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RESEARCH ARTICLE

Psychiatric Admissions of Children and Adolescents Across School Periods and Daylight-Saving Transitions

Ashley Nixon BA[1,2]; Joseph De Koninck PhD[1,2]; Stephanie Greenham PhD[2,3,4]; Rebecca Robillard PhD[1,2]; Addo Boafo MB, FRCPC, MBA[1,3,4,5]

Abstract

Objectives: This study sought to examine fluctuations in admissions to a child and adolescent inpatient psychiatry unit in relation to school breaks, school starts, as well as time change transitions in and out of Daylight-Saving Time (DST). **Methods:** Five years (2012-2017) of youth inpatient admissions to a pediatric hospital in Ontario were retrieved (n=2,498). A sub-sample was grouped weekly, starting on the Sunday of each week for a total of 260 weekly time bins. The number of admissions during in and out of school periods, school starts in the fall and winter semester, and time change transitions were compared. **Results:** Admissions were significantly higher during school periods as opposed to out of school periods, and significantly increased from prior- to post-school starts. No significant difference in admission rates were found in and out of DST changes. Weekly time series analyses for DST changes and monthly time series analyses for school starts did not identify a significant seasonality in admissions. **Conclusions:** These findings suggest that school periods and school onset may be significant stressors associated with an increased rate of psychiatric admissions. The presence of potential compensating factors is proposed to explain the lack of relationship between pedopsychiatric admissions and time change transitions.

Key Words: school, daylight-saving time, psychiatric admission, adolescent

Résumé

Objectifs: La présente étude visait à examiner les fluctuations des hospitalisations dans une unité psychiatrique pour enfants et adolescents relativement aux congés scolaires, aux retours en classe, ainsi qu'aux transitions à l'entrée et au sortir de l'heure d'été. **Méthodes:** Cinq ans (2012-2017) d'hospitalisations de jeunes patients dans un hôpital psychiatrique de l'Ontario ont été récupérés (n = 2 498). Un sous-échantillon a été assemblé chaque semaine, débutant le dimanche de chaque semaine pour un total de 260 plages horaires hebdomadaires. Le nombre d'hospitalisations durant les périodes scolaires et en dehors, les retours en classe à l'automne et au semestre d'hiver et les transitions du changement de temps a été comparé. **Résultats:** Les hospitalisations étaient significativement plus élevées durant les périodes scolaires par opposition aux périodes non scolaires, et augmentaient significativement d'avant le retour en classe à l'après retour

[1]University of Ottawa Institute of Mental Health Research at the Royal, Ottawa, Ontario
[2]School of Psychology, University of Ottawa, Ottawa, Ontario
[3]CHEO Research Institute, Children's Hospital of Eastern Ontario, Ottawa, Ontario
[4]Mental Health Program, Children's Hospital of Eastern Ontario, Ottawa, Ontario
[5]Department of Psychiatry, University of Ottawa, Ottawa, Ontario

Corresponding E-Mail: aboafo@cheo.on.ca

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en classe. Aucune différence significative des taux d'hospitalisation n'a été constatée à l'entrée ou à la sortie de l'heure d'été. Les analyses des séries de plages hebdomadaires pour les changements de l'heure d'été et les analyses des séries de temps mensuelles pour les retours en classe n'ont pas identifié de saisonnalité significative des hospitalisations. **Conclusions:** Ces résultats suggèrent que les périodes scolaires et le début de l'école peuvent être des stresseurs significatifs associés à un taux accru d'hospitalisations psychiatriques. La présence de facteurs de compensation potentiels est proposée pour expliquer l'absence de relation entre les hospitalisations pédopsychiatriques et les transitions du changement de l'heure d'été.

Mots clés: *école*, *heure d'été, hospitalisation psychiatrique, adolescent*

Introduction

A review of youth mental health in Canada from 2011 to 2018 found a 16-18% prevalence of perceived stress at a moderate to extreme level (Wiens et al., 2020). The American Psychological Association, in its 2014 Stress in America survey, found that teenagers reported school as the most common source of stress (American Psychological Association, 2014). A similar Australian study found that school-related stressors were the main source of stress among students in their final year of high school (Kouzma & Kennedy, 2004). Teens have also reported that their stress level during the school year far exceeded what they believed to be healthy (American Psychological Association, 2014). In adolescence, perception of stress is likely influenced by their appraisal of stressors, such as academic expectations and peer relations and by their psychological resilience in accordance with the stress and coping paradigm as described by Lazarus and Folkman (Lazarus & Folkman, 1984). Perceived stress is important and has been found to be strongly associated with the full range of mental health disorders among students (Auerbach et al., 2016). It is conceivable that this enhanced degree of stress during school periods could also potentially affect the frequency of admissions to an inpatient psychiatry unit. The contemporary view of resilience is that it is a dynamic result of children's interaction with multiple reciprocating systems in their environment and that it is the quality of these systems that account for most of the children's developmental success under stressful circumstances (Ungar et al., 2013). Higher levels of resilience may be protective and may prevent the development of illness or minimize the severity of psychiatric disorders (Gladstone et al. 2006). Lower resilience could render the individual vulnerable under stress to the extent of precipitating a mental health admission.

In addition to the inherent stressors associated with adolescence, this age group is estimated to experience, on average, a two hour physiologically based circadian phase delay. This typically leads to later sleep onset and wake time and starts transpiring around the time of puberty onset (Carskadon, 2008; Roenneberg et al., 2004). Research has shown that this delayed sleep-wake cycle is exacerbated in young people with emerging affective disorders (Glozier et al., 2014; Robillard et al., 2013a; Robillard et al., 2013b) and that sleep, and circadian disruptions may be important contributors to depressive symptoms in adolescents (Emens et al., 2009; Lovato & Gradisar, 2014; Tochigi et al., 2016). This is in line with the previous observation that delaying sleep onset can cause a reduction in mood in healthy individuals (Surridge-David et al., 1987). Alongside low mood, sleep loss is known to reduce school performance and disrupt general adaptation (Carskadon, 2008; Koscec Bjelajac et al., 2012). Studies have examined the potential associated benefits of delaying school start to compensate for the sleep loss caused by the circadian delay occurring during adolescence. Along with increased total sleep duration, sleep satisfaction, and motivation, reduced caffeine use, lower daytime sleepiness, less trouble staying awake, and lower depression were observed when these scheduling changes were implemented (Minges & Redeker, 2016; Owens, Belon, & Moss, 2010). It is thus reasonable to propose that the abrupt shift to an earlier wake-up time due to school start in combination with the naturally occurring delay in circadian phase could contribute to the worsening of their mood.

In addition to the school stressors and circadian phase delay that may play a role in the experience of stress and mood disruptions in adolescents, the Daylight Saving Time (DST) practice of setting the clocks one hour forward from Standard Time (ST) to DST in the spring and back again by an hour from DST to ST in the fall may also be a source of additional stress. In the spring, this aims to increase daylight in the later part of the day and delay daylight in the morning.

Human circadian rhythms are highly influenced by the timing of sunlight and it is believed that the transitions in and out of DST, by interfering with the timing of sunlight, potentially disrupts circadian rhythms (Kantermann et al., 2007; Monk & Folkard, 1976). The transition from ST to DST in the spring is similar to a circadian phase delay, and

the transition from DST to ST in the fall is similar to a phase advance (Tonetti et al., 2013). Studies indicate that these transitions and disrupted circadian rhythms, particularly the transition into DST in the spring, potentially have adverse health effects such as disrupted sleep (Lahti et al., 2006; Schneider & Randler, 2009; Tonetti et al., 2013); an increase in daytime sleepiness (Schneider & Randler, 2009); mood problems (Emens et al., 2009; Pinho et al., 2016), and an increase in male suicide rates (Berk et al., 2008). The disruption of circadian rhythms caused by these one-hour changes in and out of standard time are thought to take 0 to 14 days or more to re-synchronize (Monk & Folkard, 1976; Valdez et al., 2003) and have been reported to decrease the total amount of sleep by an average of 32 minutes (Medina et al., 2015).

Hansen et al (2017) reported that the transition from DST to ST (in the fall) was associated with an increase in the incidence rate of depressive episodes (as documented during acute hospital contacts) in adults using nationwide data from the Danish Psychiatric Central Research Register. It was postulated that the sudden one hour decrease of daylight in the afternoon contributed to the surge in depression. However, Pillai et al., (2017) reviewed monthly rates of admissions for major depressive disorder from 2006 to 2013 in Canada using a time-series analysis to determine if there are seasonal variations. The 95,459 unique patients ranged from 18 years to over 65 years. They did not find significant seasonality of hospitalizations for major depressive disorder across any of the gender or age subgroups. These studies were conducted on adult admissions that may not generalize to adolescents. Indeed, the fall return to ST is an opportunity to obtain an immediate additional hour of sleep and for a short time at least, a reduction in the circadian phase delay which is typical during adolescence (Carskadon, 2008; Roenneberg et al., 2004). Conversely, worsening of sleep loss and phase delay may only occur with the one-hour delay caused by the spring change to DST. Other research also suggests that the later sunset during the summer may add to social jetlag (Kohyama, 2011). In other words, the additional evening light may increase social activities during the evening thus delaying sleep initiation further. This social jetlag could exacerbate adolescents' phase delay during the summer and further increase the sleep loss resulting from early school start times in the fall. A study of the effects on adolescents in Russia (Borisenkov et al., 2017), reported that social jetlag worsened during the period of permanent DST (i.e. 2011 to 2014), which potentially exerted a negative influence on adolescents' sleep habits, mood, and behavior. One additional factor to take into account is the fact that sleep abnormalities have been found to be present in adolescents admitted to our inpatient psychiatric unit. In a first study, seventeen inpatients underwent full overnight polysomnography while they were on the ward. Significant sleep abnormalities were observed and described compared to a control group (Boafo et al., 2019). These included sleep initiation and REM sleep latency abnormalities, shallower sleep and high REM density. A second study submitted for publication showed a positive association between sleep disturbances and symptoms pertaining to eating disturbances, adjustment to trauma, and school attendance. The presence of sleep disturbances may be exacerbating the vulnerability to the circadian disruptions associated with DST transitions.

Aims/Hypotheses

The primary aim of this study was to examine temporal patterns of change in child and adolescent admissions to an inpatient psychiatry unit. Admissions across the entire calendar year were gathered to assess potential fluctuations in relation to school periods, school break transitions, and time change transitions in and out of DST.

On the basis of the hypothesis that school can be an important source of stress and often reduces total sleep time, it was predicted that psychiatric admissions would be significantly higher during school periods than during the summer school break and during the Christmas/New Year (holiday) break. It was also hypothesised that the transitions from school break to school period in both the fall and winter semesters would yield a significant increase in admissions. As for time change transitions, it was expected that the fall return to ST would have no effect on admissions. This null effect was predicted based on the competing effects of an additional hour of sleep and the loss of one hour of daylight. The spring transition was expected to be accompanied by an increase in admissions due to the associated one hour sleep deprivation and ensuing phase delay.

Methods

Participants

Data on participants were obtained for all patients consecutively admitted to the inpatient psychiatry unit at a tertiary pediatric hospital in Ottawa (ON, Canada) between January 1st, 2012 and December 31st, 2017. The data were collected from hospital admission records combined with the existing clinical outcomes database held by the inpatient psychiatric unit.

Table 1 presents the distribution of total admissions per year as well as age and sex distributions. Admissions ranged from 332 to 467 per year for a total of 2498. Females represented about 70% of the admissions.

Table 1. Descriptive information about age and sex of admissions per year from January 2012 to December 2017

Year	Total admissions	% Female	% Male	6-12y n	13-15y n	16-17y n	Age in years Mean	Median	SD
2012	332	68.7	31.3	12	132	188	15.48	16	1.44
2013	419	75.4	24.6	11	192	216	15.37	16	1.43
2014	441	68.0	32	22	184	235	15.32	16	1.69
2015	378	70.4	29.6	25	161	192	15.15	16	1.82
2016	461	67.3	32.7	31	173	257	15.27	16	1.73
2017	467	69.4	30.6	23	177	267	15.35	16	1.75
Total	2498	69.7	30.1	124	1019	1355	16.32	16	1.66

At the time of admission, participants were administered the Childhood Acuity of Psychiatric Illness Scale – Child and Adolescent Version (CAPI; Lyons, 1998). Table 2 presents the distribution of percentage of symptoms which characterises the sample. The CAPI is a measure of risk behaviors, symptoms and functioning. It has four subscales – Risk behaviors subscale, Symptoms subscale, Functioning subscale and Systems Support subscale. The items are rated from a score of 0 to 3: score (0) none, score (1) mild, score (2) moderate or score (3) severe. The CAPI is used because it has other items of interest in an inpatient setting such as non-suicidal self-injury, aggressive behavior toward people or toward objects, and is sensitive to short-term change. The scale has good inter-rater reliability (0.78 to 0.85), good internal consistency (0.87) and good concurrent validity with the Child Behavior Checklist and the Global Assessment of Functioning (Lyons, 1998).

Procedures

Admissions were aggregated into weekly time bins, starting on the Sunday of each week from April 1st, 2012 to March 25th, 2017 for a total of 260 weekly time bins (2057 total admissions). In-school and out of school periods were quantified by averaging weekly psychiatric admissions across the five years. The fall semester's in-school period started the second week of September since it can be assumed that students across the different school boards in the Ottawa region were in school at that time. The week prior to the September long weekend was excluded to account for variations across school boards. In the fall, school periods ended approximatively on the third week of December and the winter semester spanned the second week of January to the third week of June. Out of school periods were defined as the time gaps between the in-school periods.

School start transition periods were based on two-week time bins in order to encompass the different school start dates from the various school boards in the region. Analyses were done with the understanding that there may be discrepancies of a few days between participants of different school boards. Specifically, the sum of all psychiatric admissions was calculated across the following periods: two-weeks prior to school start, two-weeks during school start (last week of August and the first of September for the fall semester and the first two weeks of January for the winter semester to account for the various school boards in the region), and two-week post school start.

The switch from ST to DST was defined as the week (starting on Sunday) in which the pre-determined transition date in March occurred. The switch back from DST to ST was defined as the week (starting on Sunday) in which the pre-determined transition date in November occurred. The sums of psychiatric admissions were calculated over one-week prior to the switch, the one-week during the switch, and the one-week post switch independently for the fall and spring-time change.

Finally, we conducted time series analyses on monthly admissions for which we had demographic data. In this case, we had admissions by sex from January 1st, 2012 to December 31st, 2017 (2498 total admissions).

Approval for this retrospective study was granted by the Research Ethics Board of the Children's Hospital of Eastern Ontario (CHEO) – REB Protocol No: 17/215X.

Statistics

Statistical analyses were conducted with the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, Version 23.0. Armonk, USA). Time series analyses were done with TIBCO Statistica (Version 13). An

Table 2. Percentage of symptoms rated as 2-3 in the CAPI which characterises the sample from April 2012 to March 2016

Symptoms	% (n)
Suicidal behavior/ideation	73.9 (1390)
Depression	69.0 (1298)
Anxiety	42.1 (792)
Sleep	37.0 (696)
Self-harm	28.5 (536)
Impulsivity	28.5 (536)
Aggression to others	16.5 (310)
Reality/Psychosis	14.8 (278)
Noncompliance	11.8 (222)
Aggression to objects	9.3 (175)

CAPI; Childhood Acuity of Psychiatric Illness Scale – Child and Adolescent Version

independent samples t-test was used to compare psychiatric admissions during school periods to non-school periods.

To assess potential fluctuations in relation to school break transitions, two repeated measures ANOVAs were done to assess changes in rates of psychiatric admissions across school start transition points (two weeks prior to school start, two weeks during school start, and two weeks after school start) in the fall and winter semesters. A chi-square was also done to extend these analyses and evaluate whether changes in rates of admission across school start transition points differed from the fall and winter semesters. A time series analysis was applied to monthly admissions across the full five years to assess if seasonality was present in the data. Separate time series analyses were also done by sex.

To assess admission fluctuations in relation to time changes, two repeated measures ANOVAs were done to compare admissions between time change transition points (one week prior to the transition, one week during the transition, and one week after the transition) in the fall (DST to ST) and spring (ST to DST). A chi-square was run to assess whether changes in admissions across time change transition points differed between the fall and spring to further support these analyses. Finally, a time series analysis was applied using the weekly admissions across the full five years to assess seasonality.

Additional chi-square and t-tests were run to decompose effects between dyads of time points when a chi-square or repeated measures ANOVA was significant. Significance threshold was set at $p = .050$.

Results

The weekly psychiatric admissions from 2012-13 to 2016-17 are illustrated in Figure 1. The resulting sub-sample size was 2057 admissions. Across the five years, the weekly admission average was 7.91 (±SD; ±3.23) with a minimum of one and maximum of 17 weekly admissions.

Overall, weekly admissions were significantly higher during in school periods (M = 8.5, SD = 1.5) than during out of school periods (M = 6.4, SD = 1.6; $t(49) = 4.33$, $p < .001$).

School Start Transitions

Mean numbers of admissions during school-start-transition points for the fall semester averaged across five years are presented in Figure 2 (left panel). Results indicate a significant difference across the three school start transition points ($F(2,18) = 19.86$, $p < .001$, $\eta p^2 = .69$). Significant increases were found from prior- to post-school start ($t(9) = -6.74$, $p < .001$) and from during school start to post-school start ($t(9) = -3.97$, $p = .003$). No significant difference was found between prior to during school start in the fall ($p > .050$).

The results of a repeated measures ANOVA between the transition points for the winter semester across 5 years are presented in Figure 2 (right panel). There was a significant difference across the three transition time points ($F(2,18) = 9.71$, $p = .001$, $\eta p^2 = .52$). Significant increases in admission were found between prior- to during school start ($t(9) = -5.29$, $p = .001$). No significant difference was found between during school start to post school start in the winter semester ($p > .050$).

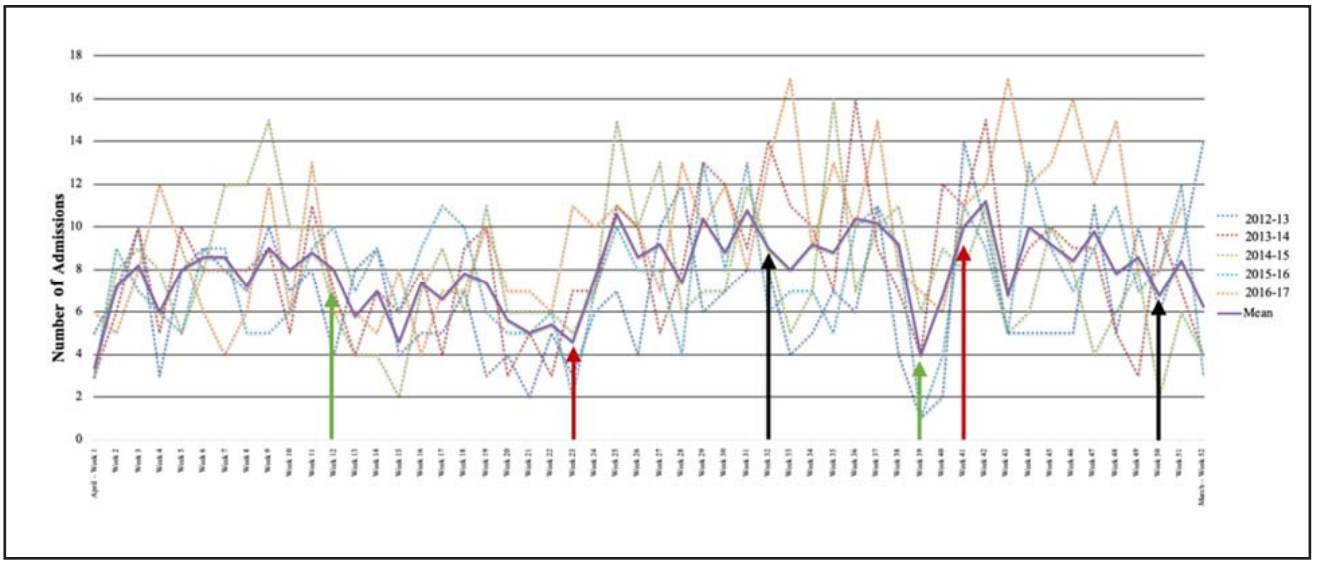
The changes in rates of bi-weekly admissions between school start transition time points significantly differed between fall and winter, $X^2(2, n = 440) = 11.21$, $p = .004$. Standardized residuals suggested that, while the percentages of admissions were similar before the fall and winter semesters (25% of all fall admissions and 22% of all winter admissions respectively), admissions during school were more frequent in the winter semester (65%) than in the fall semester (35%). Admissions after the end of the fall semester were slightly more frequent (47%) than those after the winter semester (35%). In other terms, the surge in admissions during school times was more pronounced in the winter than in the fall.

The monthly time series analyses for school starts demonstrated no seasonality in the data. Separate time series analyses by sex also did not show any significant seasonality.

Daylight Saving Time

The mean admission rates for time change transition points in the fall and spring are illustrated in Figure 3. There was no significant difference in psychiatric admissions across

Figure 1. Distribution of weekly admissions for each year (raw data: dotted lines) and mean (full purple line). Approximate main calendar events are indicated by arrows using the 2012-13 year calendar. Red arrows are for school start weeks, green arrows are for the start of school breaks and the black arrows for the fall and spring daylight-saving time change.



the time changes in the fall (DST to ST; $F(2,8) = .17$, $p = .846$, $\eta p^2 = .041$) and in the spring (ST to DST; $F(2,8) = .016$, $p = .984$, $\eta p^2 = .004$). Patterns of change in rates of admissions across time change periods were similar across the fall (34.7% pre, 34.7% during, 30.6% post) and the spring (33.3% pre, 34.5% during, 31.4% post), X^2 (2, n = 255) = .110, $p = .946$.

As for the weekly time series analyses looking at DST transitions, no significant seasonality was observed.

Discussion

Results from this study indicate a surge in child and adolescent psychiatric admissions during school periods as opposed to non-school periods. Furthermore, results suggest a more delayed increase in psychiatric admissions in the weeks following the start of the fall semester school start, whereas in the winter semester, the surge in admissions is initially more pronounced and abrupt at school onset. Based on our clinical experience, we speculate that the students who undergo school-related stress may benefit from the prolonged opportunity to rest during the two months of vacation in the summer. However, it is also possible that for many children and youth, the increased time spent at home during such breaks may be stressful and not restful. Academic workload and expectations gradually accumulate over the subsequent 3-4 weeks of starting school in the fall. This may cause a more progressive increase in stress and may explain the increase in admissions during the latter part of the fall semester. The start of the winter semester, typically in the first week of January, may present a different picture in that students have 2-3 weeks to finish all their work and prepare for exams which often occur rapidly at the end of January. In our view, this may create a more rapid surge in stress, which could contribute to the more frequent admissions in the first two weeks of school in January. Monitoring stress levels at school on a weekly basis would be required to support these interpretations. This would be consistent with the findings by Agarwal (2011) that the demands of academic performance may be negatively associated with mental well-being. This study however did not reveal any influence of DST change transitions on children and adolescent psychiatric admissions. It needs mentioning that this study is not able to conclusively attribute variations in admissions to any one particular factor and the admissions could be associated with a number of other factors; for example, social factors could play an important role in the development of poor mental well-being and psychiatric admissions. The school context can bring peer victimization and bullying which can be linked to anxiety and depression (Bond et al., 2007; Hawker & Boulton, 2000; Menesini et al., 2009).

Figure 2. The psychiatric admission mean 2 weeks prior, 2 weeks during, and 2 weeks post-school start in the fall (left panel) and in the winter (right panel). Error bars represent standard errors of the mean, *p <.05.

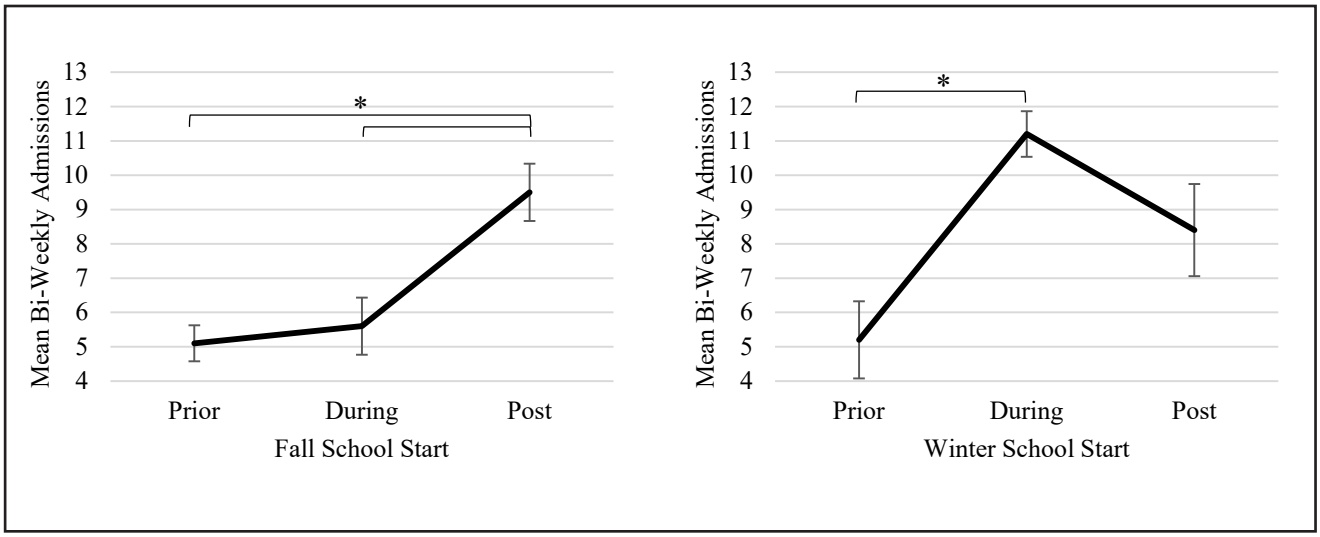
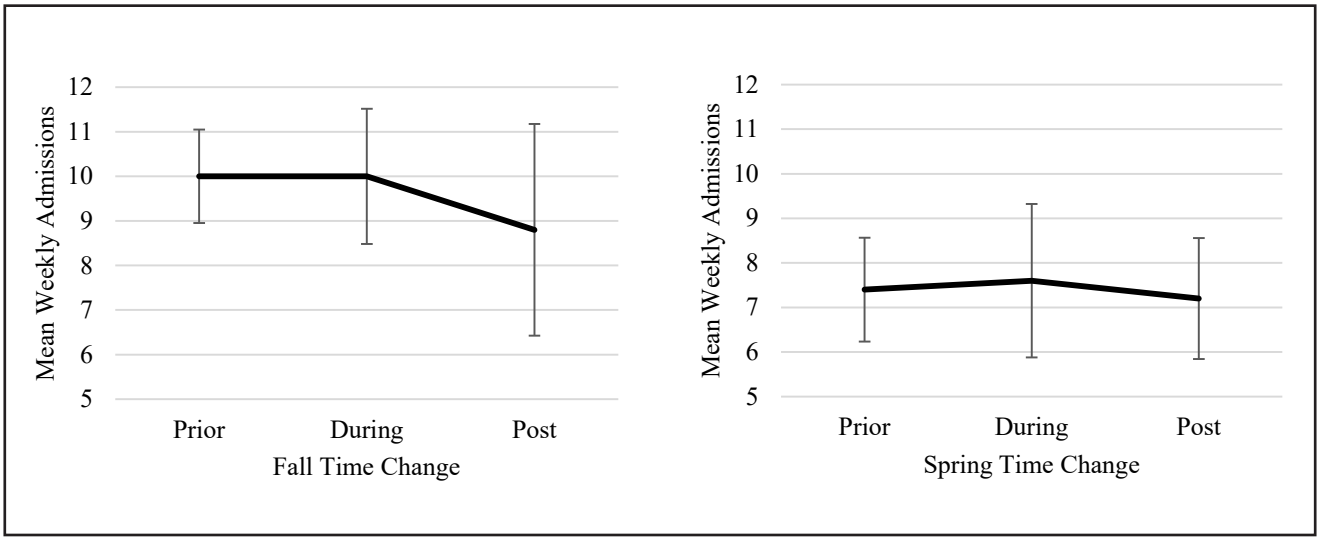


Figure 3. Mean weekly psychiatric admissions 1 week prior, 1 week during, and 1week post time change in the fall (DST to ST; left panel) and spring (ST to DST; right panel). Error bars represent standard errors of the mean.



Early wake up times imposed by an early school start time during adolescence has long been linked to sleep loss and daytime sleepiness (Carskadon et al., 1998; Dexter et al., 2003). Considering the delayed sleep-wake cycle that adolescents typically experience (Carskadon, 2008; Roenneberg et al., 2004) and early school start times, sleep deprivation is likely to occur. Even with only one night of sleep deprivation, significant increases in anger, confusion, anxiety, depression, and fatigue can occur in adolescents (Short & Louca, 2015). Sleep deficits could possibly be one of the factors contributing to higher rates of psychiatric admissions during school periods as compared to non-school periods.

Another possible explanation for this more abrupt increase in the winter semester is that students have a shorter break during the winter than during the summer which may not offer an adequate opportunity to recover sleep loss and establish a stable sleep-wake cycle.

The absence of a significant increase in pedopsychiatric admissions in the fall switch to ST is consistent with our hypothesis but at variance with the Hansen et al. (2017) observation of an increase in admissions for depression in an adult sample. At the fall transition from DST to ST, sleep opportunity is increased but daylight exposure in the afternoon is decreased. The additional hour of sleep could potentially compensate for the reduction in light exposure in the late afternoon. The impacts of this increased sleep duration may not be as pronounced in adults, such as in the sample studied by Hansen et al. (2017), since the delayed-phased experienced during adolescence tends to normalise with age (Roenneberg et al., 2004; Thorleifsdottir et al., 2002), therefore, the time change may not have the same sleep loss effects.

Admissions may not have increased in the spring time change from ST to DST due to a simultaneous school break which may compensate for the effects of the 1-hour sleep loss. Specifically, the spring-time change occurs around the same time as the 1-week March break for most students. Therefore, the effects of the 1-hour reduction in sleep may be attenuated by the flexibility in sleep schedule and time to recuperate during the spring school break. Another factor which may compensate for the 1-hour sleep reduction may be the increase in daylight exposure in the late afternoon. The absence of changes in psychiatric admission rates could be potentially linked to the fact that sleep deprivation has been found to lead to low mood (Roberts & Duong, 2014), but that bright light exposure is associated with better mood (Tuunainen et al., 2009). Furthermore, potential ST/DST effect in the current study may be more subtle than what could be observed in other countries, where school start times may often be earlier than in most Canadian schools.

In brief, in the case of the fall time transition, it is not possible to disentangle the effects of the additional hour of sleep from that of the one-hour reduction of daylight in late afternoon without an experimental manipulation. In the case of the spring 1-hour time change and its associated sleep loss, it would be interesting to examine psychiatric admissions in other regions, such as Alberta and Manitoba where the spring school break is a few weeks after the spring time change. Finally, it would be of interest to determine if the spring switch to DST induces an additional phase delay that prevails through the summer and in combination with social jetlag could eventually exacerbate sleep loss upon the return to school in September. This could potentially be achieved by comparing the sleep schedule of young individuals in the province of Saskatchewan who maintain Central Standard Time throughout the year.

This study is limited by the possibility that some of the patients included in these analyses were not in school, had different school schedules or were in a different schooling environment such as home school. Generalizability is also limited by the unequal sex distribution, however, the higher proportion of females in this study is aligned with the typical higher rates of mental disorders in adolescent females (Cohen et al., 1993).

Future research is needed to better understand the specific school-related stressors associated with these surges at school onset and untangle the multiple factors surrounding the potentially noisy relationship between pedopsychiatric admissions, sleep, and daylight-saving time transitions.

In conclusion, the present study supports the notion that school may be a significant stressor affecting rates of psychiatric admission in children and adolescents. The time change transitions in and out of DST were not found to have a significant impact on pedopsychiatric admissions, however, various limiting factors may be at play which warrants further investigations.

Conflicts of Interest

The authors have no financial relationship to disclose.

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