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Accident rates and the impact of daylight saving time transitions

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ABSTRACT

One-third of nations have adopted some form of Daylight Saving Time (DST). Associated costs and benefits include impacts on accident rates. Using data from 12.6 million accident claims in New Zealand during 2005–2016, we model accident rates as a function of various date-based predictors including days before/after the start and end of DST, holidays, day of week, and month of year. This is the first study to consider multiple accident categories (Road, Work, Falls and Home & Community), and the first in the southern hemisphere. The start of DST is associated with significantly higher rates of road accidents (first day +16% and second day +12%). Evidence that accident rates for Falls and Home & Community decline (increase) *prior* to the start (end) of DST suggest potential behavioural adaption from anticipating the change. While Work accidents show limited impact from DST changes, they exhibit a significant decline over the course of the week (Friday 13% lower than Monday), whereas Road accidents exhibit a significant increase (Friday 19% higher than Monday). Our results have implications for both DST implementation and policy.

1. Introduction

The biannual routine of changing clock times for Daylight Saving Time (DST) can engender yawns—both physical and metaphorical. Yet, similar to shift pattern changes for employees (Kroemer, 1992), the transitions can have a significant impact on accident rates.

Experience with DST is extensive. The first mooting of DST was in New Zealand, in 1895, although the country did not enact DST until 1927, eleven years after first adoption in several European countries. Today DST is employed in one-third of countries, comprising some 20 percent of the world's population (Anon, BBC). Despite the prevalence of DST, studies on its impact on accident rates are mostly confined to road and traffic accidents − perhaps since data for other accidents is difficult to obtain or parse in many jurisdictions.

Underlying theory posits two pathways relating DST to accident rates, one related to changes in sleep patterns and the other to changes in ambient light times.

1.1. Sleep deprivation

A sleep pattern survey of 55,000 subjects found adjustments to the autumn DST shift relatively easy, but more difficult in the spring, with lower quality sleep in subjects up to two weeks afterwards (Kantermann et al., 2007). Similar results have been found among children, with the increase in daytime sleepiness following the spring shift particularly egregious in "owls" (Schneider and Randler, 2009). A review of over twenty articles (Harrison, 2013) found sleep disruption in both spring and autumn changes, with sleep and tiredness disruptions lasting up to a week.

Given the sleep disruptions, it comes as little surprise that studies of DST transitions on accidents find significant negative effects. Sleep deprivation is understood to reduce awareness and plays a role in many accidents (Dinges, 1995). A study of accidental deaths in the U.S. from 1986 to 1988 showed fatality rates in the week following the spring DST shift around 6.5% higher than the preceding and succeeding week (Coren, 1996). No impact was found for the autumn shift. A study of fatal traffic crashes in New Mexico 1989–1992 found the proportion of alcohol-related fatalities rose significantly in the first week after both the spring and autumn shifts (Hicks et al., 1998). They concluded that sleepiness increased the "sedative and performance disruptive effects" of ethanol (Roehrs et al., 1994). More recently, a 4% increase in the risk of acute myocardial infarction in the week following the spring shift to DST in Sweden has been attributed to the "adverse effect of sleep deprivation and circadian adjustments on cardiovascular health" (Janszky et al., 2012).

An insightful study of fatal automobile accidents in the US from 1975 to 1995 (Varughese and Allen, 2001) found a significant increase in fatal accidents on the Monday following the spring shift to DST—consistent with the above-mentioned sleep deprivation affect. However, they also found a significant increase in fatal accidents on the

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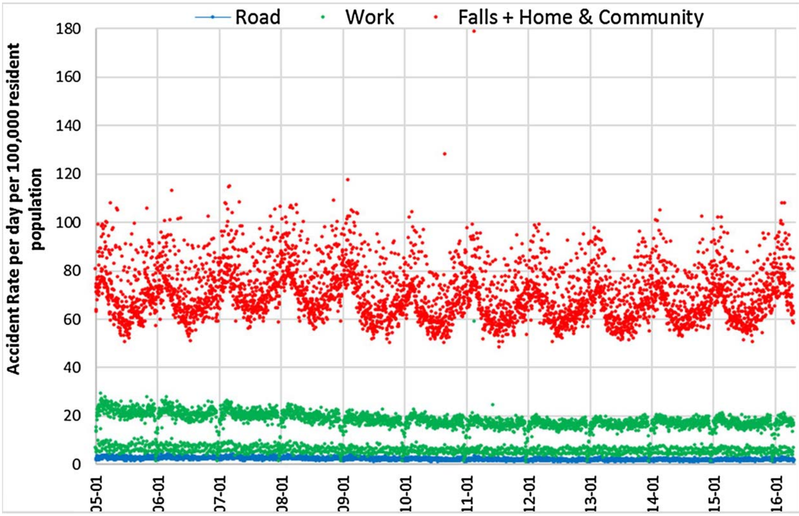

Fig. 1. The levels and seasonal variability in accident rates by category.

Sunday of the autumn shift. Suggesting this may be a behavioural adaption from *anticipating* DST, they reasoned that increased accidents may arise from some individuals taking advantage of the extra hour of sleep and staying out later, then driving home later and less alert.

1.2. Changes in ambient light

In addition to sleep, another pathway posited for the relationship between DST transitions and accident rates is the discrete change in ambient light during critical times of the day such as peak hour traffic. Seeking to save energy, the US Congress extended the length of DST in 1974–10 months. This allowed a study (Meyerhoff, 1978) using March-April data in 1973 (without DST) and in 1974 (with DST). DST was estimated to reduce fatal traffic accidents by around 2% for several weeks following *both* the spring and autumn transitions. At first glance, this seems counter-intuitive − one might expect the impacts to be equal and opposite in the two seasons. However, the phase changes in ambient light conditions do not necessarily coincide in a symmetric way with traffic and pedestrian volume curves (rush hours, etc.)

Another study using US data from 1987 to 1997 found significant changes in the numbers of fatal crashes involving pedestrians associated with DST transitions. In the spring (autumn) transition rates increased (decreased) in the morning and decreased (increased) in the evening. While crashes involving non-pedestrians were much more common, DST appears to have less impact on them (Sullivan and Flannagan, 2002). For pedestrians and non-pedestrians, the greatest change was in the increase in evening accidents associated with the autumn transition.

Not all studies show significant impacts. One study (Lahti et al., 2010), based on data from Finland for the period 1981–2006, showed no significant association between DST shifts and changes in the gross rate of traffic accidents.

Clearly, the literature presents mixed results concerning the impact of DST transitions. The differences will relate in part to variations in region, time period, fatal or non-fatal accidents, pedestrian or non-pedestrian, etc. Further investigations of traffic accidents, but also of a broader range of accident categories, are warranted. We note that there appears to be only three articles dealing with the impact of DST on non-traffic accidents, one on accidental deaths (Coren, 1996), one on construction accidents (Holland and Hinze, 2000), and one relating to acute myocardial infarctions (Janszky et al., 2012).

1.3. Objectives

Our aims are to (i) identify the impact of DST transitions on multiple accident categories, and (ii) compare the magnitude of DST transition effects with other date-based variables (public holidays, school holidays, long weekends, day of week, month of year, and year). As the independent variables are known in advance, the model can be utilised to predict accident rates—in this case with a relatively high degree of accuracy. This could assist in workforce planning in medical facilities.

Our study relating to New Zealand accidents is, we believe, the first study on multiple accident categories, and the first study pertaining to the southern hemisphere.

2. Material and methods

2.1. Data

The study data were provided by the Accident Compensation Corporation (ACC), a Crown corporation providing insurance cover for all accidents suffered by New Zealand residents and visitors. As it operates under a “no fault” system for claims made to it, it covers everyone sustaining an injury in New Zealand (and in some cases New Zealanders injured while travelling overseas on short trips), regardless of the cause or nature of the injury. Note that the right to sue is forgone.

The data set is comprised of the number of injury claims for accidents (hereafter referred to as “accidents”) recorded as having occurred each day (0000h–2359 h) in four broad categories and multiple age categories for the period 01 January 2005–30 April 2016–spanning 11 DST starts and 12 DST ends. The average number of accidents per day was 3795, apportioned as 2.7% “Road”, 16.5% “Work”, and 80.8% “Falls and Home & Community”.[1] The data includes some, but not all, fatalities (e.g., a person or medical institute may lodge a claim after admission for an injury, which subsequently proves fatal, or a family member may make a claim to receive death benefits).[2]

On 30 September 2010 and 22 February 2011 two major earthquakes in Christchurch resulted in an extremely high number of accidents (see the two highest points in Fig. 1). For these two dates we replaced the number of accidents with the average from six days with the same day of week − a year earlier (and a week either side), and a year later (and a week either side).

We divided the number of accidents by the daily *resident* population figures (linearly interpolated from quarter-end figures) to obtain an

[1] Claim types are mutually exclusive, and prioritised in the following order: 1. Road 2. Work 3. Sport and 4. Fall and Home & Community. We exclude sport accidents due to the difficulty of modelling the change of sporting codes coincident with DST start and end, and the very high interaction between seasonality and day of week.

[2] Accidents are also classified by *diagnosis* (the most common are soft tissue injury, and laceration/puncture/wound/sting), and *cause* (the most common are lifting/carrying/straining and collision/knocked over by an object).