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The Influence of Daylight Saving Time on US Civil Aviation Operations and Safety

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Daylight Saving Time (DST) involves biannual clock shifts, impacting various sectors, including transportation. While prior research has linked DST transitions to increased workplace injuries and automobile accidents, its effects on aviation safety remain unexplored. This study examines the relationship between DST transitions and aviation accident rates in the continental United States from 1978 to 2024 using data from the National Transportation Safety Board (NTSB). A statistical analysis was conducted to identify variations in accident frequencies surrounding DST transitions. Results indicate no significant increase in aviation accidents following DST changes, contrasting with findings in other industries. This study highlights DST's impact on aviation safety, by providing insights into its negligible impact on aviation safety. Future research should explore pilot fatigue and operational disruptions associated with DST through qualitative assessments of flight crew experiences.

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Introduction

Daylight Saving Time (DST) is the practice of setting the clocks forward one hour from standard time during the summer months, and back again in the fall, to make better use of natural daylight. As of 2025, approximately 70 countries, representing 40% globally participate in Daylight Saving Time practices (Buckle et al., 2025). The biannual time shift comprises a springtime one-hour advanced, known as a phase advance, and an autumnal one-hour delay, termed a phase delay.

Before industrialization, daily activities aligned naturally with sunrise and sunset (Fukuyama, 1992; Landes, 1998). Historical figures such as Benjamin Franklin and George Vernon Hudson proposed daylight optimization practices that later evolved into DST (Neumann & von Blanckenburg, 2025). Port Arthur, Ontario, Canada, was the first city in the world to enact DST, on 1 July 1908 to extend business hours (Reid, 2025). DST was first adopted nationwide in 1916 in Germany as an economic measure by the Imperial Office of the Interior to conserve coal during wartime (Neumann & von Blanckenburg, 2025). The United States followed suit with the Standard Time Act of 1918 during World War I as an energy-saving measure—based on the idea that moving the clock forward an hour meant one fewer evening hour during which electric lights were needed. Although repealed post-the war, DST was reinstated during World War II. The Uniform Time Act of 1966 standardized annual DST transitions federally, excluding Hawaii and Arizona (Brumage, 2016).

Although substantial research exists on DST's impact across sectors such as motor vehicles and industrial workplaces, the aviation industry remains relatively unexplored. Given aviation's high-reliability demands and susceptibility to human factors like fatigue and circadian disruption, understanding DST's influence on pilot performance and operational safety is crucial. This study addresses the research gap by evaluating the relationship between DST transitions and aviation accident counts within the continental United States from 1978 to 2024. The research intend to seek whether there are statistically significant differences between accident count before and after phase advance in spring and phase delay in fall.

In the next section, we present a literature review of the origin of DST and its impact on workplace and automobile accidents. We also review the impact of circadian rhythm on aviation operations. and DST impacts on aviation activities. Then, we discuss the methodology and statistical methods used for our analysis. Next, we present our results. Finally, we conclude the paper.

Literature Review

The implementation of DST has long been controversial due to its implications for human health, safety, and performance (Carter et al., 2022; Malow, 2022; Rishi et al., 2024). Several studies highlight potential negative impacts, including disruptions to circadian rhythms, leading to increased workplace injuries and transportation accidents (Roenneberg et al., 2019; Zhang et al., 2020). The effects have been associated with a variety of short-term physiological and cognitive impairments, as well as long-term health risks. Studies have documented increases in sleep loss, cardiovascular incidents, emergency room visits, and declines in work performance and mental health (Ferrazzi et al., 2018; Zhang et al., 2020).

DST and Occupational Safety

Research has shown that DST can influence workplace safety, though findings are mixed across contexts. Barnes and Wagner (2009) found a statistically significant increase in both the number and severity of workplace injuries on the Monday following the spring DST transition. Their study, based on a National Institute for Occupational Safety and Health mining injury dataset from 1983–2006, also reported that workers averaged 40 minutes less sleep the night before. These results supported the hypothesis that sleep loss due to DST contributes directly to increased occupational risk.

In contrast, Lahti et al. (2011) analyzed occupational injury data in Finland between 2002 and 2006 and found no significant effect of DST on injury rates. Similarly, Robb and Barnes (2018), using over 12 million accident claims in New Zealand from 2005–2016, found that while DST had a strong impact on road accidents, it did not significantly affect workplace accidents. These findings suggest that DST-related occupational impacts may depend on regional work patterns, regulatory safeguards, and environmental factors.

In addition to accident rates, workplace performance and cognition have also been studied. Boubekri et al. (2020) found that optimized daylight and outside views positively influenced the sleep duration and cognitive performance of office workers. DST shifts, which reduce early morning light exposure, may therefore impair workplace functioning in subtle but measurable ways.

DST and Transportation Safety

The transportation sector, particularly road travel, has been a primary focus in DST impact studies. One of the earliest studies by Varughese and Allen (2001) identified an increase in fatal crashes on the Monday following the spring DST transition in the U.S., attributed to sleep deprivation. Smith (2016) extended this line of inquiry by estimating that DST-related sleep loss led to over 30 additional traffic fatalities annually from 2002–2011, with a corresponding social cost of $275 million.

Fritz et al. (2024). using data from 732,835 fatal motor vehicle accidents recorded in the U.S. Fatality Analysis Reporting System between 1996 and 2017, found a 6% increase in fatal accidents in the week following the spring DST transition. They also observed greater risk among individuals residing in the western portions of time zones. More recently, Orsini et al. (2024) used simulator-based studies to show that DST can cause measurable and prolonged effects on driver fatigue, with performance decrements continuing for weeks post-transition.

Robb and Barnes ((2018) also found a 16% and 12% increase in road accident claims on the first and second days following the spring DST change in New Zealand, respectively. This study further highlighted the variability in DST impacts across accident categories, time of week, and regional conditions.

DST and Broader Health Impacts

DST's impacts extend beyond accidents into general health domains. Zhang et al. (2020) used large-scale computational models to show that DST transitions are associated with elevated risks for cardiovascular, behavioral, and immune-related disorders. Ferrazzi et al. (2018), analyzing hospital records in Italy, found increases in emergency room visits and repeat visits surrounding DST shifts, pointing to subtle but widespread health burdens.

Boubekri et al. (2020) underscored the importance of daylight exposure on sleep and cognition, noting that optimized lighting environments improve both outcomes for office workers. Given that DST delays sunrise in the spring, these changes could degrade alertness, productivity, and cognitive functioning in both professional and educational settings.

DST and Aviation Safety

While there are no studies that explicitly studied the impact of DST on aviation safety, previous studies have focused on the role of human factors in aviation safety (Hawkins, 1993; Jin & Lo, 2017; Jin & Lu, 2020; Majumdar, 2023; Majumdar & Marais, 2025; Wiegmann & Shappell, 2003; Yang & Mott, 2020). Aviation sector's dependence on alertness, precision, and circadian stability suggests a potential area of concern. Aviation professionals, including pilots and air traffic controllers, work in highly regulated environments where fatigue is a known safety risk. Researchers have also conducted studies to evaluate the effects of fatigue and circadian rhythms on aviation safety and pilot performance (Caldwell, 2012; Gander et al., 2013; Mendonca Mr et al., 2019, 2019; Roenneberg et al., 2019)

Caldwell (2012) outlined the consequences of sleep deprivation in pilots, emphasizing that circadian misalignment increases fatigue-related risks during early-morning or late-night shifts. Wingelaar-Jagt et al. (2020) further documented the effects of both acute and chronic fatigue on military and civilian aviators, showing that sustained performance degradation is likely when rest cycles are disrupted. Although DST-related time changes are accounted for in scheduling (Ryder, 2019), the transition can still disrupt sleep quality and biological rhythms, particularly for international or rotating crews.

The aviation industry's tight operational margins and reliance on alert decision-making mean even small circadian disruptions could have outsized effects. Fatigue reduces pilot alertness and cognitive functions in collegiate training setting (Keller et al., 2019), and it also affects decision-making in flight training (Keller et al., 2019). Therefore, there is a need to evaluate DST's influence as a contributor to fatigue and performance risk in flight operations.

DST's biannual one-hour clock shifts represent a form of circadian rhythm disruption that misaligns internal biological clocks with local time, particularly for flight crews. This acute misalignment can disturb normal sleep–wake patterns. Studies have shown that the spring DST transition shortens sleep duration and leaves individuals more fatigued and cognitively impaired during the day (Roenneberg et al., 2019). Previous research indicates that DST has wide-ranging effects across occupational, transportation, and health domains. While findings vary across contexts, consistent evidence suggests that sleep loss and circadian misalignment following the spring shift can impair cognition and increase safety risks—especially in shift-based sectors like transportation.

In aviation, where performance is acutely sensitive to fatigue and circadian rhythms, these disruptions are an important concern. Caldwell (2012) found that sleep deprivation and circadian misalignment significantly degrade pilots' cognitive performance and essential flight skills, while Wingelaar-Jagt et al. (2021) documented sustained performance declines when rest cycles are disrupted. Such fatigue-induced impairments, such as slower reaction times, narrowed attention, and compromised decision-making, pose serious safety risks in flight operations. Even with schedule adjustments, DST can still affect crew rest quality and alignment, especially for pilots operating irregular or long-haul international routes. Though no prior studies have directly assessed DST's effects in aviation, the sector's high vulnerability to fatigue makes it a critical area for research. This study aims to address that gap by analyzing DST-related patterns in U.S. civil aviation incidents to inform future risk mitigation strategies.

Methodology

Data

The data for this study is obtained from the National Transportation Safety Board (NTSB). The data covers a period from 1978 to 2024 (47 years), in which we count the numbers of accidents in four categories: One Week Before DST Begins (OneWeekBeforeDSTBegins), One Week After DST Begins (OneWeekAfterDSTBegins), One Week Before DST Ends (OneWeekBeforeDSTEnds), and One Week After DST Ends (OneWeekAfterDSTEnds). Compared with the previous study focus on weekend before and after of DST change (Varughese & Allen, 2001), this study capture 7 days before and after the DST change.

In total, we have 188 cases (n=188), the number 846 is from 47 years x 4 weeks per year. Each case includes a total of aviation accidents during the week happen in the continental 48 states observing DST.

For this study, we selected starting year as 1978 because 1978 is the year Airline Deregulation Act signed into law and took effect and the US commercial aviation system has a structural change from the years before (Adrangi et al., 1997; Belobaba et al., 2016; Kuhn, 1970).

Statistical Methods

Based on the previous studies, we hypothesized that there would be an increase of accidents on the week after DST begins and ends. We used one tailed two sample t-test to test whether there is any statistically significant difference in accident counts across the DST change. We propose our hypotheses in the following:

$$H1_0: \mu_1 = \mu_2 \quad (1)$$
$$H1_a: \mu_1 < \mu_2 \quad (2)$$

$$H2_0: \mu_3 = \mu_4 \quad (3)$$
$$H2_a: \mu_3 < \mu_4 \quad (4)$$

μ_1 stands for the theoretical average for aviation accident counts of One Week Before DST Begins.
μ_2 stands for the theoretical average for aviation accident counts of One Week After DST Begins.
μ_3 stands for the theoretical average for aviation accident counts of One Week Before DST Ends.
μ_4 stands for the theoretical average for aviation accident counts of One Week After DST Ends.
Finally, we performed a time-series analysis on the average accident count across the time frame (1978–2024).

Results

This section presents the findings of our analysis of U.S. civil aviation accidents from 1978 to 2024. Table 1 shows summary statistics for aviation accidents recorded on different event days around DST transitions. The sample size includes all 47 years. The number of accidents ranges from 11 to 98, indicating the minimum accident count is 11, while the maximum accident count is 98.

Table 1

Descriptive Statistics for Week

Week	N	Mean	Std. Dev	Minimum	Maximum
OneWeekBeforeDSTBegins	47	37.47	20.42	13	98
OneWeekAfterDSTBegins	47	37.91	19.21	11	97
OneWeekBeforeDSTEnds	47	31.45	14.04	11	70
OneWeekAfterDSTEnds	47	29.94	13.10	12	69

The mean number of accidents varies across the Week, with the highest accident count observed during One Week Before DST Begins (OneWeekBeforeDSTBegins). Conversely, the lowest mean accident count is found during One Week After DST Ends (OneWeekAfterDSTEnds).

Table 2

Power Calculation for Two Sample T-Test

T-Test Groups	Mean Difference	Std. Dev	α two-sided	Group Sample Size	Power
$\mu_1 vs. \mu_2$	15	19.82	0.05	47	0.9771
$\mu_3 vs. \mu_4$	15	13.57	0.05	47	0.9996

We set the mean difference at 15, that is 15 accidents difference for DST transition. The statistical power for both comparisons exceeds the commonly accepted threshold of 0.80, which indicates a high probability of detecting a true effect if one exists. μ_1 vs. μ_2 has a power of 0.9771, meaning a 97.71% chance of correctly rejecting the null hypothesis if the true mean difference is 15. μ_3 vs. μ_4 has an even higher power of 0.9996 due to a smaller standard deviation, making the test more sensitive to differences.

Table 3

Tests of Homogeneity of Variances for OneWeekBeforeDSTBegins and OneWeekAfterDSTBegins

Levene's Test (F)	Levene's sig
0.238	0.627

Levene's test resulted in a p-value of 0.627, which is greater than the conventional alpha level of 0.05. This indicates that the null hypothesis of equal variances cannot be rejected. Therefore, we can assume equal variances between the two groups and proceed with the t-test under the assumption of homogeneity of variance.

Table 4

T-test for Equality of Means of OneWeekBeforeDSTBegins and OneWeekAfterDSTBegins

t	df	Sig. (1-tailed)	Mean Difference	Std. Err Difference	95% CI Difference Lower	95% CI Difference Upper
-0.109	92	0.4565	-0.447	4.09	-8.569	7.676

The one-tailed two independent samples t-test yielded a p-value of 0.457, which is greater than the conventional significance level of 0.05. This result suggests that the observed difference between the group means is not statistically significant in the hypothesized direction. Therefore, we fail to reject the null hypothesis. There is no sufficient evidence to suggest a statistically significant difference in mean counts between OneWeekBeforeDSTBegins and OneWeekAfterDSTBegins.

Table 5

Tests of Homogeneity of Variances for OneWeekBeforeDSTEnds and OneWeekAfterDSTEnds

Levene's Test (F)	Levene's sig
0.607	0.438

Levene's test resulted in a p-value of 0.438, which is greater than the conventional alpha level of 0.05. This means the assumption of equal variances is not violated. Therefore, we can assume equal variances between the two groups and proceed with the t-test under the assumption of homogeneity of variance.

Table 6

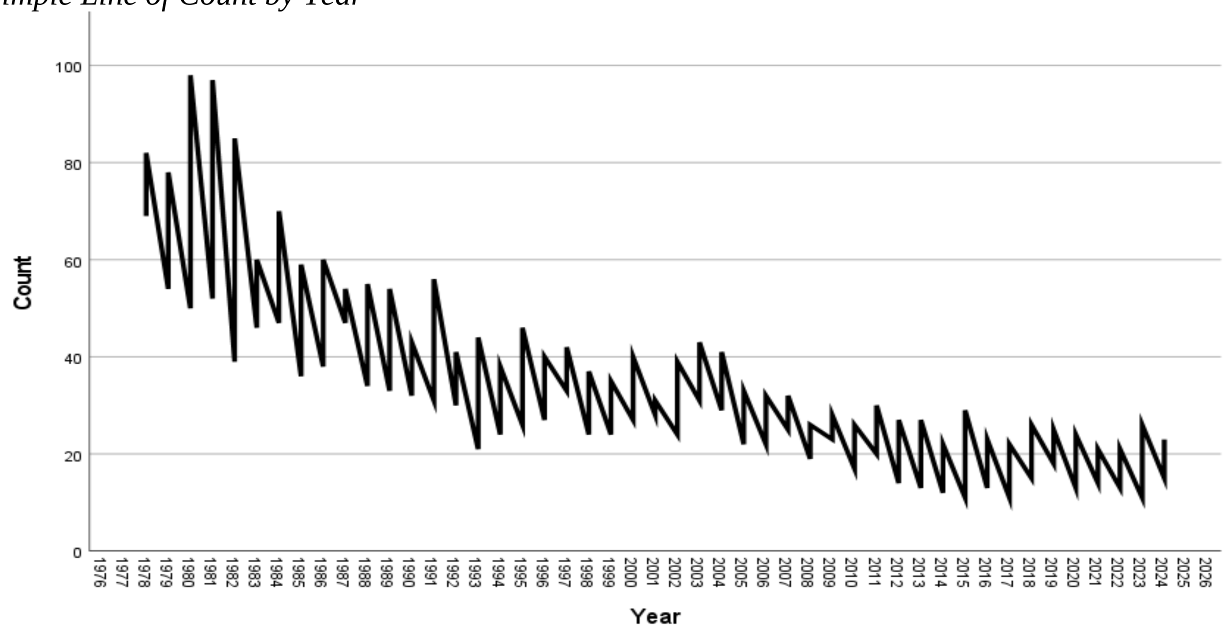
T-test for Equality of Means of OneWeekBeforeDSTEnds and OneWeekAfterDSTEnds

t	df	Sig. (1-tailed)	Mean Difference	Std. Err Difference	95% CI Difference Lower	95% CI Difference Upper
-0.539	92	0.2955	-1.511	2.801	-7.074	4.052

The one tailed two sample t-test returned a p-value of 0.296, which is greater than the typical alpha level of 0.05. This means the observed difference in means is not statistically significant in the expected direction. Therefore, we fail to reject the null hypothesis. There is no sufficient evidence to conclude that the mean count in the week before DST ends is different (specifically lower) than the week after DST ends.

Figure 1

Simple Line of Count by Year



The chart above reveals a consistent and sharp downward trend, suggesting accidents happened during each year has substantially decreased over time. This trend likely reflects a steadily improving aviation safety record, attributable to multiple factors, including:

- advancements in aviation technology,
- improved understanding of human factors,

- the implementation of Safety Management Systems (SMS), and
- more effective organizational and regulatory practices.

These improvements have been widely documented in the literature (Bowen & Lu, 2004; Cusick et al., 2017; Perrow, 2011; Stolzer, 2016; Wiegmann & Shappell, 2003).

Conclusion

This study examined the potential relationship between Daylight Saving Time (DST) transitions and aviation accident rates across the continental United States from 1978 to 2024. In contrast to other sectors, such as road transportation and occupational safety, our findings did not reveal statistically significant differences between accident count before and after phase advance in spring and phase delay in fall. As for the practical difference in term of accident count change between two weeks of DST transition, there is 0.34 increase in spring(you lose one hour) and there is 1.51 decrease in fall (you gain one hour). That generally complies with our experience, most of us feel happy with extra hour of sleep in the morning!

Future research should explore these subtler impacts using natural language processing techniques to analyze unstructured narrative accident reports. Additionally, qualitative studies examining flight crew and ground crew experiences could offer valuable insights into how DST affects fatigue and operational performance. As for policy discussions about the permanence or abolition of DST continue, such evidence-based insights will be vital to guide aviation scheduling and fatigue management practices.

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