

Effects of Season and Daylight Saving Time Shifts on Sleep Symptoms

Canadian Longitudinal Study on Aging

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Abstract

Background and Objectives

There has been conflicting evidence regarding the association between seasonal changes and daylight saving time (DST) and sleep disorders. This topic is of particular interest currently because the United States and Canada are considering the elimination of seasonal clock changes. The aim of this study was to compare sleep symptoms among participants who were interviewed in different seasons and before/after the transition into DST and standard time (ST).

Methods

A total of 30,097 people aged 45–85 years taking part in the Canadian Longitudinal Study on Aging were studied. Participants completed a questionnaire on sleep duration, satisfaction, sleep-onset insomnia, sleep-maintenance insomnia, and hypersomnolence symptoms. Sleep disorders were compared between participants who were interviewed during different seasons and at different times of the year (DST/ST). Data were analyzed using χ^2 , analysis of variance, binary logistic, and linear regression tests.

Results

Among participants interviewed in different seasons, we found no difference in dissatisfaction with sleep, sleep onset, sleep maintenance, and hypersomnolence. Those interviewed in summer had slightly shorter sleep duration compared with those in winter (6.76 ± 1.2 vs 6.84 ± 1.3 hours). Participants interviewed 1 week before vs 1 week after DST transition showed no difference in sleep symptoms, except for a 9-minute decrease in sleep duration a week after transition. However, those who were interviewed a week after transition to ST compared with a week before reported more dissatisfaction with sleep (28% vs 22.6%, adjusted odds ratio [aOR] 1.34, 95% CI 1.02–1.76), higher sleep-onset insomnia (7.1% vs 3.3%, aOR 2.26, 95% CI 1.19–4.27), higher sleep-maintenance insomnia (12.9% vs 8.2%, aOR 1.64, 95% CI 1.02–2.66), and more hypersomnolence with adequate sleep (7.3% vs 3.6%, aOR 2.08, 95% CI 1.14–3.79).

Discussion

We found small seasonal variations in sleep duration but no difference in other sleep symptoms. The transition from DST to ST was associated with a transient increase in sleep disorders.

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Glossary

aOR = adjusted odds ratio; CLSA = Canadian Longitudinal Study on Aging; DST = daylight saving time; ST = standard time.

Sleep plays an essential role in maintaining good health, mood, cognition, job performance, and social activity. Physiologic processes that affect sleep behavior are influenced by the circadian rhythm. Circadian rhythms are roughly 24-hour physiologic cycles which are mediated by the suprachiasmatic nucleus of the hypothalamus and serve as the main driving force behind sleep-wake cycles. The circadian rhythm organizes several endogenous factors, such as core body temperature, releasing of melatonin and other hormones, and cell division.^{1,2} It also receives input from several exogenous factors, also known as zeitgebers, which include light exposure, ambient temperature, physical/mental activity, meals, etc.²⁻⁴

Of these exogenous influences, light exposure is one of the most important modulators of circadian rhythms. Because low core body temperature and the absence of light induce sleep, sleep may vary across seasons, with longer sleep durations documented in winter and shorter durations in summer.⁵ Light exposure early in the night delays the circadian phase while light exposure in the morning advances the phase, leading to earlier bedtimes and awakenings.^{3,6}

When exogenous factors do not align with one's endogenous circadian rhythms, people experience circadian malalignment. Jet lag, night shifts, and the transitions between the daylight saving time (DST) and the standard time (ST) are common situations associated with circadian malalignment.⁷⁻⁹ Jet lag and the transitions between DST and ST cause temporary circadian malalignment as individuals eventually adapt to their new schedule.^{7,9} Nevertheless, such malalignment has been associated with sleep disruption, neurocognitive dysfunction, fatigue, sleepiness, and decreased mood. For example, it has been estimated that sleep problems also account for roughly 13% of workplace injuries.¹⁰ According to the American Sleep Society, drowsy driving results in over 1,500 deaths and 40,000 injuries each year in the United States alone.¹¹ Some studies suggest possible chronic effects on negative health and performance outcomes,^{7,9} metabolic dysfunction (i.e., diabetes, obesity, proinflammatory states),¹² cardiovascular disease, and increased mortality.¹³

The transitions to and from DST have been associated with higher rates of car accidents¹⁴ as well as an increased risk of stroke and hospital visits,^{15,16} myocardial infarction,^{17,18} and general accidents.¹⁶ In a recent survey conducted by the American Academy of Sleep Medicine, respondents were most likely to use the "extra hour" gained in the Fall, during the transition to ST, to catch up on sleep.¹⁹ Is this increased sleep duration responsible for these negative outcomes? Are sleep disturbances different when transitioning to DST in spring as compared with ST in the Fall?

To shed some light on these questions, we conducted a cross-sectional study using data collected as part of the Canadian

Longitudinal Study on Aging (CLSA). Specifically, the goal of this study was to (1) assess whether participants reported seasonal variations in sleep satisfaction, quantity, and sleep disorders and (2) determine whether transitions in and out of DST/ST were associated with different levels of sleep disturbances. Because the United States and Canada have recently begun to discuss the possibility of removing the time changes indefinitely, this topic has taken on an even greater significance.

Methods

Study Population

The CLSA is a comprehensive nationwide study in Canada, involving 30,097 participants aged 45–85 years, who were randomly selected from 7 provinces (recruitment methods are described elsewhere). Data were collected through a combination of in-home visits, on-site visits, and telephone interviews. This analysis focuses on the baseline data gathered between 2011 and 2015.²⁰

Standard Protocol Approvals, Registrations, and Patient Consents

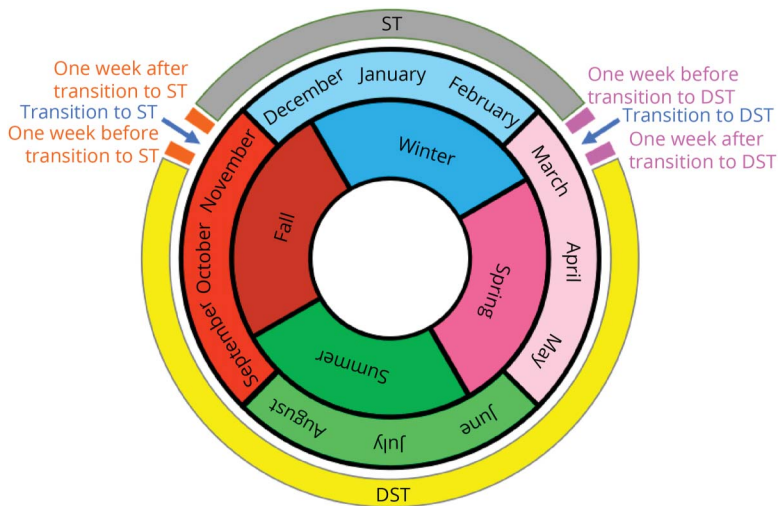
The CLSA protocol received approval from 13 research ethics boards across Canada.²¹ All participants provided their informed consent before participation.²⁰

Measurements of Sleep Symptoms

At baseline, participants were questioned about their sleep satisfaction, number of hours they slept per day, the presence of sleep-onset and maintenance insomnia disorders, and the presence of hypersomnolence disorder. These questions were based on the criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*. Details of the questionnaires can be found in our previous study²² and in the eMethods (links.lww.com/WNL/C788).

1. Sleep pattern dissatisfaction was determined by the question "How satisfied or dissatisfied are you with your current sleep pattern?"²³ recorded on a 5-point Likert scale. Participants were then divided into 2 categories: dissatisfied (those answering "very dissatisfied" or "dissatisfied") vs not dissatisfied (those answering "neutral," "satisfied," or "very satisfied").
2. Number of hours of actual nighttime sleep in the past month (numeric variable).
3. Difficulty initiating sleep was queried as "Over the last month, how often did it take you more than 30 minutes to fall asleep?"²⁴ Those reporting this symptom ≥ 3 nights per week were considered to have difficulty initiating sleep. Sleep-onset insomnia disorder was defined as sleep dissatisfaction, along with difficulty initiating sleep ≥ 3

Figure Schematic Diagram of Time Periods



One week before transition to daylight saving time (DST), 1 week after transition to DST, getting used to DST, 1 week before transition to standard time (ST), 1 week after transition to ST, and getting used to ST.

nights per week that moderately or severely affected their function and lasted ≥ 3 months. Note that to accurately assess the acute changes in sleep after the transition to DST/ST, we excluded “duration ≥ 3 months” from all criteria of sleep disorders (i.e., sleep-onset insomnia, sleep-maintenance insomnia, and hypersomnolence disorders) for comparisons before vs after the transition to DST/ST.

4. Difficulty maintaining sleep was assessed by asking “Over the last month, how often did you wake in the middle of the night or too early in the morning and found it difficult to fall asleep again?”²⁴ Participants who reported this ≥ 3 nights per week were considered to have symptoms of sleep-maintenance insomnia. Sleep-maintenance insomnia disorder was defined as dissatisfaction with the sleep pattern and difficulty maintaining sleep for a minimum of 3 nights per week that moderately or severely affected the participant’s ability to function and lasted ≥ 3 months.
5. Difficulty staying awake was queried as “Over the last month, how often do you find it difficult to stay awake during your normal waking hours when you want to?”²⁴ Participants who reported this happening at least 3 times per week were considered to have symptoms of excessive sleepiness. Hypersomnolence with adequate sleep was defined as this difficulty staying awake for ≥ 3 days per week despite reporting at least 7 hours of sleep, lasting ≥ 3 months (owing to a low number of participants reporting dysfunction from difficulty staying awake, the requirement of dysfunction was not included in the definition of this disorder). In this study, hypersomnolence disorder was termed “hypersomnolence with adequate sleep” to avoid confusion with standard definitions of hypersomnolence disorder.

Date of Interview

The sleep module of CLSA was evaluated as part of the in-home interview, and the interview date was recorded. We

correlated each interview date with the season during which it was conducted.

Similarly, according to the National Research Council, the second Sunday in March marks the beginning of DST (clocks turn forward by 1 hour) and the first Sunday of November marks the beginning of ST (clocks turn backward by 1 hour).²⁵ We analyzed 6 time periods: (1) 1 week before transition to DST, (2) 1 week after transition to DST, (3) established DST, (4) 1 week before transition to ST, (5) 1 week after transition to ST, and (6) established ST (Figure). The exact dates of these transitions are presented in eTable 1 (links.lww.com/WNL/C788).

To examine the seasonal variation of sleep disorders and the association between time zone and sleep disorders, we compared sleep variables among participants who were interviewed during different seasons and time zones. Primary and secondary objectives are as follows:

1. Comparison of sleep disorders among participants who were interviewed in different seasons;
2. Comparison of sleep disorders among participants interviewed during 1 week before vs 1 week after transition to DST; and
3. Comparison of sleep disorders among participants interviewed during 1 week before vs 1 week after transition to ST.

Further sensitivity and secondary analyses are presented in eResults (eTables 2–6, links.lww.com/WNL/C788).

Statistical Analysis

Statistical analysis was conducted using SPSS version 24. Descriptive results were presented as mean and standard deviation for continuous variables and frequency for categorical variables.

Table 1 Baseline Characteristics of Participants Interviewed in Different Seasons

Characteristics	Winter (n = 7,104)	Spring (n = 9,278)	Summer (n = 6,831)	Fall (n = 6,884)	p Value
Age, y, mean ± SD	63.3 ± 9.9	63.0 ± 10.1	62.6 ± 10.7	62.9 ± 10.4	0.002
Male sex, %	46.0	51.6	49.0	49.0	<0.001
Marital status, %					
Single, never lived with a partner	8.6	8.1	8.6	7.7	0.005
Married/living with a partner	66.9	69.6	68.0	69.6	
Widowed, divorced, or separated	24.4	22.3	23.4	22.6	
Education, %					
Less than secondary school graduation	5.5	5.3	5.0	6.1	0.066
Secondary school graduation, no post-secondary education	9.6	9.2	9.0	10.1	
Some post-secondary education	7.6	7.2	7.7	7.4	
Post-secondary degree/diploma	77.4	78.3	78.2	76.4	
Retirement status, %					
Completely retired	46.3	44.5	43.6	44	0.001
Partially retired	11.4	11.1	10.3	11.3	
Not retired	42.3	44.4	46.1	44.7	
Ever smoking, %	48.5	47.9	45.9	45.9	0.002
Alcohol at least once a month, %	73.0	74.3	74.9	73.4	0.058
Anxiety, %	8.4	9.0	8.4	8.7	0.456
Depression, %	17.3	17.4	17.1	16.0	0.102

To compare sleep symptoms in the 4 seasons, we used the χ^2 test for categorical variables and the analysis of variance test for continuous variables.

Binary logistic regression and linear regression were used to compare sleep symptoms and sleep duration between participants interviewed 1 week before vs after DST, before vs

after ST, and DST vs ST, adjusting for age, sex, and province. The odds ratio and 95% CI are presented in tables.

Data Availability

Data are available from the CLSA webpage (clsa-elcv.ca) for researchers who meet the criteria for access to deidentified CLSA data.

Table 2 Sleep Symptoms Among Participants Interviewed in Different Seasons

Characteristics	Winter (n = 7,104)	Spring (n = 9,278)	Summer (n = 6,831)	Fall (n = 6,884)	p Value
Dissatisfied with sleep, % (n)	25.9 (1,840)	25.5 (2,360)	25.1 (1,717)	26.3 (1,811)	0.4
Difficulty initiating sleep (≥ 3 per week), % (n)	16.5 (1,172)	15.3 (1,412)	15.9 (1,084)	15.6 (1,072)	0.2
Sleep-Onset Insomnia Disorder (DSM-V), % (n)	6.3 (340)	6.0 (429)	6.4 (335)	5.7 (301)	0.5
Difficulty maintaining sleep (≥ 3 per week), % (n)	24.2 (1,714)	23.6 (2,184)	23.7 (1,618)	24.4 (1,678)	0.6
Sleep-Maintenance Insomnia Disorder (DSM-V), % (n)	11.0 (524)	11.0 (696)	10.8 (508)	11.2 (518)	0.9
Difficulty staying awake (≥ 3 per week), % (n)	8.9 (629)	8.9 (822)	8.6 (587)	9.1 (628)	0.8
Hypersomnolence with adequate sleep (DSM-V ^a), % (n)	4.1 (247)	4.4 (345)	4.1 (234)	4.6 (266)	0.5
Sleep duration, h, mean ± SD	6.84 ± 1.3	6.81 ± 1.3	6.76 ± 1.2	6.79 ± 1.2	0.006

Abbreviation: DSM-V = Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.

^a For DSM-V, all the criteria involved in the definition of hypersomnolence disorder have been considered, except for the "dysfunction" component.

Table 3 Baseline Characteristics of Participants Interviewed During 1 Week Before/After Transition to DST/ST

Characteristics	1 wk before transition to DST (n = 695)	1 wk after transition to DST (n = 738)	p Value	1 wk before transition to ST (n = 588)	1 wk after transition to ST (n = 573)	p Value
Age, y, mean ± SD	63.8 ± 9.5	62.8 ± 9.4	0.045	62.0 ± 9.9	62.9 ± 10.6	0.154
Male sex, %	46.2	46.2	1	50.0	50.8	0.814
Marital status, %						
Single, never lived with a partner	7.1	9.2	0.35	7.4	8.1	0.737
Married/living with a partner	66.9	66.1		70.4	71.3	
Widowed, divorced or separated	26.0	24.7		22.3	20.6	
Education, %						
Less than secondary school graduation	7.1	3.3	0.013	4.1	6.5	0.151
Secondary school graduation, no post-secondary education	9.8	9.5		11.6	9.9	
Some post-secondary education	8.6	9.5		8.2	6.3	
Post-secondary degree/diploma	74.5	77.7		76.1	77.3	
Retirement status, %						
Completely retired	49.9	44	0.071	41.4	44.3	0.595
Partially retired	12.1	12.7		12.2	11.2	
Not retired	38	43.3		46.4	44.5	
Ever smoking, %	52.4	50.2	0.427	45.9	43.6	0.441
Alcohol at least once a month, %	74.6	71.7	0.211	74.1	72.6	0.595
Anxiety, %	8.4	9.8	0.359	8.9	7.7	0.523
Depression, %	15.0	19.0	0.049	13.6	16.9	0.121

Abbreviations: DST = daylight saving time; ST = standard time.

Furthermore, the opinions expressed in this article are of the author's own and do not reflect the views of the CLSA.

Results

Seasonal Variation

Among the 30,097 included participants, 7,104 were interviewed during winter (46% male, average age ± SD: 63.3 ± 9.9 years), 9,278 during spring (51.6% male, age: 63.0 ± 10.1 years), 6,831 during summer (49% male, age: 62.6 ± 10.7 years), and 6,884 during Fall (49% male, age: 62.9 ± 10.4 years). Further baseline characteristics are reported in Table 1.

We found no difference between dissatisfaction with sleep, difficulty initiating sleep, difficulty maintaining sleep, and difficulty staying awake during the day among participants who were interviewed in different seasons. We found a modest difference in sleep duration; participants who were interviewed in summer had the shortest sleep durations (6.76 ± 1.2 hours) while those who were interviewed in winter reported the longest sleep durations (6.84 ± 1.3 hours). See Table 2 for details.

One Week Before vs One Week After Transition to DST

Comparing the 695 participants who were interviewed a week before transition to DST and 738 interviewed a week after transition, no sex difference was observed, but a 1-year age difference was noted (63.8 ± 9.5 vs 62.8 ± 9.4) (Table 3). Sleep-onset and maintenance insomnia disorders and hypersomnolence with adequate sleep were similar between the 2 groups. Those who were interviewed a week before transition to DST reported 9-minute longer sleep duration than those who were interviewed a week after transition (6.91 ± 1.3 vs 6.76 ± 1.3, adjusted difference -0.14, 95% CI -0.27 to 0.00) (Table 4 and eTable 2, links.lww.com/WNL/C788).

One Week Before vs One Week After Transition to ST

A total of 588 participants were interviewed a week before transition, and 573 were interviewed a week after transition to ST. No age or sex difference was observed between these groups (Table 3). Unlike the DST findings, those who were interviewed a week after transition to ST reported more

Table 4 Sleep Symptoms Among Participants Interviewed During 1 Week Before/After Transition to DST/ST

Characteristics	1 wk before transition to DST (n = 695)	1 wk after transition to DST (n = 738)	Before vs after transition to DST aOR (95% CI)	1 wk before transition to ST (n = 588)	1 wk after transition to ST (n = 573)	Before vs after transition to ST aOR (95% CI)
Dissatisfied with sleep, % (n)	24.6 (171)	26.1 (192)	1.06 (0.83 to 1.35)	22.6 (133)	28.0 (160)	1.34 (1.02 to 1.76)
Difficulty initiating sleep (≥ 3 per week), % (n)	15.6 (108)	17.6 (130)	1.16 (0.87 to 1.53)	12.6 (74)	15.9 (91)	1.30 (0.93 to 1.82)
Sleep-Onset Insomnia Disorder (DSM-V) any duration, % (n)	6.4 (35)	7.3 (41)	1.13 (0.70 to 1.81)	3.3 (15)	7.1 (33)	2.26 (1.19 to 4.27)
Difficulty maintaining sleep (≥ 3 per week), % (n)	23.7 (165)	25.2 (186)	1.07 (0.84 to 1.37)	22.1 (130)	25.1 (144)	1.20 (0.91 to 1.58)
Sleep-Maintenance Insomnia Disorder (DSM-V) any duration, % (n)	11.3 (54)	12.1 (61)	1.01 (0.68 to 1.51)	8.2 (31)	12.9 (50)	1.64 (1.02 to 2.66)
Difficulty staying awake (≥ 3 per week), % (n)	7.8 (54)	8.8 (65)	1.12 (0.76 to 1.63)	8.0 (47)	11.5 (66)	1.48 (0.99 to 2.22)
Hypersomnolence with adequate sleep (DSM-V ^a) any duration/any dysfunction, % (n)	3.8 (23)	4.7 (29)	1.27 (0.72 to 2.24)	3.6 (18)	7.3 (35)	2.08 (1.14 to 3.79)
Sleep duration, h mean \pm SD	6.91 \pm 1.3	6.76 \pm 1.3	-0.14 (-0.27 to 0.00)	6.86 \pm 1.2	6.84 \pm 1.3	-0.01 (-0.16 to 0.13)

Values in bold indicate that there is statistical significance at the level of $p < 0.05$. To compare sleep duration between groups adjusted difference is reported instead of aOR.

Abbreviations: aOR = adjusted odds ratio; DSM-V = *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*; DST = daylight saving time; ST = standard time.
^a For DSM-V, all the criteria involved in the definition of hypersomnolence disorder have been considered, except for the "dysfunction" component.

dissatisfaction with sleep (28% vs 22.6%, adjusted odds ratio [aOR] 1.34, 95% CI 1.02–1.76), higher sleep-onset insomnia (7.1% vs 3.3%, aOR 2.26, 95% CI 1.19–4.27), higher sleep-maintenance insomnia (12.9% vs 8.2%, aOR 1.64, 95% CI 1.02–2.66), and more hypersomnolence with adequate sleep (7.3% vs 3.6%, aOR 2.08, 95% CI 1.14–3.79) (Table 4 and eTable 2, links.lww.com/WNL/C788). This increase in sleep disturbances was transient; all symptoms were no longer increased in those interviewed 1 week later (i.e., 2 weeks after transition) (eTable 3).

Discussion

We conducted a cross-sectional study, using data collected from a cohort of middle-aged and older participants across Canada (i.e., the CLSA) between 2011 and 2015 to determine whether sleep symptoms varied by season and during transitions in and out of DST/ST. We found only modest differences in sleep duration by season. Although transition to DST was not associated with reported sleep disruption, the transition back to ST was associated with several sleep disorder symptoms.

We found that people reported somewhat longer sleep during winter and shorter sleep during summer, although there were no seasonal variations in sleep dissatisfaction, difficulty initiating sleep, difficulty maintaining sleep, nor difficulty staying awake

during the day. These findings are consistent with some previous studies that found seasonal variations in sleep duration,^{26,27} although current evidence remains quite mixed. For example, a recent publication supported a shorter sleep duration in spring relative to winter, while some other studies had found no seasonal differences.^{5,28,29} One hypothesis for these discrepancies pertains to the varying measures used to assess sleep across these studies. Some used self-reported data while others used more objective measures such as wearable devices. Furthermore, the previously cited studies took place in different countries, which differ in their seasonal zeitgeber variations, including the timing of light exposure. Of note, seasonal variations in light are high in Canada compared with many other countries. Even with these large differences, we found only small seasonal variations in sleep duration.²⁶

Regarding sleep disorders, some studies have also found no difference in sleep problems across the seasons.^{30,31} In other studies, winter has been linked with increased reports of sleep disorders³⁰ and decreased early awakenings,³² and some studies found less disturbed sleep in spring.³² These studies vary widely in their methodology, population, and setting, which may also account for the mixed nature of the evidence. Of note, many factors that can greatly influence sleep disorders tend to remain constant throughout the year (e.g., sleep hygiene habits, other disorders that may be causing the sleep disorders, medications), perhaps explaining the absence of differences seen in our study.

Relative to 1 week before transition from ST to DST, the prevalence of sleep-onset insomnia, sleep-maintenance insomnia, and hypersomnolence with adequate sleep was similar when assessed 1 week after transition. However, when looking at the transition from DST to ST, participants reported being more dissatisfied with sleep, having higher sleep-onset and sleep-maintenance insomnia, and having more hypersomnolence with adequate sleep 1 week after transition. These findings are partly unexpected because it is during the transition from DST to ST that there is an “extra hour” of sleep.

In a study of 469 teenagers in Germany, transition to DST was associated with higher daytime sleepiness until the third week after the transition. This effect was more prominent in older students who were evening-type individuals.³³ According to a UK study on 120 young participants, sleep latency and efficiency deteriorated during the week after the transition to ST.³⁴ In another study conducted on 10 individuals using wrist-worn accelerometers during sleep, the transition to DST between 2003 and 2004 resulted in a 60-minute shortening of sleep duration and a 10% reduction in sleep efficiency.³⁵ In another study during 1983–2006 on the National Institute of Occupational Safety and Health, workers slept 40 minutes less on Mondays after the transition to DST and faced higher levels of injuries, but no significant changes were observed in sleep or injury on Mondays after the transition to ST.³⁶ From the shift work literature, it is well-documented that phase advancing (i.e., transitioning to DST) is typically harder and associated with more disturbances in sleep and alertness, than phase delay (i.e., transitioning to ST).³⁴ These results are unlikely to simply be due to seasonal variations in sleep disorders because we did not find any evidence of seasonal variations in this sample.

One explanation for these findings may be the differences in the available light required for adjustment. When looking at light exposure in Montreal, for example, the day before the transition from ST to DST, sunrise occurs at roughly 6 AM while sunset occurs around 6 PM. After the transition, sunrise occurs at 7 AM and sunset occurs around 7 PM.³⁷ The opportunity for natural morning light exposure, which facilitates phase advancing,³ is thus still available after the transition. Conversely, when people in Montreal must transition from DST to ST, they would benefit from evening/nighttime light exposure and morning light avoidance to facilitate their circadian phase delay.^{3,38} However, natural light exposure occurs roughly from 8 AM to 6 PM before the transition and from 7 AM to 5 PM after the transition.³⁹ This timing of light exposure could, therefore, make it harder for circadian rhythms to phase delay. Relative to the transition from ST to DST, shifting from DST to ST may result in slower circadian adaptation (i.e., prolonged circadian misalignment) and thus explain the transiently higher reports in sleep disorders that we found.

Finally, it is important to note the relative transience of the sleep disruptions that we observed after the shift to ST.^{3,40} Any increase in sleep disturbance was no longer evident

only 1 week later (i.e., 2 weeks after transition). This suggests that, as disruptive as these transitions may feel in the short term, there may be less long-term chronic sleep implications of the repeated switch back and forth from DST to ST.

Some limitations should be noted. This is a cross-sectional study using self-reported measures—we cannot establish any causal links. Self-report may be subject to expectation biases or to general mood effects (e.g., shift to ST is associated with the onset of an often-difficult Canadian winter). In addition, although our participant groups were similar in their demographics, this remains a between-group design, and thus, we cannot conclude with certainty that the higher frequencies of sleep disorders reported 1 week after the transition to ST were directly due to the transition. Future studies with repeated individual assessment, with correlation with objective sleep measures, and including those living in areas with different light/seasonal changes would be of considerable interest. Our sample only includes middle-aged/older adults; the results may have been different if younger individuals had been included in the sample. In addition, even within the same time zone, sunset and sunrise differ according to the meridian. However, we attempted to reduce the confounding effect of this variable by adjusting for provinces. For future studies, it would be helpful to evaluate the consequences of transitioning from ST to DST and vice versa on possible accidents, sick leave, and cognitive impairments. Another weakness of the study is the lack of information on the specific temperature and precipitation on the days that the questionnaires were administered. However, because the study was conducted over a period of 3 years with participants randomly selected from 9 cities in a very large country, it is considered unlikely that local weather patterns may have a significant effect on the results. Efforts were made to account for any residual confounding factors by adjusting for the participant’s province, which could account for differences in latitude and climate patterns.

On the other hand, this study has many strengths. First, it has a large sample size and, therefore, allows for more precise estimates. Second, it is one of the few studies to assess the seasonality of a wide range of sleep parameters and sleep disorders as well as their relation to DST and ST transitions.

Our findings suggest that there may be small seasonal variations in sleep duration, without any difference in insomnia or somnolence prevalence. In addition, the transition from DST to ST is associated with a transient increase in self-reported sleep disruption.

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Appendix Authors

Name	Location	Contribution
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Ronald B. Postuma, MD, MSc	Research Institute of the McGill University Health Centre; Centre for Advanced Research in Sleep Medicine, Hôpital du Sacré-Coeur de Montréal; Department of Neurology and Neurosurgery, McGill University, Montreal, Quebec, Canada	Drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; study concept or design

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