

Original quantitative research

Factors associated with sleep duration across life stages: results from the Canadian Health Measures Survey

Vicky C. Chang, MPH (1,2); Jean-Philippe Chaput, PhD (3,4); Karen C. Roberts, MSc (1); Gayatri Jayaraman, PhD (1); Minh T. Do, PhD (1,2,5)

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Abstract

Introduction: Sleep is essential for both physical and mental well-being. This study investigated sociodemographic, lifestyle/behavioural, environmental, psychosocial and health factors associated with sleep duration among Canadians at different life stages.

Methods: We analyzed nationally representative data from 12 174 Canadians aged 3–79 years in the Canadian Health Measures Survey (2009–2013). Respondents were grouped into five life stages by age in years: preschoolers (3–4), children (5–13), youth (14–17), adults (18–64) and older adults (65–79). Sleep duration was classified into three categories (recommended, short and long) according to established guidelines. Logistic regression models were used to identify life stage-specific correlates of short and long sleep.

Results: The proportion of Canadians getting the recommended amount of sleep decreased with age, from 81% of preschoolers to 53% of older adults. Statistically significant factors associated with short sleep included being non-White and having low household income among preschoolers; being non-White and living in a lone-parent household among children; and second-hand smoke exposure among youth. Boys with a learning disability or an attention-deficit/hyperactivity disorder and sedentary male youth had significantly higher odds of short sleep. Among adults and older adults, both chronic stress and arthritis were associated with short sleep. Conversely, mood disorder and poor/fair self-perceived general health in adults and weak sense of community belonging in adults and older men were associated with long sleep.

Conclusion: Our population-based study identified a wide range of factors associated with short and long sleep at different life stages. This may have implications for interventions aimed at promoting healthy sleep duration.

Keywords: *sleep, life stages, preschoolers, children, youth, adults, older adults*

Introduction

Sleep is essential for the promotion and maintenance of health across all stages of life.¹ However, sleep deprivation has become highly prevalent in modern societies.^{1,2} For example, recent national surveys in Canada showed that approximately

20–30% of children and adolescents^{3,4} and one-third of adults and older adults⁵ sleep less than the recommended amount for their age.

Insufficient sleep has been linked to a number of adverse physical and mental health outcomes, including obesity, diabetes,

cardiovascular disease, injuries, anxiety, depression, neurological disorders and all-cause mortality.² In addition, sleep loss and related disorders contribute to substantial societal and economic burdens resulting from productivity losses and health care costs.^{6,7} There is some evidence suggesting a U-shaped relationship between sleep duration and health outcomes, where both short and long sleep,

Highlights

- A large proportion of Canadians across all life stages do not get the recommended amount of sleep.
- This population-based study identified a wide range of factors associated with sleep duration at different life stages.
- Sociodemographic factors, such as non-White ethnicity, low household income and living in a lone-parent household, are associated with short sleep in younger children.
- Second-hand smoke exposure is associated with short sleep in youth.
- Psychosocial and health-related factors, such as arthritis, chronic stress, self-perceived health, mood disorder, and sense of community belonging, are associated with short and/or long sleep in adults and older adults.

Author references:

1. Public Health Agency of Canada, Ottawa, Ontario, Canada
2. Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada
3. Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada
4. Department of Pediatrics, University of Ottawa, Ottawa, Ontario, Canada
5. Department of Health Sciences, Carleton University, Ottawa, Ontario, Canada

Correspondence: Minh T. Do, Opioid-Related Harms Division, Public Health Agency of Canada, 785 Carling Avenue, Ottawa, ON K1A 0K9; Tel: 613-797-7587; Fax: 613-941-2057; Email: minht.do@canada.ca

especially among adults, are associated with increased risk of chronic diseases.⁸⁻¹⁰ A 2016 systematic review found that shorter sleep in children and youth was associated with excess adiposity, lower quality of life/well-being, and poorer emotional regulation and academic achievement.¹¹

Despite the growing evidence on the health consequences of short (and long) sleep, public health research and education has paid relatively little attention to sleep compared to other health-related behaviours (e.g., diet, physical activity).¹ To better identify targets for interventions aimed at improving sleep, an understanding of factors associated with sleep duration is warranted.

In addition to genetic and physiological factors, sleep duration is likely affected by a combination of behavioural, psychological, social, cultural and environmental factors.¹² Studies in various countries have explored potential correlates of sleep duration among children,¹³⁻¹⁸ adolescents¹⁸⁻²¹ and adults.²²⁻²⁶ For example, sociodemographic factors, such as ethnicity, parental education and household income,¹⁷⁻¹⁹ as well as lifestyle factors, especially screen time (e.g., television, computer),^{15-17,20,21} have been identified as important correlates of sleep duration among children and adolescents. In adults, additional sociodemographic correlates, including employment and marital status, as well as various factors related to lifestyle (e.g., physical activity, smoking) and physical and mental health (e.g., self-rated general health, depression, chronic conditions) were found to affect sleep duration.²²⁻²⁶

To the best of our knowledge, there has not been a detailed assessment of factors associated with sleep duration in the general Canadian population. Given cross-cultural differences in sleep duration and its correlates,²⁶⁻²⁸ identifying determinants of sleep duration in the Canadian context may have important implications for informing the development of future intervention strategies aimed at improving sleep. Furthermore, despite age-related differences in sleep needs and patterns,² previous studies have not comprehensively examined life stage-specific associations between potential correlates and sleep duration within a single population. Hence, the objective of this study was to investigate sociodemographic, lifestyle/behavioural, environmental, psychosocial

and health factors associated with short and long duration of sleep among Canadians at different life stages.

Methods

Data source and study population

This study utilized data from the Canadian Health Measures Survey (CHMS), cycles 2 (2009–2011) and 3 (2012–2013). Details of the CHMS have been described elsewhere.^{29,30} Briefly, the CHMS is an ongoing cross-sectional survey that uses a multi-stage stratified sampling design to collect nationally representative data from the Canadian household population 3–79 years of age. Residents of the three territories, people living on reserves or other Aboriginal settlements, full-time members of the Canadian Forces and residents of institutions and certain remote regions were excluded from the sampling frame. The sample for each cycle represented approximately 96% of the Canadian population in the target age range. The combined (household- and person-level) response rates were 55.5% and 51.7% for cycles 2 and 3, respectively.

The CHMS consists of an in-home household interview that collects information on various sociodemographic, lifestyle and health characteristics, followed by a visit to a mobile examination centre to take direct physical measures (e.g., height, weight). Written informed consent was obtained from respondents aged 14 years and older or from parents/guardians of those younger than 14 years who gave permission to participate. All processes of the CHMS were reviewed and approved by Health Canada and the Public Health Agency of Canada Research Ethics Board.

Analyses for this study were based on all respondents within the target age range (3–79 years) of the CHMS (cycle 2: $n = 6395$; cycle 3: $n = 5785$). Data from two survey cycles were pooled to increase sample size and precision of estimates. To keep consistency of the age groupings, cycle 1 (which covered 6–79 year-olds only) was not included in our analysis. Respondents with missing data on sleep duration ($n = 6$) were excluded, yielding a sample size of 12 174 respondents. To examine sleep duration and its correlates separately by life stage, respondents were grouped into five age categories, including preschoolers (3–4 years), children (5–13 years), youth (14–17 years), adults (18–64 years)

and older adults (65–79 years), consistent with existing sleep duration recommendations.³¹⁻³³

Sleep duration

During the household interview, respondents (or parents/guardians for those aged less than 12 years) were asked to report the number of hours (to the nearest half hour) in a 24-hour period they usually spend sleeping, excluding time spent resting. Respondents were classified into three sleep duration categories (recommended, short or long) according to the *Canadian 24-Hour Movement Guidelines for the Early Years* (preschoolers),³¹ the *Canadian 24-Hour Movement Guidelines for Children and Youth* (children and youth),³² and the United States National Sleep Foundation's sleep time duration recommendations (adults and older adults).³³ The recommended hours of daily sleep were 10–13 hours/day for preschoolers, 9–11 hours/day for children, 8–10 hours/day for youth, 7–9 hours/day for adults and 7–8 hours/day for older adults.³¹⁻³³ Respondents with sleep durations shorter or longer than the recommended range were classified as “short sleepers” or “long sleepers,” respectively.

Correlates

Potential correlates of sleep duration were identified from the existing literature¹³⁻²⁶ as applicable to each age group.

Sociodemographic factors included age (years); sex (male or female); ethnicity (White or non-White); highest level of education (less than secondary school degree, secondary school degree or post-secondary school degree) attained in the household for preschoolers, children and youth or by the respondent for adults and older adults; household type (no children < 18 years of age, couple with children < 18 years or lone-parent with children < 18 years); and household income adequacy. Based on total annual household income and number of people living in the household, household income adequacy was categorized as low (< \$30 000 for 1–2 people, < \$40 000 for 3–4 people, < \$60 000 for ≥ 5 people); middle (\$30 000–\$59 999 for 1–2 people, \$40 000–\$79 999 for 3–4 people, \$60 000–\$79 999 for ≥ 5 people); or high (≥ \$60 000 for 1–2 people, ≥ \$80 000 for ≥ 3 people).³⁴ We also examined marital status (married/common-law, divorced/separated, widowed or

TABLE 1
Characteristics of the study population, by age group, 2009–2013, Canadian Health Measures Survey

Characteristics	Age group (years)				
	Preschoolers (3–4)	Children (5–13)	Youth (14–17)	Adults (18–64)	Older adults (65–79)
Total unweighted, <i>n</i>	802	3 030	1 092	5 905	1 345
Age (years), mean (SE)	3.5 (0.03)	9.0 (0.08)	15.5 (0.07)	41.3 (0.23)	70.6 (0.20)
Sex, female (%)	47.8	48.9	47.7	50.4	52.5
Ethnicity, non-White (%)	35.8	34.0	30.9	25.3	12.4 ^E
Highest level of education^a (%)					
Post-secondary degree	81.4	83.8	80.6	62.8	49.6
Secondary school degree	12.4	12.1	14.3	26.9	19.5
Less than secondary school	6.2 ^E	4.1	5.1 ^E	10.3	30.9
Household income adequacy (%)					
High	45.7	47.0	53.9	51.7	33.2
Middle	24.0	26.9	26.7	28.0	39.7
Low	30.3	26.1	19.4	20.3	27.1
Household type (%)					
No children <18 years	NA	NA	NA	65.4	98.7
Couple with children <18 years	84.1	81.3	75.6	29.9	— ^F
Lone-parent with children <18 years	15.9	18.7	24.4	4.7	— ^F
Marital status (%)					
Married/common-law				62.3	70.1
Divorced/separated	NA	NA	NA	8.0	10.3
Widowed				1.4	16.1
Single (never married)				28.2	3.5 ^E
Employment status (%)					
Full-time				65.6	9.8
Part-time	NA	NA	NA	17.9	9.4
Unemployed				16.5	80.8
Physical activity guideline adherence^b (%)					
Yes	76.9	44.3	23.0	19.2	10.0
No	23.1	55.7	77.0	80.8	90.0
Screen time–based sedentary behaviour guideline adherence^c (%)					
Yes	19.9	30.1	27.6	37.0	26.1
No	80.1	69.9	72.4	63.0	73.9
Second-hand smoke exposure at home (%)					
No	96.3	92.5	88.1	NA	NA
Yes (every day or almost every day)	3.7 ^E	7.5	11.9		
Smoking status (%)					
Never			88.3	52.0	41.1
Former	NA	NA	— ^F	24.7	46.7
Current			10.4	23.3	12.3
Alcohol consumption (%)					
Non-drinker			47.2	16.7	23.0
< once per week			45.3	33.9	28.5
1–6 times per week	NA	NA	7.4	41.4	31.6
Daily			— ^F	8.0	16.8

Continued on the following page

TABLE 1 (continued)
Characteristics of the study population, by age group, 2009–2013, Canadian Health Measures Survey

Characteristics	Age group (years)				
	Preschoolers (3–4)	Children (5–13)	Youth (14–17)	Adults (18–64)	Older adults (65–79)
Self-perceived mental health (%)					
Excellent/very good			75.5	70.7	69.8
Good	NA	NA	19.5	22.0	25.6
Poor/fair			5.0 ^E	7.3	4.6 ^E
Sense of community belonging (%)					
Strong			77.9	61.8	77.9
Weak	NA	NA	22.1	38.2	22.1
Chronic stress (%)					
No				74.6	89.6
Yes	NA	NA	NA	25.4	10.4
Self-perceived general health (%)					
Excellent/very good	84.4	81.6	59.8	53.1	45.7
Good	15.2	16.4	33.7	35.7	38.2
Poor/fair	— ^F	2.0 ^E	6.5 ^E	11.1	16.1
BMI, 3–4 years (%)					
Thin/normal	66.6				
At risk of overweight	23.9	NA	NA	NA	NA
Overweight/obese	9.5 ^E				
BMI, ≥5 years (%)					
Underweight		1.8 ^E	— ^F	1.9	1.3 ^E
Normal		66.7	65.9	38.8	23.8
Overweight	NA	20.3	17.8	33.6	44.4
Obese		11.1	14.2	25.7	30.5
Chronic conditions (%)					
Learning disability/ADHD	1.4 ^E	9.4	13.2	NA	NA
Mood disorder	NA	NA	3.9 ^E	11.9	8.1
Asthma	8.7 ^E	11.4	15.9	10.2	7.2
COPD	NA	NA	NA	2.4	5.9
Arthritis	NA	NA	NA	11.8	43.7
Osteoporosis	NA	NA	NA	3.4	15.2
Diabetes	NA	NA	NA	4.5	16.9
Hypertension	NA	NA	NA	17.9	61.6
Heart disease	NA	NA	NA	2.7	17.2
Stroke	NA	NA	NA	0.7 ^E	3.5 ^E
Cancer	NA	NA	NA	1.3 ^E	3.1 ^E
Thyroid condition	NA	NA	NA	6.1	12.5
Kidney disease	NA	NA	NA	1.6	3.4 ^E
Liver/gallbladder disease	NA	NA	NA	2.5	2.3 ^E

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; BMI, body mass index; COPD, chronic obstructive pulmonary disease; NA, not applicable; SE, standard error.

Note: Means and percentages were weighted using sampling weights.

^a Highest level of education attained in the household (for preschoolers, children and youth) or by the respondent (for adults and older adults).

^b Preschoolers: ≥180 min/day of physical activity (any intensity); children and youth: ≥60 min/day of moderate-to-vigorous physical activity; adults and older adults: ≥150 min/week of moderate-to-vigorous physical activity, in bouts of ≥10 min. Based on respondents with ≥4 valid days of accelerometer data.

^c Recreational screen time of ≤1 h/day for preschoolers and ≤2 h/day for all other age groups.

^e Interpret with caution (coefficient of variation is between 16.6% and 33.3%).

^f Data do not meet Statistics Canada's guidelines for release due to extreme variability (coefficient of variation > 33.3%).

single/never married) and employment status (full-time [≥ 30 hours/week], part-time [< 30 hours/week] or unemployed) among adults and older adults.

Lifestyle/behavioural and environmental factors included physical activity, screen time-based sedentary behaviour, active and/or passive smoking and alcohol consumption.

For consistency with sleep duration, we assessed physical activity and sedentary behaviour based on adherence to current Canadian guidelines.^{31,32,35} Physical activity was objectively measured using an activity monitor (Actical accelerometer) worn by respondents for 7 days following the mobile examination centre visit. Only respondents with 4 or more valid days of accelerometer data (i.e., wear time of ≥ 10 hours [≥ 5 hours for 3–5 year-olds] each day)³⁰ (~75%) were assessed for guideline adherence; those with less than 4 valid days were included as a separate “missing” category for the logistic regression analysis. Preschoolers who accumulated 180 or more minutes of physical activity (any intensity) per day,³¹ children

and youth who accumulated 60 or more minutes of moderate-to-vigorous physical activity per day,³² and adults and older adults who accumulated 150 or more minutes of moderate-to-vigorous physical activity (in bouts ≥ 10 minutes) per week³⁵ were considered to have met the guidelines. Sedentary behaviour was assessed based on parent/guardian- or self-reported recreational screen time (i.e., watching television, playing video games and/or using a computer during leisure-time), with adherence defined as 1 hour/day or less for preschoolers³¹ and 2 hours/day or less for all other age groups.^{32,35}

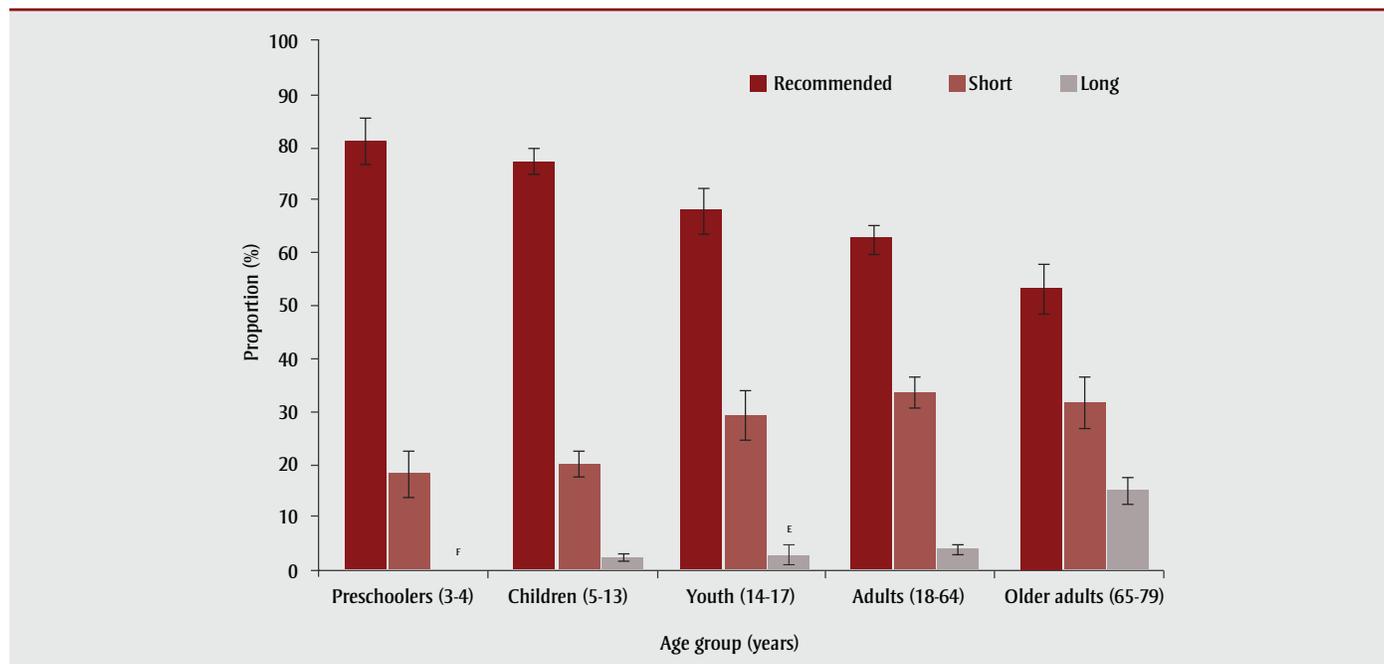
Passive smoking among preschoolers, children and youth was defined as regular (i.e., every day or almost every day) exposure to second-hand smoke at home. Smoking status (never, former or current) and alcohol consumption (non-drinker, less than once per week, 1–6 times per week or daily) were examined in youth, adults and older adults.

We assessed psychosocial factors, including self-perceived mental health (excellent/very good, good or poor/fair) and

sense of belonging to the local community (strong or weak) among youth, adults and older adults. We also examined self-perceived chronic stress (yes [extremely or quite a bit stressful in life] or no [a bit, not very or not at all stressful in life]) in adults and older adults.

Health factors included self- or parent/guardian-perceived general health (excellent/very good, good or poor/fair); body mass index, derived from directly measured weight and height and categorized according to standard World Health Organization cut-offs appropriate for each age group;^{36–38} and presence of each of the following self-reported, health professional-diagnosed chronic conditions: mood disorder, asthma, chronic obstructive pulmonary disease, arthritis, osteoporosis, diabetes, hypertension, heart disease, stroke, cancer, thyroid condition, kidney disease and liver/gall bladder disease. Due to the low prevalence of most chronic conditions among preschoolers, children and youth, we only examined asthma in these age groups and mood disorder in youth. We also examined learning disability or attention-deficit/hyperactivity disorder (ADHD) among preschoolers, children and youth.

FIGURE 1
Proportion of the population in different sleep duration categories, by age group, 2009–2013, Canadian Health Measures Survey



Notes: Error bars represent 95% confidence intervals.

The recommended number of hours of sleep per day are 10–13 for preschoolers, 9–11 for children, 8–10 for youth, 7–9 for adults and 7–8 for older adults.^{31,33} Sleep durations shorter or longer than the recommended range are classified as “short” or “long,” respectively.

^E Interpret with caution (coefficient of variation is between 16.6% and 33.3%).

^F Data do not meet Statistics Canada’s guidelines for release due to extreme variability (coefficient of variation $> 33.3\%$).

Statistical analysis

To account for the complex sampling design of the CHMS, sampling weights were used in all of our analyses, and variance estimates were obtained using the bootstrap method.^{31,32} All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

First, we conducted descriptive analyses to examine the distribution of all variables of interest in the study population and to estimate the proportion of the population in each of the three sleep duration categories, by age group. Next, we used univariable logistic regression to estimate unadjusted associations between potential correlates and short (vs. recommended) sleep duration in each age group, as well as long (vs. recommended) sleep duration in adults and older adults. Because of the small numbers of long sleepers among preschoolers ($n < 10$; $< 1\%$), children ($n = 91$; 2%) and youth ($n = 29$; 3%), we did not model long sleep as an outcome in these age groups. Variables that were statistically significant at $p < .20$ in the univariable analyses were selected as candidates for inclusion in multivariable models and were retained if they remained significant at $p < .20$, or if removing them resulted in greater than 10% change in the odds ratio (OR) for any of the other variables.^{39,40} Age and sex were retained in all multivariable models regardless of statistical significance. We also evaluated potential interactions with sex by including product terms (sex \times correlate), which were retained in the final model if statistically significant at $p < .05$, in which case effect estimates were reported separately for males and females. Respondents with missing data on any of the variables ($< 5\%$) were excluded from the logistic regression analysis to ensure equal samples used for model building.

Results

Characteristics of participants in each age group are shown in Table 1. The study sample ($n = 12\,174$) represented approximately 31.6 million Canadians aged 3–79 years. The proportion of Canadians who slept for the recommended amount of time decreased across life stages (p -trend $< .001$), from 81% of preschoolers and 77% of children to 68%, 63% and 53% of youth, adults and older adults, respectively (Figure 1). The prevalence of short sleep duration increased from

TABLE 2
Crude (unadjusted) logistic regression models for correlates of short (vs. recommended) sleep duration in preschoolers, children and youth

Correlates	Preschoolers (3–4 years old)		Children (5–13 years old)		Youth (14–17 years old)	
	OR	95% CI	OR	95% CI	OR	95% CI
Age, per 1-year increase	0.86	0.47–1.59	1.30	1.18–1.44	1.23	1.03–1.48
Sex						
Male	1.00	Ref	1.00	Ref	1.00	Ref
Female	1.43	0.85–2.41	1.18	0.84–1.66	1.33	0.87–2.04
Ethnicity						
White	1.00	Ref	1.00	Ref	1.00	Ref
Non-White	2.46	1.33–4.53	1.68	1.13–2.49	0.90	0.45–1.79
Highest household education level						
Post-secondary degree	1.00	Ref	1.00	Ref	1.00	Ref
Secondary school degree	1.45	0.68–3.10	1.16	0.62–2.14	1.40	0.84–2.34
Less than secondary school	4.54	0.66–31.4	1.39	0.67–2.88	0.45	0.10–2.12
Household income adequacy						
High	1.00	Ref	1.00	Ref	1.00	Ref
Middle	1.06	0.55–2.05	1.38	0.89–2.15	0.79	0.43–1.44
Low	2.87	1.64–5.03	1.63	1.04–2.56	0.87	0.43–1.76
Household type						
Couple	1.00	Ref	1.00	Ref	1.00	Ref
Lone parent	0.99	0.44–2.22	1.70	1.05–2.75	1.04	0.57–1.88
Physical activity guideline adherence						
Yes	1.00	Ref	1.00	Ref	1.00	Ref
No	0.82	0.43–1.56	1.39	0.93–2.07	0.99	0.47–2.12
Screen time–based sedentary behaviour guideline adherence						
Yes	1.00	Ref	1.00	Ref	1.00	Ref
No	1.28	0.63–2.59	1.60	1.09–2.34	1.55	0.70–3.46
Second-hand smoke exposure at home						
No	1.00	Ref	1.00	Ref	1.00	Ref
Yes (every day/almost every day)	2.01	0.58–6.91	1.70	0.84–3.42	2.00	1.00–4.00
Current smoker						
No					1.00	Ref
Yes		NA		NA	1.44	0.63–3.31
Alcohol consumption						
Non-drinker					1.00	Ref
Less than once per week		NA		NA	1.36	0.83–2.24
At least once per week					1.63	0.53–5.06
Self-perceived mental health						
Excellent/very good					1.00	Ref
Good		NA		NA	1.09	0.58–2.04
Poor/fair					1.72	0.66–4.47
Sense of community belonging						
Strong					1.00	Ref
Weak		NA		NA	1.42	0.81–2.51

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TABLE 2 (continued)
Crude (unadjusted) logistic regression models for correlates of short (vs. recommended) sleep duration in preschoolers, children and youth

Correlates	Preschoolers (3–4 years old)		Children (5–13 years old)		Youth (14–17 years old)	
	OR	95% CI	OR	95% CI	OR	95% CI
Self-perceived general health						
Excellent/very good	1.00	Ref	1.00	Ref	1.00	Ref
Good	1.22 ^a	0.54–2.73	1.80	1.00–3.13	1.06	0.59–1.89
Poor/fair			0.91	0.32–2.61	1.44	0.66–3.14
BMI, 3–4 years						
Thin/normal	1.00	Ref				
At risk of overweight	1.07	0.56–2.03	NA		NA	
Overweight/obese	1.05	0.28–4.01				
BMI, ≥5 years						
Underweight			0.77	0.19–3.21	0.60	0.02–17.8
Normal		NA	1.00	Ref	1.00	Ref
Overweight			1.51	0.95–2.41	0.93	0.51–1.69
Obese			1.75	1.04–2.95	1.37	0.59–3.19
Asthma						
No	1.00	Ref	1.00	Ref	1.00	Ref
Yes	0.64	0.19–2.19	1.14	0.67–1.94	1.36	0.68–2.74
Learning disability/ADHD						
No	1.00	Ref	1.00	Ref	1.00	Ref
Yes	1.10	0.001–994.2	1.75	0.95–3.25	1.29	0.64–2.63
Mood disorder						
No					1.00	Ref
Yes		NA		NA	2.67	1.05–6.83

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; BMI, body mass index; CI, confidence interval; NA, not applicable; OR, odds ratio; Ref, reference category.

^a Due to small cell sizes, the two categories (“good” and “poor/fair”) were combined in the analysis for preschoolers.

approximately 20% in preschoolers and children to 29% in youth and 34% in adults and 32% in older adults. Less than 5% of Canadians in each age group reported sleeping longer than the recommended range, with the exception of older adults (15%).

Unadjusted associations between potential correlates and short and long sleep are shown in Tables 2 and 3.

Table 4 presents life stage-specific multivariable models for correlates of short sleep. Among preschoolers, ethnicity (non-White vs. White; OR = 1.94, 95% confidence interval [CI]: 1.03–3.65) and household income adequacy (low vs. high; OR = 2.59, 95% CI: 1.12–5.65) were significantly associated with short sleep. Children who were non-White (OR = 2.08, 95% CI: 1.42–3.04) or living in a lone-parent household (OR = 1.76,

95% CI: 1.07–2.91), as well as youth regularly exposed to second-hand smoke at home (OR = 2.54, 95% CI: 1.25–5.16), had significantly higher odds of short sleep. In addition, interactions with sex ($p < .05$) were noted for learning disability/ADHD in children and screen time-based sedentary behaviour in youth, with significant associations observed among boys only. Chronic stress in both adults (OR = 1.63, 95% CI: 1.14–2.33) and older adults (OR = 1.95, 95% CI: 1.01–3.87); arthritis in both adults (OR = 1.53, 95% CI: 1.08–2.16) and older adults (OR = 1.42, 95% CI: 1.01–1.98); being non-White (OR = 1.41, 95% CI: 1.11–1.79) and having poor/fair self-perceived mental health (OR = 1.82, 95% CI: 1.24–2.69) in adults; and less than secondary school education (OR = 1.83, 95% CI: 1.22–2.75) in older adults were all significantly associated with short sleep (Table 4). Conversely, female (vs. male) adults (OR = 0.76, 95%

CI: 0.59–0.98) and older adults who were unemployed (OR = 0.46, 95% CI: 0.22–0.96) or employed part-time (OR = 0.40, 95% CI: 0.18–0.87) and those with a mood disorder (OR = 0.46, 95% CI: 0.25–0.85) were less likely to have short sleep.

Table 5 presents multivariable models for correlates of long sleep among adults and older adults. In both age groups, less than secondary school education (vs. post-secondary degree) was significantly associated with long sleep. Adults living as a couple with children younger than 18 years (vs. no children) were less likely (OR = 0.41, 95% CI: 0.17–0.96) to have longer sleep than the recommended duration, while unemployed (vs. employed) older adults were more likely (OR = 3.52, 95% CI: 1.02–12.2) to sleep longer than the recommended duration. A weak sense of community belonging (OR = 2.09, 95% CI: 1.21–3.61), poor/fair self-perceived general health (OR = 2.50, 95% CI: 1.21–5.18) and mood disorder (OR = 3.06, 95% CI: 1.40–6.69) in adults, as well as a weak sense of community belonging in older men (OR = 3.58, 95% CI: 1.97–6.52) were also associated with long sleep.

Discussion

Even at a young age, a large proportion of Canadians do not get the recommended amount of sleep, with a prevalence of short sleep duration ranging from approximately one-fifth of preschoolers and children to one-third of youth, adults and older adults. In contrast, long sleep duration is relatively uncommon except in older adults.

Our analysis of a large-scale population-based survey identified a wide range of factors associated with short and long sleep at different stages of life. Notably, sociodemographic factors (e.g., ethnicity, household income, lone-parent household) appeared to play a stronger role in determining sleep duration in preschoolers and children, whereas environmental and lifestyle factors (e.g., second-hand smoke exposure, screen time-based sedentary behaviour) may be more important in youth. In addition to sociodemographic factors (e.g., education, employment status), several psychosocial and health-related factors, including arthritis, chronic stress, mood disorder, self-perceived general or mental health and sense of community belonging, were found to be associated with short and/or long sleep among adults and older adults.

TABLE 3
Crude (unadjusted) logistic regression models for correlates of short and long sleep duration in adults (18–64 years) and older adults (65–79 years)

Correlates	Short (vs. recommended) sleep				Long (vs. recommended) sleep			
	Adults		Older adults		Adults		Older adults	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age, per 1-year increase	1.01	1.00–1.02	0.98	0.94–1.01	0.99	0.96–1.01	1.02	0.97–1.07
Sex								
Male	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Female	0.80	0.63–1.01	1.13	0.77–1.66	1.15	0.72–1.86	1.00	0.64–1.56
Ethnicity								
White	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Non-White	1.29	1.05–1.59	1.42	0.84–2.41	0.90	0.48–1.66	0.63	0.26–1.52
Highest respondent education level								
Post-secondary degree	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Secondary school degree	1.17	0.89–1.54	0.91	0.53–1.57	2.83	1.48–5.40	1.58	0.85–2.91
Less than secondary school	1.23	0.89–1.70	1.81	1.17–2.79	3.99	1.70–9.35	2.78	1.55–5.00
Household income adequacy								
High	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Middle	1.09	0.86–1.39	0.97	0.56–1.68	1.43	0.74–2.78	1.65	0.88–3.08
Low	1.18	0.90–1.55	1.17	0.66–2.06	1.95	0.99–3.83	2.88	1.41–5.85
Household type								
No children <18 years	1.00	Ref			1.00	Ref		
Couple with children <18 years	1.19	0.88–1.60		NA	0.28	0.14–0.57		NA
Lone-parent with children <18 years	1.47	0.80–2.69			0.72	0.38–1.37		
Marital status								
Married/common-law	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Divorced/separated	1.59	1.00–2.55	1.73	0.94–3.18	1.86	0.53–6.52	2.01	0.94–4.54
Widowed	2.04	0.96–4.31	1.16	0.77–1.73	1.70	0.01–211.8	0.73	0.39–1.36
Single (never married)	0.89	0.67–1.17	0.75	0.30–1.89	2.03	1.07–3.82	1.87	0.81–4.33
Employment status								
Full-time	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Part-time	0.76	0.56–1.03	0.36	0.17–0.77	2.77	1.44–5.35	2.37	0.65–8.68
Unemployed	1.00	0.78–1.28	0.48	0.25–0.92	3.06	1.47–6.37	3.93	1.33–11.6
Physical activity guideline adherence								
Yes	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
No	1.23	0.81–1.86	0.73	0.39–1.39	1.51	0.35–6.51	0.83	0.28–2.45
Screen time–based sedentary behaviour guideline adherence								
Yes	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
No	0.85	0.69–1.05	0.97	0.61–1.54	2.39	1.27–4.52	0.86	0.51–1.43
Smoking status								
Never	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Former	1.08	0.84–1.38	0.90	0.58–1.41	1.53	0.66–3.52	1.33	0.89–1.98
Current	1.37	1.11–1.67	0.32	0.68–2.57	2.12	1.11–4.08	1.87	0.90–3.87
Alcohol consumption								
Non-drinker	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
< once per week	0.83	0.54–1.27	0.94	0.54–1.64	0.98	0.52–1.83	0.65	0.32–1.29
1–6 times per week	0.78	0.56–1.09	0.88	0.45–1.72	0.57	0.25–1.29	0.73	0.36–1.46
Daily	0.83	0.50–1.36	0.61	0.36–1.03	0.72	0.26–2.04	0.59	0.30–1.18

Continued on the following page

TABLE 3 (continued)
Crude (unadjusted) logistic regression models for correlates of short and long sleep duration in adults (18–64 years)
and older adults (65–79 years)

Correlates	Short (vs. recommended) sleep				Long (vs. recommended) sleep			
	Adults		Older adults		Adults		Older adults	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Self-perceived mental health								
Excellent/very good	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Good	1.43	1.07–1.93	1.15	0.71–1.86	1.55	0.81–2.95	1.30	0.71–2.37
Poor/fair	2.71	1.95–3.75	1.16	0.43–3.12	4.85	1.58–14.9	1.18	0.39–3.52
Sense of community belonging								
Strong	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Weak	1.30	1.02–1.65	1.58	0.96–2.61	2.39	1.38–4.13	1.95	1.20–3.16
Chronic stress								
No	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Yes	1.93	1.39–2.67	2.09	1.05–4.13	1.28	0.73–2.27	1.25	0.55–2.84
Self-perceived general health								
Excellent/very good	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Good	1.47	1.10–1.97	1.44	1.07–1.92	1.89	1.01–3.54	0.96	0.61–1.50
Poor/fair	2.07	1.48–2.88	2.02	1.31–3.11	5.24	2.67–10.3	1.24	0.66–2.35
BMI								
Underweight	1.37	0.49–3.84	0.94	0.03–35.1	1.61	0.04–71.5		– ^a
Normal	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref
Overweight	1.14	0.89–1.47	1.38	0.89–2.15	0.82	0.38–1.80	1.22	0.62–2.40
Obese	1.11	0.85–1.44	1.26	0.87–1.83	1.63	0.90–2.93	1.76	0.93–3.35
Chronic conditions (yes vs. no)								
Mood disorder	1.37	1.06–1.77	0.59	0.32–1.08	4.34	2.12–8.82	0.61	0.29–1.27
Asthma	1.05	0.67–1.65	1.98	0.96–4.10	2.18	0.88–5.39	1.93	0.73–5.08
COPD	1.29	0.75–2.25	1.02	0.54–1.93	2.51	1.01–6.23	0.69	0.31–1.55
Arthritis	1.69	1.20–2.40	1.47	1.05–2.07	1.25	0.47–3.34	1.03	0.64–1.65
Osteoporosis	1.35	0.83–2.20	1.12	0.67–1.86		– ^a	0.85	0.43–1.70
Diabetes	1.47	0.80–2.69	1.04	0.58–1.88	1.30	0.30–5.53	1.56	0.82–2.96
Hypertension	1.23	0.90–1.66	1.01	0.62–1.63	1.21	0.48–3.09	1.37	0.81–2.33
Heart disease	1.38	0.82–2.35	1.05	0.66–1.66		– ^a	1.11	0.69–1.77
Stroke	1.48	0.30–7.37	1.43	0.33–6.20		– ^a	1.99	0.53–7.49
Cancer	0.70	0.30–1.65	0.91	0.43–1.89	3.38	0.03–44.7	0.93	0.30–2.85
Thyroid condition	0.98	0.64–1.49	0.73	0.41–1.28	1.09	0.10–11.9	0.75	0.37–1.51
Kidney dysfunction/disease	1.01	0.49–2.08	2.19	0.72–6.62		– ^a	1.01	0.04–23.4
Liver/gallbladder disease	1.07	0.45–2.53	0.83	0.25–2.72	1.95	0.07–56.3		– ^a

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; CI, confidence interval; NA, not applicable; OR, odds ratio; Ref, reference category.

^a Estimate suppressed due to extreme variability.

The prevalence estimates of short sleep duration in our study are similar to those reported previously in Canada^{4,5,41} and the USA,^{18,42} although differences in age groupings and methods of assessing sleep duration may have contributed to some inconsistencies. For example, based on child-reported sleep duration averaged across all days of the week, a 2016 Canadian study found that short sleepers

were more common among children aged 10–13 years (31%) than among those aged 14–17 years (26%),³ whereas short sleepers were more common among youth aged 14–17 years (29%) than among children aged 5–13 years (20%) in our study.

Our results for the associations between sociodemographic factors and short sleep duration in the younger age groups are in

line with previous research.^{17,43} For example, a recent United States birth cohort study showed that low maternal education, low household income and ethnicity (Black, Hispanic and Asian vs. White children) were associated with chronic sleep curtailment from infancy to mid-childhood.¹⁷ The influence of sociocontextual factors on sleep at a young age may be related to variations in bedtime routines

TABLE 4
Multivariable logistic regression models for correlates of short (vs. recommended) sleep duration in preschoolers, children, youth, adults and older adults

Correlates	OR	95% CI
Preschoolers, 3–4 years (n = 775)		
Sex (female vs. male)	1.42	0.83–2.44
Ethnicity (non-White vs. White)	1.94	1.03–3.65
Highest household education level		
Post-secondary degree	1.00	Ref
Secondary school degree	0.99	0.40–2.49
Less than secondary school	2.81	0.36–22.2
Household income adequacy		
High	1.00	Ref
Middle	1.07	0.52–2.19
Low	2.59	1.12–5.65
Household type (lone-parent vs. couple)	0.53	0.16–1.73
Children, 5–13 years (n = 2 848)		
Ethnicity (non-White vs. White)	2.08	1.42–3.04
Household type (lone-parent vs. couple)	1.76	1.07–2.91
Sedentary behaviour guideline adherence (no vs. yes)	1.41	0.92–2.16
Learning disability/ADHD ^a (yes vs. no)		
Males	3.13	1.40–6.99
Females	0.73	0.35–1.52
Youth, 14–17 years (n = 1 001)		
Highest household education level		
Post-secondary degree	1.00	Ref
Secondary school degree	1.44	0.73–2.83
Less than secondary school	0.39	0.07–2.02
Household income adequacy		
High	1.00	Ref
Middle	0.66	0.34–1.29
Low	0.80	0.37–1.74
Second-hand smoke exposure at home (yes vs. no)	2.54	1.25–5.16
Sedentary behaviour guideline adherence ^b (no vs. yes)		
Males	4.32	1.37–13.6
Females	1.00	0.46–2.17
Mood disorder (yes vs. no)	1.84	0.67–5.03
Adults, 18–64 years (n = 5 445)		
Sex (female vs. male)	0.76	0.59–0.98
Ethnicity (non-White vs. White)	1.41	1.11–1.79
Sedentary behaviour guideline adherence (no vs. yes)	0.80	0.64–1.01
Smoking status		
Never	1.00	Ref
Former	0.98	0.72–1.32
Current	1.21	0.97–1.50
Self-perceived mental health		
Excellent/very good	1.00	Ref
Good	1.22	0.90–1.67
Poor/fair	1.82	1.24–2.69

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or behaviours (e.g., regular bedtime, parent-child interactive routines) across families of different structures (e.g., lone-parent vs. couple), cultures and socioeconomic status,^{44,45} as well as factors such as family stress and the living/bedroom environment (e.g., noise, crowding).^{17,18} Furthermore, our findings support existing evidence on the links between learning disability/ADHD and sleep deprivation or disturbances in children, possibly relating to shared neurobiological pathways and effects of ADHD medications.^{46,47} In particular, the significant association noted in boys alone is consistent with studies reporting a higher prevalence of sleep problems in boys (vs. girls) with ADHD.^{48,49} However, a more detailed examination of sleep in relation to specific subtypes of learning disability/ADHD in boys and girls is warranted to further understand the moderating role of gender.⁴⁹

While active smoking has been previously linked to short sleep duration and sleep problems among adolescents,^{50,51} our study is one of the very few demonstrating an association between second-hand smoke exposure and short sleep duration in this age group. These results are similar to a recent British Columbia study that assessed overall second-hand smoke exposure rather than exposure in the home environment.⁵² Possible mechanisms through which second-hand smoke exposure may interfere with sleep include nicotine-stimulating effect, nicotine withdrawal at night and disruption of pulmonary function.^{52,53} Future studies, including those with objective measures of second-hand smoke, are warranted to confirm these findings.

Despite evidence suggesting that screen time is inversely associated with sleep duration in children and adolescents,⁵⁴ we only found a significant association among male youth. Sex has also been noted as an effect modifier in several other studies where male adolescents were more likely to show an association between television watching and short sleep compared to female adolescents.^{54,55} These age and gender differences may be related to the type and timing (e.g., bedtime) of screen time exposure.

In addition to sociodemographic characteristics, psychosocial and mental health-related factors appeared to play an important role in sleep duration among

TABLE 4 (continued)
Multivariable logistic regression models for correlates of short (vs. recommended) sleep duration in preschoolers, children, youth, adults and older adults

Correlates	OR	95% CI
Sense of community belonging (weak vs. strong)	1.20	0.93–1.54
Chronic stress (yes vs. no)	1.63	1.14–2.33
Self-perceived general health		
Excellent/very good	1.00	Ref
Good	1.25	0.91–1.71
Poor/fair	1.34	0.91–1.97
Arthritis (yes vs. no)	1.53	1.08–2.16
Cancer (yes vs. no)	0.57	0.26–1.23
Older adults, 65–79 years (n = 1 094)		
Sex (female vs. male)	1.20	0.76–1.89
Ethnicity (non-White vs. White)	1.48	0.86–2.55
Highest respondent education level		
Post-secondary degree	1.00	Ref
Secondary school degree	0.99	0.59–1.66
Less than secondary school	1.83	1.22–2.75
Marital status		
Married/common-law	1.00	Ref
Divorced/separated	1.54	0.87–2.73
Widowed	1.05	0.65–1.80
Single (never married)	0.64	0.19–2.12
Employment status		
Full-time	1.00	Ref
Part-time	0.40	0.18–0.87
Unemployed	0.46	0.22–0.96
Sense of community belonging (weak vs. strong)	1.51	0.86–2.65
Chronic stress (yes vs. no)	1.95	1.01–3.87
Mood disorder (yes vs. no)	0.46	0.25–0.85
Arthritis (yes vs. no)	1.42	1.01–1.98
Asthma (yes vs. no)	1.79	0.78–4.08
Kidney disease (yes vs. no)	1.98	0.67–5.87

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; CI, confidence interval; OR, odds ratio; Ref, reference category.

Note: All models adjusted for age (continuous). Models for children, youth and adults additionally adjusted for age squared to account for the nonlinear relationship between age and short sleep duration.

^a *p*-value for sex × learning disability/ADHD interaction term = 0.004.

^b *p*-value for sex × sedentary behaviour guideline adherence interaction term = 0.02.

adults and older adults in our study. These findings are consistent with previous research,^{23–26} although it should be noted that the relationship between mental health and sleep is bidirectional and likely involves a complex interplay between biological and behavioural factors.⁵⁶ Notably, in contrast to studies reporting associations between lifestyle/behavioural factors and sleep duration in adults,^{22–24} these factors were not significant in our study, although unadjusted models suggested a possible link between

current smoking and both short and long sleep in adults (Table 3).

Our results also highlight the importance of examining specific determinants of both short and long sleep durations. For example, while a high level of self-perceived lifetime stress (possibly a marker of coping ability) was associated with short sleep, having been diagnosed with a mood disorder (e.g., depression) was associated with long sleep, suggesting different measures or domains of mental

health may affect sleep differently. Moreover, the association between arthritis and short sleep observed in both adults and older adults is likely mediated through pain-related sleep problems.⁵⁷ Finally, our finding of an association between sense of community belonging and long sleep is novel and warrants additional research with regard to the role of community-level factors (e.g., social support) contributing to healthy sleep durations, including potential sex differences.

Strengths and limitations

Strengths of our study included the population-based design, large sample size, use of evidence-informed recommendations to define sleep duration categories,^{31–33} detailed assessment of a wide range of factors associated with both short and long sleep, and investigation of the associations, including potential sex differences, by life stage.

Our study had several limitations. First, sleep duration was assessed based on self- or parent/guardian-reported information, which has generally been shown to overestimate actual sleep duration and potentially bias the observed relationships between sleep duration and related factors or health outcomes.^{58,59} Including objective measurements of sleep, such as actigraphy-assessed sleep duration, may help reduce bias associated with measurement errors in future studies.⁵⁸ Similarly, with the exceptions of body mass index and physical activity, all other factors were assessed by self- or parent/guardian-reports, which were subject to social desirability and recall bias.

Second, given the cross-sectional nature of the CHMS, the temporality of associations could not be established. For example, while chronic stress may have contributed to short sleep duration among adults and older adults, it is also possible that inadequate sleep resulted in chronic stress.

Third, due to insufficient sample size, young adults (aged 18–24 years) were not examined as a separate life stage in our analyses; this age group may have distinct sleep patterns and correlates of sleep duration that warrant further research.

Fourth, the sleep questionnaire in the CHMS did not include details such as time

TABLE 5
Multivariable logistic regression models for correlates of long (vs. recommended) sleep duration in adults and older adults

Correlates	OR	95% CI
Adults, 18–64 years (n = 3 882)		
Sex (female vs. male)	1.10	0.64–1.91
Highest respondent education level		
Post-secondary degree	1.00	Ref
Secondary school degree	1.88	0.94–3.75
Less than secondary school	3.25	1.31–8.04
Household type		
No children <18 years	1.00	Ref
Couple with children <18 years	0.41	0.17–0.96
Lone-parent with children <18 years	0.48	0.15–1.51
Employment status		
Full-time	1.00	Ref
Part-time	1.96	0.97–3.94
Unemployed	1.64	0.68–3.97
Sedentary behaviour guideline adherence (no vs. yes)	1.56	0.78–3.11
Self-perceived general health		
Excellent/very good	1.00	Ref
Good	1.33	0.74–2.37
Poor/fair	2.50	1.21–5.18
Sense of community belonging (weak vs. strong)	2.09	1.21–3.61
Mood disorder (yes vs. no)	3.06	1.40–6.69
Older adults, 65–79 years (n = 913)		
Highest respondent education level		
Post-secondary degree	1.00	Ref
Secondary school degree	1.56	0.85–2.88
Less than secondary school	2.23	1.24–4.03
Household income adequacy		
High	1.00	Ref
Middle	1.32	0.68–2.58
Low	2.01	0.96–4.17
Employment status		
Full-time	1.00	Ref
Part-time	2.72	0.75–9.90
Unemployed	3.52	1.02–12.2
Sense of community belonging ^a (weak vs. strong)		
Males	3.58	1.97–6.52
Females	1.28	0.62–2.62
Mood disorder (yes vs. no)	0.61	0.28–1.31

Abbreviations: CI, confidence interval; OR, odds ratio; Ref, reference category.

Note: All models adjusted for age (continuous).

^a *p*-value for sex × sense of community belonging interaction term = 0.02.

spent napping and sleep duration on weekdays compared to weekends, which may provide additional insights into the role of different factors in determining sleep duration. Finally, despite the broad range of potential correlates evaluated, the CHMS lacked information on other factors that may affect sleep duration, such as shift work, caffeine intake and the bedroom environment.

Conclusion

Short sleep duration is highly prevalent among Canadians across all stages of life. The present study provides the first detailed examination of correlates of sleep duration in a nationally representative sample of Canadians. Although more research is needed to disentangle the complex interrelations between various factors and sleep, surveillance efforts should continue to monitor sleep and related factors to inform public policies aimed at promoting healthy sleep duration across life stages.

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Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions and statement

VC and MD conceptualized the study. VC conducted the data analyses, interpreted the results and drafted the manuscript. JC, KR, GJ and MD contributed to the interpretation of results and critically reviewed and revised the manuscript. All authors approved the final version submitted.

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