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CE - LETTER TO THE EDITOR

Daylight saving time transitions and circulatory deaths: data from the Veneto region of Italy

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Dear Sir,

Living organisms are characterized by circadian mechanisms. The central circadian clock is located within the suprachiasmatic nucleus of the hypothalamus, and peripheral clocks have also been widely found across organisms. Such complex machinery allows living organisms to synchronize and optimally adapt to either their external or their internal environments [1]. On the other hand, circadian misalignment of an organism with its environment may increase cardiovascular risk factors and lead to the development of cardiovascular (CV) diseases [2]. Daylight saving time (DST), which was adopted during the First World War to save energy and is still in use in many countries worldwide, can be a cause of circadian misalignment. Based on concerns about human health, Finland and other northern state members called for the abolition of DST, and a proposal by the European Commission to discontinue the bi-annual shifts has been recently approved by the European Parliament.

We aimed to investigate a possible relationship between deaths from circulatory diseases, i.e., cardiovascular and cerebrovascular diseases, and DST transitions in a large Italian region. Analyses were carried out with the archive of mortality records from January 2000 to December 2015 of the Veneto region of Italy (≈4,900,000 inhabitants). The causes of death were coded following the rules established by the World Health Organization, according to ICD-9 until 2006 and to ICD-10 from 2007 onward. Deaths were classified according to broad categories used in standard reports of mortality statistics. The number of deaths observed in each of the 7 days after the spring and the autumn shifts (post-transitional weeks) was compared with the mean number of deaths registered on the corresponding day of the week of the 2 weeks before and the 2 weeks after the post-transitional week (referred to as the 'reference period'). The analysis was carried out for all deaths from circulatory diseases (ICD-9 codes 390–459, ICD-10 I00–I99), in the whole study population and for subjects aged <65 and ≥ 65 years. Furthermore, deaths from cerebrovascular diseases (ICD-9 430–438, ICD-10 I60–I69), ischaemic heart diseases (ICD-9 410–414, ICD-10 I20–I25), and all other circulatory diseases were investigated. Regarding cerebrovascular and ischaemic heart diseases, such categories included both acute and chronic conditions. A sensitivity analysis limited to deaths from acute myocardial infarction (AMI, ICD-9 410, ICD-10 I21–I22) was performed. The study had enough power to detect a statistically significant 3% excess mortality for all circulatory deaths (approximately 5000 deaths in the post-transitional weeks over the study period). The 95% confidence interval of the ratio of deaths observed in the post-transitional weeks with respect to that

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of the reference period was computed based on the Poisson distribution.

A total of 10,387 circulatory deaths were registered in the spring and autumn post-transitional weeks through the 16-year study period (Table 1). Overall, no excess mortality was found in the post-transitional weeks with respect to the reference period in both spring and autumn. Similarly, no differences after the spring and autumn transitions were shown by age subgroups, i.e., people aged ≤ or ≥ 65 years. For subgroups by specific disease, no differences were found for deaths from cerebrovascular diseases and ischaemic heart disease in spring and autumn, respectively. A separate analysis restricted to deaths from AMI did not provide statistically significant results (data not shown). When analysing the day-of-week pattern of mortality, a statistically significant excess of deaths was registered on Tuesdays only in the spring ($p = 0.011$), but not in the autumn post-transitional week (Fig. 1).

We did not find an increase in the overall number of deaths in the post-transitional weeks following DST. However, a significant excess of death was observed on Tuesday only after the spring shift. On the one hand, we are aware of the limitations common to analyses of routinely collected health data. The analyses were carried out on a broad range of ICD-9 and ICD-10 codes (all circulatory diseases, all cerebrovascular and ischaemic heart diseases, including chronic conditions); furthermore, only the date of death could be

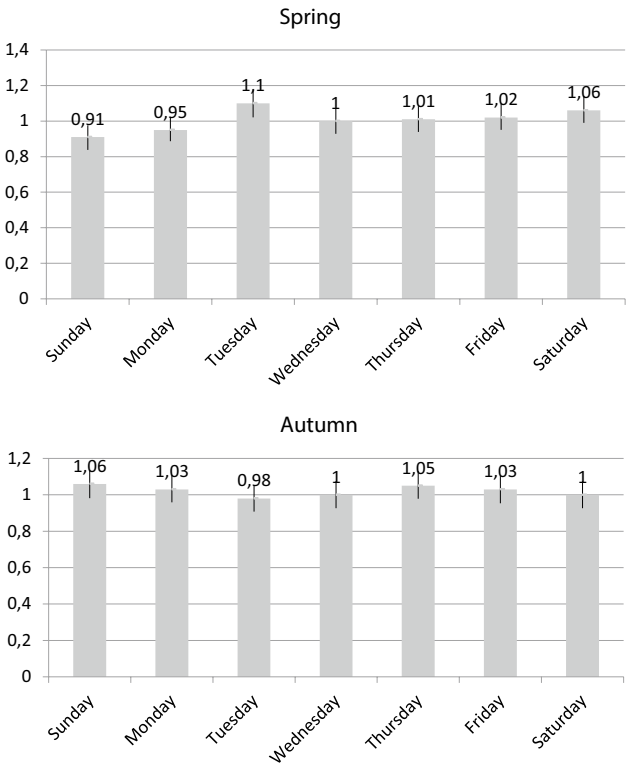

Fig. 1 Ratio of observed/expected number of circulatory deaths (including cerebrovascular disease, ischaemic heart disease, and other circulatory diseases) for each day of the post-transitional weeks after spring and autumn DST shift (Veneto region of Italy, years 2000–2015)

Table 1 Observed deaths in the post-transitional weeks, and ratio to the expected with 95% confidence intervals

	Observed deaths (*O*)	Expected deaths (*E*)	*O*/*E* ratio	95% CI	*P* value
All circulatory deaths					
Spring	5296	5263	1.01	0.98–1.03	0.653
Autumn	5091	4988	1.02	0.99–1.05	0.147
All circulatory, < 65 years					
Spring	369	364	1.01	0.91–1.12	0.807
Autumn	352	336	1.05	0.94–1.16	0.396
All circulatory, ≥ 65 years					
Spring	4927	4900	1.01	0.98–1.03	0.703
Autumn	4739	4652	1.02	0.99–1.05	0.205
Cerebrovascular diseases					
Spring	1221	1177	1.04	0.98–1.10	0.206
Autumn	1149	1175	0.98	0.92–1.04	0.458
Ischemic heart diseases					
Spring	1869	1845	1.01	0.97–1.06	0.582
Autumn	1769	1724	1.03	0.98–1.08	0.284
Other circulatory diseases					
Spring	2206	2242	0.98	0.94–1.03	0.454
Autumn	2173	2089	1.04	1.00–1.08	0.069

Veneto region (Italy), years 2000–2015

assessed, without the possibility to account for the date of onset of the disease. On the other hand, the same methodology recently allowed, in the same geographical area, the demonstration of a significant excess of cardiovascular mortality on Mondays [3]. In 2008, investigators from the Karolinska Institute first reported a higher incidence of AMIs following the spring DST shift [4]. Six further studies, conducted in Europe and in the United States, confirmed a modest increase in AMI occurrence, after the spring DST shift [5]. For other acute CV diseases, two studies evaluated the possible association between DST and stroke. The first study, based on a prospective stroke registry in Germany, collected more than 44,000 patients (years 2000–2005) and observed that the transition to or from DST resulted in an immediate shift in the time points of stroke onset within the first week after the time change, compared with the last week before the clock change. In particular, significant shifts were already present on Mondays and Tuesdays [6]. More recently, a Finnish study evaluated the effects of DST transitions on the number of hospitalizations and in-hospital mortality for ischaemic stroke (years 2004–2013) [7]. The number of hospitalizations increased during the first 2 days after the transition, and women and subjects aged > 65 years

were more susceptible to temporal changes after transitions [7]. It is known that the time of onset of acute CV diseases is not randomly distributed throughout the day, but exhibits a circadian rhythmicity with peak incidence in the morning hours [8]. Studies on the association between DST and the incidence of AMIs or strokes seemed to identify a preference for the first days after the transitions. This is not surprising, since Monday is a recognized high-risk timeframe for the onset of cardio- and cerebrovascular events [3, 9, 10]. The adjustment to DST shifts is neither immediate nor without consequences, and increased sleep fragmentation and sleep latency present a cumulative effect of sleep loss for at least the following week, or even longer [11]. Individual circadian preference (chronotype) could play an additional role [12–14], but the lack of data on both chronotype and sleep characteristics represents a common important limitation to this study as well as to the other available studies.

In conclusion, the findings of the present study do not show any increase in the overall number of CV deaths in the post-transitional weeks following DST. However, a significant excess of death was observed on the Tuesday after the spring shift. A recent expert document on the impact of DST on the circadian timing system suggested discontinuing the bi-annual shift of DST [15]. Our findings, which are consistent with that of previous studies on either AMI or stroke, showed that an excess of death occurred in the first days following the spring shift and should stimulate further research on the possible effects of phase advance and sleep deprivation on cardiovascular health.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest regarding the publication of this work.

Statement of human and animal rights This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent None.

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