* 2015;187:E198-205.
36. Cai H, Wang X-P, Yang G-Y. Sleep disorders in stroke: an update on management. *Aging Dis* 2021;12:570-85.
37. Bernhardt J, Hayward KS, Kwakkel G, et al. Agreed definitions and a shared vision for new standards in stroke recovery research: the Stroke Recovery and Rehabilitation Roundtable taskforce. *Int J Stroke* 2017;12:444-50.
38. Bakken LN, Kim HS, Finset A, et al. Subjective sleep quality in relation to objective sleep estimates: comparison, gender differences and changes between the acute phase and the six-month follow-up after stroke. *J Adv Nurs* 2014;70:639-50.
39. Blissitt PA. Sleep-disordered breathing after stroke: nursing implications. *Stroke* 2017;48:e81-4.
40. Canadian Chronic Disease Surveillance System (CCDSS). Ottawa: Public Health Agency of Canada; modified 2021 Dec. 15. Available: https://health-infobase.canada.ca/ccdss/data-tool/ (accessed 2022 Nov. 12).
41. Yu AY, Holodinsky JK, Zerna C, et al. Use and utility of administrative health data for stroke research and surveillance. *Stroke* 2016;47:1946-52.
42. Tu K, Wang M, Young J, et al. Validity of administrative data for identifying patients who have had a stroke or transient ischemic attack using EMRALD as a reference standard. *Can J Cardiol* 2013;29:1388-94.
43. Hall R, Mondor L, Porter J, et al. Accuracy of administrative data for the coding of acute stroke and TIAs. *Can J Neurol Sci* 2016;43:765-73.
44. Boulos MI, Kamra M, Colelli DR, et al. SLEAP SMART (Sleep Apnea Screening Using Mobile Ambulatory Recorders After TIA/Stroke): a randomized controlled trial. *Stroke* 2022;53:710-8.

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