

Testimony of Beth A. Malow, MD, MS

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US. House of Representatives Committee on Energy and Commerce

Subcommittee on Consumer Protection and Commerce

On

**"CHANGING TIMES: REVISITING SPRING FORWARD, FALL BACK"**

March 9, 2022

Chairwoman Schakowsky, Ranking Member Bilirakis, and distinguished members of the Subcommittee on Consumer Protection and Commerce:

My name is Dr. Beth Malow. I am a practicing neurologist and sleep medicine researcher at Vanderbilt University Medical Center. I received my undergraduate and medical degrees from Northwestern University. My research focuses on how sleep and circadian neurobiology affects health and wellbeing across the lifespan-- in children, adolescents, and adults. I have been fortunate to have grant support from the National Institutes of Health, the Department of Defense, and the Patient-Centered Outcomes Research Institute. Today I am here in my personal capacity as a sleep researcher and in coordination with my sleep medicine and sleep research colleagues of the American Academy of Sleep Medicine (AASM), the National Sleep Foundation, the Society for Research on Biological Rhythms, and the Sleep Research Society. Views expressed do not necessarily reflect those of my employer.

Thank you for inviting me to participate in this important hearing today. I commend this subcommittee for thoughtfully considering changes to Daylight Saving Time (DST), including consequences related to the health and wellbeing of the American people. I strongly recommend both eliminating the transition back and forth to Daylight Saving Time and adopting Permanent Standard Time. In my opinion, and in the opinion of other sleep medicine experts, doing so would have multiple positive health benefits.

My testimony will focus on:

1. The adverse health effects of transitioning from Standard Time to DST on the second Sunday in March;
2. The biological case for staying on Standard Time year round;
3. The support of national organizations for permanent Standard Time; and
4. A review of other aspects important to this discussion, including energy consumption and economic effects.

### **Adverse health effects of abruptly transitioning from Standard Time to DST in March**

An American Academy of Sleep Medicine (AASM) survey from July 2020 of more than 2,000 U.S. adults found that 63 percent support the elimination of seasonal time changes in favor of a national, fixed, year-round time, and only 11 percent oppose it.<sup>1</sup>

In addition to inconvenience, there are clear adverse health effects attributed to the Standard Time to DST transition. In a 2020 commentary published in *JAMA Neurology*,<sup>2</sup> coauthors and I reviewed the evidence linking the annual transition to DST to increased strokes, heart attacks, and teen sleep deprivation. Below I summarize the findings of several studies cited in that paper as well as my experience caring for children, including those with autism and sleep problems.

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<sup>1</sup><https://sleepeducation.org/wp-content/uploads/2021/04/sleep-prioritization-survey-2020-elimination-seasonal-time-changes-results.pdf>

<sup>2</sup> Malow BA, Veatch OJ, Bagai K. (2020). Are daylight saving time changes bad for the brain? *JAMA Neurol.*, 77(1):9–10. <https://pubmed.ncbi.nlm.nih.gov/31682684/>

- Increased strokes<sup>3</sup>

A Finnish study compared hospitalizations for stroke (in 3,033 patients) during the week following the transitions to DST/Standard Time to expected hospitalizations for stroke (based on 11,801 patients who had strokes at other times of the year). Hospitalizations for stroke were significantly increased during the first two days after the transitions, with a relative risk of 1.08, a 95% confidence interval of 1.01-1.15, and a p value of 0.020. Compared to the fall transition, the spring transition to DST had a 24% increased risk for in-hospital mortality.

This means that a patient's risk of having a stroke was 1.08 times more likely (risk of stroke is increased by 8%) in the two days after the transitions to and from DST. The confidence interval provides the range of values that we can be 95% confident contains the true relative risk. The p value is less than 0.050, connotating that the results are significant from a statistical standpoint. While 1.08 may appear to be a small relative risk, it helps to consider this risk in terms of the entire US population (estimated at 332,403,650 people in 2022).<sup>4</sup> A relative risk of 1.08 means that 26,592,292 people will be more likely to have strokes in the days after the transitions (332,403,650 x 0.08).

Women, older adults (> 65 years) and those with cancer were more likely to have strokes after the DST transitions. For example, the relative risk in people with cancer was 1.25, or 25% more likely to have a stroke in that time period.

- Increased heart attacks<sup>5</sup>

Meta-analysis of seven studies of more than 115,000 patients documenting a higher risk of acute myocardial infarction (i.e., heart attacks) during the spring transition to DST (odds ratio of 1.05; 95% confidence interval of 1.02-1.07).

- Adolescent sleep deprivation<sup>6</sup>

Adolescents slept, on average, 30 minutes less in the week after the spring DST transition, going from 7 hours and 51 minutes before the transition to 7 hours and 19 minutes afterward (recorded by actigraphy, an objective measure of sleep patterns). They also had longer reaction times, increased lapses in vigilance, and increased daytime sleepiness.

An AASM consensus statement<sup>7</sup>, which I co-authored, recommended 8-10 hours of sleep for adolescents on a regular basis, based on a detailed literature review

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<sup>3</sup> Sipilä JO, Ruuskanen JO, Rautava P, Kytö V. (2016) Changes in ischemic stroke occurrence following daylight saving time transitions. *Sleep Med.*, 27-28:20-24. <https://pubmed.ncbi.nlm.nih.gov/27938913/>

<sup>4</sup> <https://www.commerce.gov/news/blog/2022/01/us-population-estimated-332403650-jan-1-2022>

<sup>5</sup> Manfredini, R., Fabbian, F., Cappadona, R., De Giorgi, A., Bravi, F., Carradori, T., Flacco, M. E., & Manzoli, L. (2019). Daylight saving time and acute myocardial infarction: A meta-analysis. *Journal of Clinical Medicine*, 8(3), 404. <https://doi.org/10.3390/jcm8030404>

<sup>6</sup> Medina, D., Ebben, M., Milrad, S., Atkinson, B., & Krieger, A. C. (2015). Adverse effects of daylight saving time on adolescents' sleep and vigilance. *J Clin Sleep Med.*, 11(8), 879–884. <https://doi.org/10.5664/jcsm.4938>

<sup>7</sup> Paruthi S, Brooks LJ, D'Ambrosio C, Hall WA, Kotagal S, Lloyd RM, Malow BA, Maski K, Nichols C, Quan SF, Rosen CL, Troester MM, Wise MS. (2016). Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for healthy children: methodology and discussion. *J Clin Sleep Med.*, 12(11):1549–1561. <https://doi.org/10.5664/jcsm.6288>

documenting adverse effects of chronic sleep loss on attention, behavior, learning problems, depression, and self-harm.

- Adult fatigue

An AASM 2019 survey of more than 2,000 adults in the US found that more than half of Americans (55%) typically feel tired after the clocks move forward an hour for DST.<sup>8</sup>

- Sleep disorders and autism

One of my areas of expertise is sleep and autism. Children on the autism spectrum are already susceptible to poor sleep, which affects 50-80% of this population, and is characterized by delays in falling asleep, staying asleep, or both.<sup>9</sup> These children struggle with changes in routines, including the transition to DST. Parents have related that their child's sleep patterns are worsened for several weeks after transitioning to DST in the spring when they lose an hour of sleep. I have cared for several children whose sleep worsened after the change to DST, accompanied by more meltdowns and hyperactivity, with the behavioral effects lasting several weeks. This was very stressful to the families. Effective interventions for sleep problems in this population include limiting evening light and maximizing morning light. Permanent Standard Time would optimize both of these interventions.

- Other effects and mechanisms:

Additional studies citing negative effects of the DST transition are summarized in a position statement published by the AASM<sup>10</sup> and include an increase in missed medical appointments, increased emergency department visits, and an increase in return visits to the hospital (only seen in spring transition to DST).

Mechanisms (see reference 11 for details) include sleep loss (during the spring transition to DST when an hour of sleep is lost) and circadian misalignment (mismatch in timing between our biological clocks and the outside world), with a variety of cellular derangements, including altered myocyte gene expression, altered epigenetic and transcriptional profile of core clock genes, increased production of inflammatory markers, and lower vagal tone resulting in higher heart rate and blood pressure.

*With general agreement that transitioning back and forth between Standard Time and DST is detrimental, the question becomes: which is healthier, permanent DST or permanent Standard Time?*

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<sup>8</sup> <https://aasm.org/about/newsroom/attachment/sleep-prioritization-survey-2019-spring-daylight-saving-time-results/>

<sup>9</sup> Maxwell-Horn A, Malow BA. (2017) Sleep in Autism. *Semin Neurol.*, 37(4), 413-418. <https://pubmed.ncbi.nlm.nih.gov/28837988/>

<sup>10</sup> Rishi MA, Ahmed O, Barrantes Perez JH, et al. (2020). Daylight saving time: an American Academy of Sleep Medicine position statement. *J Clin Sleep Med.*, 16(10),1781–1784. <https://doi.org/10.5664/jcsm.8780>

## The biological case for staying on Standard Time year round

Changing clocks from Standard Time to DST is different than flying from Chicago in the central time zone to Washington, DC in the eastern time zone—because in flying from one time zone to another, we are changing our clocks AND our environment. The environmental time cues, such as sunrise and sunset, help our bodies adjust. When we change the clocks in March, and stay on DST until November, it is an artificial clock change. We change the clocks, but the environmental time cues remain the same. Therefore, we are one hour off for nearly eight months of the year.

Light is shifted one hour from the morning to the evening when we go from Standard Time to DST in March. In the winter, depending on where we live and what time we need to leave our homes for work or school, it may be pitch black. In the summer, it may be bright into the late evening hours. I recall when I lived in Ann Arbor, Michigan, and I needed to drive to the hospital in the cold and dark winter mornings. It was hard! In the summer, we needed to wait until 10 pm at night for the sky to darken to see fireworks. Western parts of Michigan, such as Kalamazoo, are dark even earlier in the winter mornings and light even later in the summer evenings.

### DST Darkens Mornings



Average US school start time is 8:03 AM. Median US work arrival time is 7:55 AM.

Wheaton et al. (2015). "School Start Times for Middle School and High School Students". *CDC Morbidity and Mortality Weekly Report*.  
Silver (2014). "Which Cities Sleep In, and Which Get to Work Early", *FiveThirtyEight*.

Therefore, DST is like living in the wrong time zone for almost eight months out of the year. Our biological clocks are in one time zone (i.e., Central) while the clocks governing our school and work times are one time zone to the east (i.e., Eastern).

How does that morning dark and evening light affect us? We need light in the morning to help us awaken and be fully alert. While the exact mechanisms of this alerting response of light are not yet known, this may be due to light's effects on levels of cortisol,<sup>11</sup> a hormone that modulates the stress response.<sup>12</sup> Morning light also keeps our sleep/wake cycles in check—light in the morning synchronizes our circadian rhythms (24-hour biological clock) and promotes our going to bed at night at a healthy hour.

On the other end, we need it to be dark outside for our brains to release natural melatonin, which is a key promoter of sleep. Melatonin is suppressed by blue light—that's why we are advised to stay off our screens before bed. Sunlight is the major source of blue light and is tens of thousands times brighter than our computer screens.

Standard Time is the healthy choice because it maximizes light in the winter mornings, when we need it to wake up and become alert, and minimizes light in the summer evenings, when it can work against our sleep. Permanent, year-round Standard Time is the best match for our biological sleep-wake cycle.

### **Health effects made worse by DST**

When we are chronically sleep deprived, we are more prone to obesity, diabetes, cardiovascular disease, hypertension, anxiety, and depression.<sup>13</sup>

In addition to chronic sleep deprivation, another neurobiological factor made worse by DST is "circadian misalignment"<sup>14</sup> - a mismatch in the timing between our work, school, and sleep routines and what is going on in the outside world. This misalignment happens when we are waking up in the dark or getting light when we should be sleeping, such as in shift workers.<sup>15</sup> Circadian misalignment has been correlated with detrimental health effects, including cancer, cardiovascular disease, Type 2 diabetes, and neurodegenerative disease (including Parkinson's disease and Alzheimer's disease).<sup>16</sup>

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<sup>11</sup> Petrowski K, Buehrer S, Niedling M, Schmalbach B (2021). The effects of light exposure on the cortisol stress response in human males, *Stress*, 24:1, 29-35 <https://doi.org/10.1080/10253890.2020.1741543>

<sup>12</sup> Russell G, Lightman S. (2019). The human stress response. *Nat Rev Endocrinol* 15, 525–534. <https://doi.org/10.1038/s41574-019-0228-0>

<sup>13</sup> Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem (2006). <https://www.ncbi.nlm.nih.gov/books/NBK19961/>

<sup>14</sup> Baron KG, Reid KJ. Circadian misalignment and health (2014). *Int Rev Psychiatry*, 26(2):139-54. <https://doi.org/10.3109/09540261.2014.911149>

<sup>15</sup> Boivin DB, Boudreau P, Kosmadopoulos A. (2022). Disturbance of the circadian system in shift work and its health impact. *Journal of Biological Rhythms*, 37(1), 3–28. <https://doi.org/10.1177/07487304211064218>

<sup>16</sup> Steele TA, St Louis EK, Videnovic A, Auger, RR. (2021). Circadian rhythm sleep-wake disorders: A contemporary review of neurobiology, treatment, and dysregulation in neurodegenerative disease. *Neurotherapeutics*, 18(1), 53–74. <https://doi.org/10.1007/s13311-021-01031-8>

## Individual susceptibility

DST affects people differently. Some people are fortunate to be able to sleep in or can work from home. Due to adoption of at-home or hybrid work schedules accelerated by COVID-19, many people now have the luxury of being able to roll out of bed at 6:45 am and be on a 7 am zoom call. But not everyone enjoys that flexibility—some people need to be physically at work by 7 am. Roughly half of US students need to be in school for in-person learning before 8 am, with many school districts starting in the 7-7:30 am time range. Workers of some racial/ethnic backgrounds and of lower socioeconomic status are more likely to very early morning work hours. These early risers are going to be more at risk for losing sleep and experiencing the associated negative consequences of chronic sleep deprivation and circadian misalignment.

Geography plays an important role, also. People who live on the western edge of a time zone have even earlier sunrises and later sunsets than those on the eastern edge of a time zone or somewhere in the middle. They have been documented to get less sleep and are also more likely to be overweight and more susceptible to diabetes, heart disease, and breast and other types of cancer,<sup>17</sup> with an estimated loss of 4.4 million days of work (1.3 hours per capita) per year, and 3% lower wages.<sup>18</sup> People who live in the northern parts of the US encounter less sunlight in the winter and more sunlight in the summer.

## Multiple organizations endorse the elimination of DST and the adoption of permanent Standard Time

The AASM supports the elimination of seasonal time changes in favor of a fixed, national, year-round time, and current evidence best supports the adoption of year-round Standard Time. Multiple national and international organizations have endorsed an AASM statement on this topic, including the Society for Research on Biological Rhythms, the National PTA, the National Safety Council, and others.<sup>19</sup>

## Other aspects to consider

- Many people assume that the latest sunrise and earliest sunset occur on December 21, the day of the winter solstice (shortest day). But in fact, the earliest sunsets occur around December 1 with the latest sunrises occurring around January 1. This phenomenon, related to the earth's tilt, is referred to as the analemma.<sup>20</sup> **Being on Standard Time in the winter months is giving us light when we need it most, in the dark morning hours.** Northern states on the Western edge of time zones are most susceptible to dark mornings, which would be exacerbated by permanent DST.

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<sup>17</sup> Gu F, Xu S, Devesa SS, Zhang F, Klerman EB, Graubard BI, Caporaso NE (2017). Longitude position in a time zone and cancer risk in the United States. *Cancer Epidemiol Biomarkers Prev.*, 26(8):1306-1311. <https://pubmed.ncbi.nlm.nih.gov/28450580/>

<sup>18</sup> Giuntella O, Mazzonna F (2019). Sunset time and the economic effects of social jetlag: evidence from US time zone borders, *Journal of Health Economics*, 65. <https://doi.org/10.1016/j.jhealeco.2019.03.007>

<sup>19</sup> <https://aasm.org/american-academy-of-sleep-medicine-calls-for-elimination-of-daylight-saving-time/>

<sup>20</sup> Analemma: <https://www.analemma.com/phenomena.html>

- Permanent DST has been tried previously in the US, most recently in 1974 during the energy crisis (Middle East oil embargo). **The dark mornings were very unpopular and permanent DST was repealed by Congress.**<sup>21</sup> The idea was that having extra light later into the afternoon would save energy by decreasing the need for electric lighting. However, energy savings from DST appear negligible.<sup>22</sup> Air conditioning needs often increase in the late afternoon in the summer and heating needs often increase in the morning in the winter.<sup>23</sup> A natural experiment in Indiana, when DST was instituted statewide in 2006, found that **DST increased residential electricity demand.**<sup>24</sup>

In summary, along with American Academy of Sleep Medicine, the National Sleep Foundation, the Society for Research on Biological Rhythms, the Sleep Research Society, and multiple other sleep and circadian rhythm physicians and researchers, I would strongly recommend eliminating the transition back and forth to DST and adopting permanent Standard Time. Thank you, again, for the opportunity to provide testimony before the committee. I look forward to answering your questions.

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<sup>21</sup> <https://www.mercurynews.com/2016/10/30/the-year-daylight-saving-time-went-too-far/>

<sup>22</sup> Congressional Research Service, Daylight Saving Time, Updated Sept. 30, 2020  
<https://crsreports.congress.gov/product/pdf/R/R45208/8>

<sup>23</sup> Sexton AL, Beatty TKM (2014). Behavioral responses to daylight savings time, *Journal of Economic Behavior and Organization*, 107, part A, 290-307. <https://doi.org/10.1016/j.jebo.2014.03.012>

<sup>24</sup> Kotchen M, Grant L. (2011). Does Daylight Saving Time Save Energy? Evidence from a Natural Experiment in Indiana. *The Review of Economics and Statistics*, 93 (4), 1172-1185. [https://doi.org/10.1162/REST\\_a\\_00131](https://doi.org/10.1162/REST_a_00131)