

Daylight Savings Time Transitions on Football Injuries and Key Performance Indicators in the Bundesliga: A Web-Scraping Approach

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Headline

Disrupted sleep patterns due to implementation of daylight savings time in the Spring has been observed to have great public health consequences. Naturally, there have been extensive investigations on the effect of daylight savings time (DST) on traffic accidents, aggression, and myocardial infarctions (1, 2, 3). However, consequences of DST on athletes have not been investigated.

Our results suggest a significantly higher incidence of injuries requiring substitutions after the onset of DST. Additionally, this study demonstrates the applicability of web-scraping in utilizing publicly available data for sports research.

Aim. This study aimed to explore the effect of DST implementation on key performance variables and match events in football games played in the top three football leagues in Germany.

Methods

Samples. The sample consisted of all matches played in the top three professional leagues in Germany during the 2010/2011 to 2017/2018 seasons. The three leagues were the Bundesliga, Bundesliga 2, and the third division of German professional football (Liga). These leagues start in July or August and end in May the following year, during which the onset and offset of DST takes place. Our data was extracted from match reports on TransferMarkt (www.transfermarkt.com). TransferMarkt is a database of football results, statistics, transfer news and fixtures, and has been used to derive data in a number of studies (4, 5, 6).

Design. A comparative data analysis was conducted retrospectively on publicly available data. Data collection was carried out from September to October 2018. Similar to existing research on DST (1, 2), we examined matches that occurred before and after onset of DST, where players potentially lost an hour of sleep. Conversely, we compared matches that occurred before and after offset of DST, where players potentially gained an hour of sleep. DST onset in Germany occurs at 2am on the last Sunday of March while DST offset occurs at 3am on the last Sunday of October. Existing studies on the effects of DST typically compared incidence rates of events of interest that occurred on the Monday right after the DST onset or offset to the following Monday (1, 2). However, as professional football games in Germany are predominantly played on Friday, Saturday or Sunday, the duration of interest was increased accordingly.

Methodology. In line with previous research on football performance variables (7), 12 variables were examined that were classified as (a) key performance variables: total shots, shots

on target, shots off target, shots saved, corners, free kicks, fouls, offsides; (b) key match events: substitutions made due to injury, total goals conceded, yellow cards, red cards. Matches played 8 days before onset of DST were classified in the PRE-ONSET group and those played on the day of and 7 days after onset of DST were classified in the POST-ONSET group. Contrastingly, matches played 8 days before offset of DST were classified in the PRE-OFFSET group and those played on the day of and 7 days after offset of DST were classified in the POST-OFFSET group. There were fewer cases for key performance variables data for all four groups, PRE-ONSET (n = 142), POST-ONSET (n = 139), PRE-OFFSET (n = 186), and POST-OFFSET (n = 163). Comparatively, match cases for the key match events data were more comprehensive, PRE-ONSET (n = 230), POST-ONSET (n = 199), PRE-OFFSET (n = 284) and POST-OFFSET (n = 221). A Python script was written using the packages BeautifulSoup and urllib to extract data from the TransferMarkt website. Dataset creation was done with openpyxl to automate the writing of data in Microsoft Excel. The accompanied script provides a basic implementation of web-scraping and data creation.

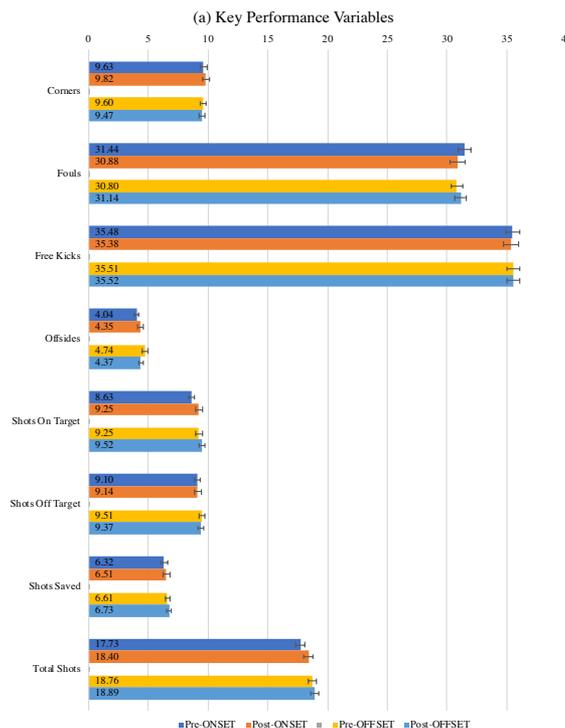


Fig. 1. Mean counts of key performance variables across matches played. Error bars denote standard error of each variable.

Statistical analysis

A Poisson Regression analysis was conducted to estimate the effect of DST on each of the 12 variables with confidence interval set at 95%. The Poisson Regression was chosen as our dependent variables consist of count data, the count data observed were independent of each other and the distribution of our count data fits a Poisson distribution (8). Furthermore, Poisson Regression addresses several limitations of using least squares analysis for performance variables which have small counts.

Additionally, effect sizes for the mean differences between the ONSET and OFFSET groups were calculated and interpreted as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2) and large (>1.2) (9). The magnitude of clear effects was determined based on the following scale: 25-75%, possible; 75-95% likely; 95-99.5%, very likely; >99.5%, almost certain (10). The effect of DLS on key performance variables and match events was investigated by evaluating the smallest worthwhile change, calculated as 0.2 multiplied by the between group standard deviations.

Results

The performance variables showed no statistically significant differences between the PRE-ONSET and POST-ONSET groups. Similarly, there were no statistically significant differences in the performance variables between the PRE-OFFSET and POST-OFFSET groups. Our findings are presented in Figure 1.

Games played in the PRE-ONSET group experienced a 37.5% increase in substitutions made due to injuries as compared to games played in the POST-ONSET group. This finding was statistically significant, $p = 0.019$. It was determined that there was a likely small increase in injury rate in matches played in the POST-ONSET group compared to the PRE-ONSET group (99.4%). The other key match events showed no statistically significant differences.

Additionally, there were no statistically significant difference in any key match events between the PRE-OFFSET and POST-OFFSET groups. Our findings for the key match events are presented in Figure 2.

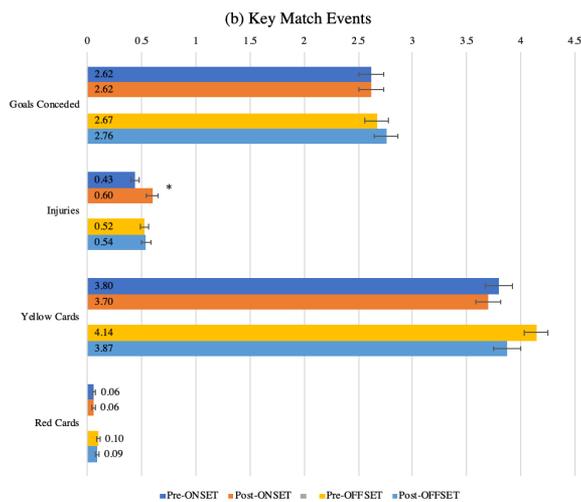


Fig. 2. Mean counts of key match events across matches played. Error bars denote standard error and asterisk denotes significant difference at significance level of 0.05.

Discussion

Our results suggest that the onset of DST, after which athletes are likely to lose 40 minutes of sleep on average (11), may affect the number of substitutions made due to injuries. The consequences of such an increased rate of significant injuries are twofold. Firstly, injuries requiring substitutions are more likely to result in a lengthier layoff and substantial period of unavailability. This layoff also results in considerable financial costs to the club. Based on the average salary of strikers in the Bundesliga in the 2006/07 season, a club incurs 42,647 euros in wages per game for every player unable to compete (12). Secondly, professional football rules allow each team to make three substitutions every game. Substitutions are valuable resources and studies have suggested that substitutes may be crucial in professional football toward winning matches by changing tactical patterns or bringing much needed energy to the team (13). Increased injury rates after DST onset suggests greater likelihood that substitutions are needed to replace injured players, which limits tactical substitutions available thereafter.

Prior research has shown a transient increase in injury incidence amongst athletes following sleep loss (14). Poor sleep quality has also been found to correlate with escalated frequency and intensity of self-reported aggression (15). It is possible that increased aggression may have contributed to greater likelihood of impulsive or hostile challenges, leading to higher impact collisions and subsequent injuries. However, as the current study did not distinguish causes of injury and did not measure aggression of players, further research is needed to affirm potential associations between sleep, aggression and injury occurrence.

Sleep has been widely regarded as an essential facet of recovery to manage fatigue and abbreviate the recovery process (16). Elevated fatigue levels due to high player workloads have been found to increase injury risk (17). Additionally, existing studies suggesting that multiple days of poor sleep could predispose athletes to sustaining injuries due to residual chronic fatigue levels (18). Although the present study does not directly measure sleep quantity, prior research informs that increased workplace injuries occur following a 40-minute truncation of sleep duration due to the onset of DST (19). However, future research should also directly measure the sleep quantity and quality of the athletes, prior to, during and after DST, to better establish the relationship between sleep and injury occurrence.

Conversely, lack of differences in the key performance variables and key match events in the PRE-OFFSET and POST-OFFSET groups can be explained by two factors. Firstly, existing reviews have found that readjusting toward standard time is easier and can be accomplished more swiftly compared to adjusting to DST onset (20). Furthermore, existing research suggests individuals may not sleep for an extra hour after DST offset (11) and that there are no significant differences in sleep quantity after readjusting to standard time (19).

The vast availability of online data in the present day allow sport scientists to capitalize on web-scraping as a key tool for sports science research, and to inform practice. In addition to DST transition findings, the current study demonstrates the viability of utilizing web-scraping in translational sports science research. This method is particularly beneficial to sports science researchers as a non-invasive tool for observing sporting trends. For example, studies using web-scraping for data acquisition have discovered a greater percentage of left-handed elite tennis players compared to commonly cited figures (21). Such discoveries could serve to inform coaches, club administrators with useful coaching or strategical insights.

Practical applications

- Football team officials can consider adopting a week-long adjustment period after DST onset. For example, shifting their schedule back by an hour for one week following DST implementation to help players better adjust to circadian rhythm transitions and limit detrimental effects of disrupted sleep.
- Athletes should be educated on the detrimental effects of sleep disruption and be aware of a short period of potentially increased susceptibility to injury after DST onset.
- Web-scraping can be utilized to make meaningful inferences from data available on the internet for sports research purposes.

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