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Daylight saving time transitions are not associated with increased seizure incidence

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Summary

Objective: Given the known association of daylight saving time (DST) transitions with increased risk of accidents, heart attack, and stroke, we aimed to determine whether seizures, which are reportedly influenced by sleep and circadian disruption, increased in frequency following the transition into DST as well.

Methods: Using Seizure Tracker's self-reported data from 12,401 individuals over 2008–2016, 932,717 seizures were assessed for changes in incidence in relation to DST transitions. Two methods of standardization – Z-scores and unit-scaled Rate Ratios – were used to compare seizure propensities following DST transitions to other time periods.

Results: As a percentile relative to all other weeks in a given year, absolute seizure counts in the week of DST fell below the median (19.68 ± 16.25 , $p=0.01$), which was concordant with weekday-specific comparisons. Comparatively, Rate Ratios for whole-week (1.06, 95% CI 1.02–1.10, $p=0.0054$) and weekday-to-weekday (RR range 1.04–1.16, all $p<0.001$) comparisons suggested a slightly higher incidence of seizures in the DST week compared to all other weeks of the year. However, examining the similar risk of the week preceding and following the DST-transition week revealed no significant weekday-to-weekday differences in seizure incidence, even though there was an unexpected, modestly decreased seizure propensity in the DST week relative to the whole week prior (RR 0.94, 95% CI 0.91–0.96, $p<0.001$).

Significance: Despite expectations that circadian and sleep disruption related to DST transitions would increase the incidence of seizures, we found little substantive evidence for such an association in this large, longitudinal cohort. While large-scale observational/epidemiologic

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Disclosure of Conflicts of Interest

L. D. Schneider reports grants from NHLBI, during the conduct of the study; personal fees from Medibio, personal fees from Hatch Baby, other from Knit, personal fees from Jazz Pharmaceuticals, outside the submitted work. R. Moss is the cofounder/owner of Seizure Tracker and received personal fees from Cyberonics, UCB, and Courtagen, and grants from Tuberous Sclerosis Alliance. D. M. Goldenholz reports grants from NIH and BIDMC, and he is an advisor for Magic Leap.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

cohorts can be effective at answering such questions, additional covariates (e.g., sleep duration, seizure type, etc.) that may underpin the association were not available, so the association has not definitively been ruled out.

Keywords

Seizures; Daylight saving time; Circadian; Sleep; Epidemiology

Introduction

Circadian disruptions have clear associations with increased risks of traffic and workplace accidents.^{1–4} However, more recent investigations have noted an association between abrupt circadian shifts and transient increases in disease incidence. Most notably, the incidence of stroke and heart attack have implicated abrupt shifts in circadian rhythm (e.g. those associated with entry into daylight saving time) as causing increased cerebro/cardiovascular morbidity and mortality.^{5,6} While the underlying mechanism for these associations remains speculative, the most plausible pathobiology likely results from neuroendocrine dysfunction,⁷ particularly given the finding of decreased fertility in IVF recipients following transitions into daylight saving time.⁸

There is a complex, bidirectional interaction between sleep and epilepsy.⁹ A common conception is that sleep deprivation is likely to contribute to an increased likelihood of seizure activity, with lack of sleep being reported as a seizure-provoking factor in up to 1/3 of patients with epilepsy.¹⁰ While this belief has been supported through studies attempting to control for common confounders associated with sleep loss,¹¹ prospective evaluation of the impact of chronic sleep disturbances found that seizure propensity is not increased in well-controlled epilepsy without relevant comorbidity, suggesting that sleep deficiency alone may not account for the increased risk of seizures.¹² In addition, one randomized controlled study found no increased risk for seizures between patients with and without sleep deprivation.¹³ Nonetheless, in large scale analyses from the Epilepsy Phenome/Genome Project (EPGP) there appears to be a sleep/wake influence on seizures that is associated with both epilepsy syndrome and seizure type.¹⁴ This phenomenon appears to be mediated, in part, by genetic factors that suggest a circadian influence. For example, neuronal excitability in epileptic mice and human epileptic brain tissue has implicated the CLOCK-BMAL1 circadian protein complex in the diurnal variation of the seizure threshold.^{15,16} Circadian cycles have been observed in seizures^{17,18} as well as diurnal variation in seizure clusters and status epilepticus.¹⁹ Therefore, abrupt circadian shifts (e.g. with daylight saving time or travel), with or without concomitant sleep deprivation, may predispose to increased seizure frequency as well.

Given the importance of sleep/wake stability and sufficiency in maintaining health through interactions with the autonomic nervous system, immune function and inflammation, and metabolism, the impacts of unnecessary circadian disruption should be assessed to determine if the risk/benefit of the daylight-saving programs warrants discontinuation.²⁰ Beginning with a disorder with a known circadian influence (e.g. epilepsy) may provide insights into additional societal burden imposed by DST transitions.²¹ Currently, 76 nations

practice some form of daylight saving, resulting in a direct influence on the lives of 1.6 billion people, potentially affecting seizure risk in 11 million individuals with epilepsy (based on a global point prevalence of active epilepsy estimated to be 6.38 per 1,000 persons²²). The short-term disruption of both circadian rhythms^{23–25} and sleep durations^{1,26} caused by the spring transition into DST (but not out of it^{1,27}) may predispose individuals with epilepsy to a breakthrough of their seizures.

The specific aim of this project is to determine whether daylight saving time (DST) changes are associated with a higher or lower risk of seizures. Comparisons of seizure rates among individuals between periods in which they have just experienced a circadian shift related to DST and a baseline of stable circadian-aligned sleep will identify if seizure propensity is affected by such circadian and sleep disruptions.

Methods

Data

In accordance with the National Institutes of Health Office of Human Subject Research Protection #12301, all de-identified, unlinked seizure records were extracted from the [SeizureTracker.com](https://www.seizuretracker.com) database for the period January 1, 2008 to December 31, 2016, comprising 14,166 individuals and 1,350,994 seizures. The data were redacted into diary format from [SeizureTracker.com](https://www.seizuretracker.com), an online and mobile free service, representing one of the world's largest patient managed seizure diary databases. The patients in this database have focal or generalized epilepsy, and include adults and children.

Preprocessing

As there was no physician curating the data, additional pre-processing of the data was undertaken: repeated patient profiles were removed; patients with unreported or impossible ages were excluded; seizures reported to occur before or after the export dates were excluded; seizures reported with identical start times were removed except for the first one, under the assumption that these represented erroneous repeat entries; seizures erroneously reported to occur prior to a patient's date of birth were excluded. The code for cleaning and analysis can be accessed at GitHub. Following preprocessing there remained 12,401 individuals and 932,717 seizures.

Nocturnal seizures were defined as those seizures occurring between the hours of 21:00 and 07:00, in order to capture the general sleep period for most individuals. Week number was defined from the first full week of the year, starting on Sunday; days from incomplete weeks at the beginning and end of the year, as well as weeks that were not fully represented in all years (i.e., the 52nd and 53rd week) were removed from analyses. When analyses were compared to the Daylight Saving Time (DST) transitions, the index day for the transitions was considered the Sunday on which the time change occurred: the 2nd Sunday in March for transition into DST and 1st Sunday in November for the transition back into standard time (ST), for the years considered.

Statistical Analysis

In order to standardize seizure propensity across individuals a Z-score was calculated from the daily seizure count for each day in comparison to all other days in the same year. Percentiles derived from the Z-score were then compared for DST transition days across years.

Because of ongoing enrollment into SeizureTracker (i.e., more individuals are reporting at the end of the year than the beginning) and because individuals with varying seizure propensity and/or reporting likelihoods may unduly influence absolute seizure counts, another method of inter-individual standardization was performed using a common machine-learning feature scaling measure.²⁸ For each year, each individuals' seizure counts were scaled to a vector with unit length (ensuring comparability across individuals of varying seizure propensities), using the following formula:

$$x' = \frac{x}{\|x\|}$$

where $\|x\|$ is the Euclidean length of the year's worth of seizures for each individual. This resulted in each individual having an individual-specific vector of yearly seizure propensity pointing into the n -dimensional space (where n is the number of days in that year) and each individual having a scaled seizure "count" on the n^{th} day of the year that reflects the projection of the unit vector into the n^{th} dimension. This method attempts to statistically balance the impact of individuals who may have a much higher baseline seizure propensity than others, by scaling each individual's reported seizure counts according to their general propensity for reporting seizures.

Following unit-vector standardization, an incidence rate of seizures was calculated by summing the scaled seizure "counts" for each individual and dividing by the number of unique individuals that had reported seizures up to that date (i.e., the "at risk" population). Because seizures had been scaled for days (rather than weeks) and because the number of "at risk" individuals (i.e., the denominator of the incidence equation) was continuously accruing, for whole-week comparisons, weighted averages were calculated using the daily "at risk" counts for weights, in order to create weekly seizure incidences. Similarly, comparisons (e.g., means, standard deviations, t -tests) across years were weighted by the "at risk" counts, to account for population size changes resulting from ongoing enrollment. Approximate rate ratios (RR) were calculated by dividing the incidence rate from one period by the incidence rate from another period:

$$\frac{Incidence_{DST,i}}{Incidence_{Comparison,i}} = \frac{Seizure\ count_{DST,i} / Person_{time_{DST,i}}}{Seizure\ count_{Comparison,i} / Person_{time_{Comparison,i}}}$$

where incidences of the i^{th} time epoch (e.g., Sundays, whole weeks, etc.) are compared between the two time periods (usually DST and some comparison time period). It is important to note that with the comparison of 2 similar time periods (e.g., DST week and

pre-DST week) that the time factor cancels out of the numerator and denominator, such that the Rate Ratio relies upon the number of at-risk individuals in each comparison period. This is why weighted statistics were performed. Nonetheless, while the denominators of “at risk” individuals were not exactly the same between incidence rates in any 2 time periods, the rate of enrollment was sufficiently slow as to suggest a negligible difference in local comparisons (between adjacent weeks) as well as within years (the longest span for RR calculation). Moreover, while yearly data were visualized and analyzed for illustrative purposes, conclusions regarding Rate Ratios were only determined in relation to those weeks that would most likely isolate the effect of the DST transition. As such, Rate Ratios from the weeks immediately before and after the DST transition week were used because they have the most similar seasonal/annual risk that may, otherwise, confound the effect of DST being explored.

In order to account for known covariates that are associated with both sleep-wake/circadian physiology and seizure propensity, in addition to accounting for the variable nature of the ongoing recruitment in this cohort over time, a secondary, exploratory analysis was performed to ascertain the association of DST and seizure propensity using linear mixed models, given the multiple seizure reports of individuals entered at various time points in the longitudinal dataset. The generalized linear mixed models included outcome variables of 1) the individual-scaled, daily seizure counts (linear mixed model) and 2) a binary outcome indicating whether an individual seized on a given day (logistic general linear mixed model), as well as adjustments for age, gender, and focal/non-focal/unknown epilepsy type as fixed effects and year as a random effect.

Data cleaning and statistical analyses were performed using R v3.4.1 (Vienna, Austria)²⁹. Continuous variables were represented by mean±SD and were compared with weighted *t*-tests, with effect sizes estimated by Cohen’s *d*. The threshold for rejection of the null hypothesis was set at $\alpha=0.05$, which was Bonferroni-corrected for multiple comparisons, as appropriate, for each primary analysis.

Results

In general, the cohort was younger (19.46 ± 16.13 yrs) with a slight female predominance (51%) (Table 1). Of the individuals who reported an etiology for their seizures, 2554 (21%) were presumed to represent a focal epilepsy and 1071 (9%) were suggestive of a “non-focal” epileptic pathology (Table 1). Most individuals reported at least 5 seizures, with at least half of the cohort having nearly 1 year or more between the first and last documented seizure (Table 1).

Seizure counts on the week (Sunday to Saturday) following the transition into DST were compared to all other weeks of the same year using Z-score-derived percentiles for raw seizure counts (Figure 1 and Supporting Table S1). In general, seizure count percentiles for the week following the transition into DST were well below the median for the rest of the year for all years but 2016 (19.68 ± 16.25 , $p=0.01$; range 4.98–55.46). Given that the increased health risks and sleep disturbances associated with DST transitions tend to only last approximately 3–5 days,^{6,30} a weekday-to-weekday analysis was also performed, again

revealing that seizure counts on weekdays within the week following the DST transition generally were below the median for the year, when compared to the same day of the week from all other weeks in the year (Figure 2).

However, due to ongoing enrollment in the SeizureTracker app and potentially disparate representation by individuals with varying seizure propensity and/or reporting likelihoods, another method of standardization and comparison was used to confirm the finding. Therefore, Rate Ratios (RR) were used to compare individually-scaled, daily seizure incidences between the Sunday of the DST transition and all other days of the year, such that a relatively higher seizure incidence on DST Sunday would result in a $RR > 1$ and a relatively lower seizure incidence on DST Sunday would result in a $RR < 1$ (Figure 3). In general, there appeared to be no significant difference in seizure rates in comparison to the Sunday transition into DST, particularly in the local temporal neighborhood (i.e., the week before and the week following the week of DST transition), which provides the nearest approximation of equivalent risk.

Due to the appearance of an infradian (approximately 7-day) cyclicity to the seizure incidence, previously reported in this and other datasets,³¹ weekday-to-weekday comparisons over the entire year were explored (Table 2, panel A; Figure 4). In contrast to the low percentile of absolute DST-week seizure counts relative to most other weeks of the year, standardization by the Rate Ratio suggested that the incidence of seizures over the week of DST is relatively higher than most other weeks of the year (all p -values less than the Bonferroni-adjusted threshold of 0.00625).

In order to explore the proximate temporal relative incidences, weekday-to-weekday comparisons of seizure incidences in the week of DST were made with regard to the week immediately preceding and the week immediately following the week of the DST transition (Table 2, panel B & C). None of the weekday-to-weekday seizure incidences were found to significantly differ between the week of DST or the preceding/following weeks at the Bonferroni corrected significance threshold. However, there was a significantly lower Rate Ratio for the full week of DST compared to the full week preceding the DST transition (RR 0.94, 95% CI 0.91–0.96, $p < 0.001$, $t = -5.22$, $df 8$, $d = -1.03$), suggesting a modestly lower incidence of seizures in the week of the DST transition. Similarly, comparisons between the transition into DST and into standard time (ST), as well as between the week of ST transition and its preceding and following weeks revealed no significant differences in seizure incidence (data not shown).

Discussion

Despite a plausible hypothesis that abrupt circadian shifts would be associated with increased risk of seizures, either through the disruption of intrinsic biorhythms in epileptogenic activity or through the induction of sleep deprivation. When comparing the weekday-specific seizure rates between the week of the DST transition and those weeks of most closely approximated risk (i.e., the week before and the week after), there was no evidence for an increased risk of seizures immediately following the transition into daylight savings time. There are a number of possible explanations for this, however the findings are

felt to be robust in this data set of nearly 1 million documented seizures in a cohort of over 12,000 individuals because of the congruence between the two analytic methods – weekly *Z*-score/percentiles that were significantly below the median for the year and Rate Ratios comparing weekday-to-weekday risks from the weeks surrounding the DST transition – used to explore the expected association.

Because of the size of the dataset, our analysis was able to take a highly granular approach, examining weekday-to-weekday comparisons of seizure occurrence. This approach was essential, given the fact that sleep disruptions are noted to persist to a maximum of 5 days after a change into DST,³⁰ with previous studies demonstrating DST-related health effects most prominently in the first 3 days.^{6,32} Regardless of year, the week of the DST transition appeared to have a lower number of seizures than the majority of weeks in the same year (Figure 1), with examinations of *Z*-score-standardized weekday-by-weekday trends demonstrating similarly low, relative seizure counts in DST weeks across years, despite the appearance of a modest increase in seizure counts during weekdays (Figure 2).

Due to a recognition of ongoing individual enrollment in the Seizure Tracker app, as highlighted in the escalation in yearly seizure counts in Figure 1, a second means of data standardization was pursued through rate ratios (RRs) of individual-scaled, yearly seizure propensities. This analysis revealed that, in comparison to all other weeks in the year, there may actually be an increased relative seizure propensity in the week and weekdays immediately following the DST transition (Figure 4 and Table 2, panel A). However, in Figure 3 there appeared to be no statistically significant variation in population seizure propensities relative to the Sunday which began with the loss of an hour due to the transition into DST ($RR > 1$ suggesting increased risk of seizures on DST Sunday relative to the comparison day).

Comparatively, a circannual trend appeared to be present in the daily relative seizure propensities (Figure 3), thus a confirmation of the relative seizure propensities in the weeks immediately preceding and following the DST transition week was undertaken on a weekday-by-weekday basis, as this was felt to capture the closest approximation of similar at-risk populations and seasonal risk factors (a methodology similar to other studies of DST-related health risk⁶). As was suspected from the trend noted in the RRs computed in relation to DST Sunday (Figure 3), the weekday-to-weekday RRs calculated between DST week and the week immediately preceding (Table 2, Panel B) and the week immediately following (Table 2, Panel C) showed no clinically or statistically significant increased seizure propensities during DST week. Contrary to our hypothesis, however, was the finding that the seizure propensity in the week immediately preceding the DST-transition week was higher ($RR < 1$), with a 6% lower risk of seizures in the DST week over the years examined (RR 0.94).

There are a number of potential explanations for the contradictory findings that, in general, were not in line with expectations. The studies on chronic sleep deprivation's relationship to seizure risk have produced conflicting results.¹¹ These inconsistencies may be due to the lack of a clear pathophysiologic basis to explain the mechanism by which sleep deprivation could cause seizure kindling. Moreover, complex behavioral factors (e.g., psychosocial

stressors, alcohol consumption, antiepileptic adherence, etc.) may confound the reported positive associations of sleep deprivation and seizure propensity.^{13,33,34} Of note, studies of DST transitions have demonstrated that, while individuals tend to lose about 40 minutes of sleep when losing an hour upon transitioning into DST, little-to-no sleep is gained when transitioning back to ST, likely due to inter-individual variability in biological (e.g., chronotype) and social influences.^{1,27} In particular, epileptic patients may have a more resistant sleep and circadian physiology, as epidemiologic studies have revealed a tendency toward more of a morningness chronotype, with earlier mid-sleep period, earlier sleep times on weekdays, and longer sleep durations on non-work days,^{12,35} which may have diminished the effects of the artificial circadian phase advance imposed by the loss of an hour from DST transitions.

While the major strength of this study was the size of this longitudinal dataset and the multiple analytic strategies attempting to mitigate ongoing recruitment and individual variation in seizure reporting, a number of limitations may have also contributed to the lack of observed association. Most notably, patient reports of seizures may be inaccurate measures of comprehensive seizure burden (including electrographic clinically silent seizures and seizures during sleep). There may be a systematic negative bias for certain seizure types that may have been most affected by DST transitions; one study reported failure to document 85.8% of seizures during sleep despite regular reminders.³⁶ Additionally, given the hypothesis that the amount of sleep disruption may mediate the relationship between DST transitions and seizure risks, the lack of reported sleep durations may have precluded the ability to reveal an association. This relates not only to sleep durations in general, but also to the known variability in sleep-stage-dependent seizure risk³⁷ and differential associations of seizure types (e.g., frontal seizures) with sleep-wake states and intrinsic daily and multi-day biorhythms.^{37–39} And, even though regions that do not observe DST (e.g., Hawaii, Arizona, and parts of Indiana) likely represent a minority of the dataset (due to relative population density), because no geographic data was linked to seizure records, the inclusion of this subset of locales may have diminished the effective association. Due to the ongoing enrollment into the dataset, a number of stratification strategies were contemplated to account for differences in seizure type, syndrome, gender, and age. However, due to the *a priori* assumption that DST effects would require day-to-day comparisons, sample sizes on individual days became so small (even zero) as to be uninterpretable or unreliable – due to inflated risk of type II error following the multiplicative increase in multiple comparisons. Nonetheless, in order to compare weekdays in the DST week vs those in the week before and after, generalized linear mixed models were generated to explore the hypothesized association of DST with seizure propensity. Even before adjusting for the multiple comparisons ($\alpha_{adj} = 0.0006$) DST was neither statistically nor clinically significantly associated with seizure propensity (Supporting Tables S2-S9). Thus, while the benefit of the large sample size was impeded by the temporal granularity, the ability to compare data longitudinally over many DST transitions was felt to be an appropriate tradeoff.

In conclusion, in this large, longitudinal, population-based, naturalistic sample of self-enrolled epileptic patients no clear association was found between DST transitions and

seizure propensity. While the nature of the dataset precluded exploration of the hypothesized mechanisms (e.g., actual sleep duration as a mediating factor), the scale of the sample, aggregated over nearly a decade, and subjected to two methods of standardization suggest that these findings are robust. Nonetheless, the biorhythmicity of epileptic activity with sleep-state and seizure-specific variability, suggest that a more detailed study, likely involving wearable biosensors, may be required to discern the suspected associations going forward.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

1. No significant increase in seizures was noted in the days following transition into daylight saving time.
2. Relative to the preceding week, there was a modest decrease in seizure incidence in the week of the DST transition.
3. Taken together, our findings suggest sleep loss/circadian disruption may not actually increase seizure propensity.

Figure 1. Boxplots of weekly absolute seizure counts, stratified by year.

Each black dot represents one week's absolute seizure count and the red diamond represents the week of the daylight saving time (DST) transition (beginning on Sunday). Note the plateau in seizure reporting around 2014. The shaded bar chart and right-sided axis demonstrate the percentile of the red diamond. Boxplot elements: center line, median; box limits, upper and lower quartiles; whiskers, $1.5 \times$ interquartile range.

Figure 2. Boxplots of yearly DST-week seizure count percentiles, stratified by weekday. Weekday-specific seizure count percentiles aggregated over the years 2008–2016, demonstrating daylight saving time (DST)-related seizures tend to fall below the median seizure count of similar weekdays within the same year. There appears to be a protective effect on weekends. Boxplot elements: center line, median; box limits, upper and lower quartiles; whiskers, 1.5× interquartile range.

Figure 3. Individual-scaled daily Rate Ratio (RR) trends averaged over 2008–2016.

Rate Ratios (RRs) were calculated for the individual-scaled seizure incidence on Sunday of the daylight saving time (DST) transition, relative to all other days in the year; therefore, $RRs > 1$ represent a relatively increased incidence of seizures on the DST-transition Sunday. Each year was indexed to DST Sunday representing day 0, with the week of transition into DST indicated in red and the week of transition into standard time (ST) represented in green. The black line represents the mean and the shaded envelope represents the standard deviation, both weighted by the number of individuals at risk.

Figure 4. Comparison of weekly seizure Rate Ratios, stratified by year.

Ratios (RRs) were calculated for the individual-scaled seizure incidence during week of the daylight saving time (DST) transition (Sunday to Saturday), relative to all other weeks in the year; therefore, $RRs > 1$ represent a relatively increased incidence of seizures in the DST-transition week – each dot represents one week. Boxplot elements: center line, median; box limits, upper and lower quartiles; whiskers, $1.5 \times$ interquartile range.

Table 1.

Description of the cohort.

<i>Cohort description</i>	
<i>Age mean$\pm$SD</i> [*]	19.46 $\pm$ 16.13
<i>Female N (%)</i> ^{*^o}	6322 (51%)
<i>Focal N (%)</i> ^{*[†]}	2554 (21%)
<i>“Non-focal” N (%)</i> ^{*[‡]}	1071 (9%)
<i>Entries per individual median [IQR]</i>	5 [2,24]
<i>Duration in days from first to final entry median [IQR]</i>	355 [104,866]

^{*} Descriptive statistics calculated from each individual's first entry into the SeizureTracker database.

^o Not all individuals reported gender.

[†] Focal epilepsy were defined as patients who checked any of the list A items AND did not check any of the list B items in the patient profiles.

[‡] “Non-focal” epilepsy were defined as patients who did not check any of the list A items AND did check any of the list B items. List A: brain tumors, brain trauma, brain hematoma, stroke, brain surgery, brain malformations, Tuberous Sclerosis. List B: Alzheimer, metabolic disorder, genetic abnormalities, electrolyte abnormalities, alcohol or drug abuse, Dravet, Angelman Syndrome, Neurofibromatosis, trisomy 21, Aicardi, Sturge-Weber, Rett, hypothalamic hamartoma.

Table 2.

Weekday-to-weekday comparisons between epochs.

A. DST vs. all non-DST weeks						
	Rate Ratio mean (95% CI)	<i>p</i>	<i>t</i>	<i>df</i>	<i>d</i>	
<i>Sunday</i>	1.06 (1.03, 1.08)	<0.001	4.62	467	0.05	
<i>Monday</i>	1.04 (1.02, 1.06)	<0.001	4.07	459	0.28	
<i>Tuesday</i>	1.16 (1.14, 1.18)	<0.001	16.28	460	0.45	
<i>Wednesday</i>	1.05 (1.04, 1.07)	<0.001	6.60	460	0.27	
<i>Thursday</i>	1.10 (1.08, 1.12)	<0.001	9.43	460	0.37	
<i>Friday</i>	1.06 (1.04, 1.07)	<0.001	7.21	460	0.16	
<i>Saturday</i>	1.08 (1.06, 1.10)	<0.001	8.34	469	0.28	
<i>Full week</i>	1.06 (1.02, 1.10)	0.0054	2.80	462	0.08	
B. DST vs pre-DST week						
	Rate Ratio mean (95% CI)	<i>p</i>	<i>t</i>	<i>df</i>	<i>d</i>	
<i>Sunday</i>	0.94 (0.80, 1.07)	0.40	−0.89	8	0.04	
<i>Monday</i>	0.89 (0.79, 0.99)	0.059	−2.20	8	0.36	
<i>Tuesday</i>	1.02 (0.92, 1.12)	0.72	0.37	8	0.53	
<i>Wednesday</i>	0.92 (0.86, 0.97)	0.021	−2.87	8	−0.66	
<i>Thursday</i>	1.04 (0.95, 1.13)	0.41	0.87	8	0.15	
<i>Friday</i>	0.89 (0.81, 0.96)	0.020	−2.91	8	−0.57	
<i>Saturday</i>	1.04 (0.97, 1.11)	0.30	1.12	8	0.58	
<i>Full week</i>	0.94 (0.91, 0.96)	<0.001	−5.22	8	−1.03	
C. DST vs post-DST week						
	Rate Ratio mean (95% CI)	<i>p</i>	<i>t</i>	<i>df</i>	<i>d</i>	
<i>Sunday</i>	1.02 (0.87, 1.18)	0.76	0.31	8	−0.34	
<i>Monday</i>	1.03 (0.89, 1.16)	0.72	0.38	8	0.55	
<i>Tuesday</i>	1.07 (0.97, 1.18)	0.20	1.40	8	0.17	
<i>Wednesday</i>	1.00 (0.89, 1.10)	0.93	−0.09	8	0.54	
<i>Thursday</i>	1.04 (0.98, 1.09)	0.23	1.28	8	0.00	
<i>Friday</i>	0.97 (0.91, 1.03)	0.33	−1.03	8	0.04	
<i>Saturday</i>	1.04 (0.98, 1.09)	0.18	1.39	8	0.23	
<i>Full week</i>	1.02 (0.97, 1.07)	0.51	0.69	8	0.10	

Abbreviations: DST – daylight saving time.