RESEARCH ARTICLE

THE EFFECT OF EXTENSION OF DAYLIGHT SAVING TIME ON THE FREQUENCY OF ROAD TRAFFIC ACCIDENTS

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ARTICLE INFO	ABSTRACT
	Background: There is still debate about the effects of daylight saving time (DST) on both energy saving and social activities. The aim of the present study was to investigate the impact of extension of DST on the frequency of road traffic accidents. **Methods:** This cross-sectional retrospective study involved 1.548 road traffic accident patients who were referred to emergency departments from December 2015 to February 2016, and from December 2016 to February 2017. The type and time of the accident, as well as the demographic characteristics of the patients involved, were recorded. **Results:** A total of 1.548 patients, comprising 1.071 (69.2%) males and 477 (30.8%) females, were enrolled in the present study. There were no significant differences in the number of road traffic accidents according to DST ($p > 0.05$). Of the patients, 773 (49.9%) were referred due to a motor vehicle accident, 554 (35.8%) due to a motor vehicle-pedestrian accident, and 221 (14.3%) due to a motorcycle accident. **Conclusions:** We conclude that DST had no effect on the frequency of road traffic accidents.

INTRODUCTION

The majority of traffic accidents, in which 1,250,000 people die annually, occur in low- and moderate-income countries (Duma, 2005). In 2002, the World Health Organization (WHO) revealed that traffic accidents constituted 2.1% of all global deaths, ranking as the 11th leading cause of death (Duma, 2005). Traffic accidents are the 15th leading cause of death in Turkey (Gupta, 2017). Discussion of the effect of time of day on the occurrence of traffic accidents is ongoing. Walking in the dark is associated with 2.7- and 7.4-fold increased rates in traffic accidents in urban and rural areas, respectively, compared with walking in daylight (Jensen, 1998). Daylight saving time (DST), which has been implemented for the last 2 years in Turkey, results in individuals frequently traveling in the dark. The primary aim of DST is to reduce energy consumption. Beyond energy saving, leaving home early in darkness may increase the risk of traffic accidents. Therefore, we analyzed the influence of DST on the frequency of road traffic accidents. The results will clarify the debate over permanent implementation of DST.

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MATERIALS AND METHODS

All patients referred to the Emergency Medicine Clinic of Kanuni Sultan Suleyman Education and Research Hospital because of traffic accidents from December 2015 to February 2016, and from December 2016 to February 2017were retrospectively reviewed after granting of approval by the local Ethics Committee in January 2018. Our hospital is the only center that cares for trauma victims in an area of people. The gender and age of the patients, as well as the type and time of the accident, were recorded. The patients were first hemodynamically stabilized and the standard advanced trauma life support (ATLS) protocol was applied according to the updated ATLS-9 guidelines.

Statistical analysis

The data were analyzed using SPSS software (ver. 15.0; SPSS Inc., Chicago, IL, USA). Data are expressed as means ± standard deviation (SD), medians, numbers (n) and percentages. The Mann–Whitney U test was used to compare non-normally distributed qualitative parameters. Quantitative data were compared by chi-squared test and Pearson's chi-squared test. The results were evaluated at a confidence interval of 95% and a significance level of $p < 0.05$.

RESULTS

In total, the 1.548 patients comprised 1.071 (69.2%) males and 477 (30.8%) females with an average age 31.1 ± 16 years (range: 1–89 years). Regarding referral dates, 48.1% (n = 744) of the patients were referred from December 2015 to February 2016 and 51.9% (n = 804) were referred from December 2016 to February 2017 (Table 1). The number of traffic accidents did not differ significantly between the two referral periods. Of the patients, 773 (49.9%) were referred because of an in-vehicle traffic accident (IVTA); 554 (35.8%) due to an extravehicular traffic accident (EVTA), and 221 (14.3%) due to a motorcycle accident (MA) (Table 1); the difference in accident type proportions was significant ($p < 0.01$). Regarding time of day, the highest traffic accident rate (36%) was from 3:01 AM to 9:00 AM, followed by 09:01 AM to 3:00 PM (26.7%), and 09:01 PM to 3:00 AM (24.9%) (Table 1); the difference in proportion of accidents by time of day was significant ($p < 0.01$). The accident rate from 3:01 PM to 9:00 PM was significantly higher than that from 09:00 AM to 3:00 PM and 9:01 PM to 03:00 AM; there was no significant difference between the latter two periods ($p > 0.05$) and both showed a higher rate of traffic accidents compared to that from 03:01 AM and 09:00 AM. Of the total accidents in the period December 2015 to February 2016, 208 (28%) occurred from 09:00 AM to 3:00 PM; 259 (34.8%) from 3:01 PM to 9:00 PM; 187 (25.1%) from 9:01 PM to 03:00 AM; and 90 (12.1%) from 03:01 AM to 09:00 AM. Of the total accidents in the period December 2016 to February 2017, 206 (25.6%) occurred from 09:00 AM to 3:00 PM, 298 (37.1%) from 3:01 PM to 09:00 PM, 198 (24.6%) from 9:01 PM to 03:00 AM, and 102 (12.7%) from 03:01 AM to 09:00 AM (Table 2). The accident occurrence time did not differ significantly among the referral periods ($p = 0.687$; Table 2). The average age of the patients referred from December 2015 to February 2016, and from December 2016 to February 2017, was 31.12 ± 15.73 and 31.12 ± 16.26 years, respectively ($p = 0.728$). Regarding gender, 512 (68.8%) males and 232 (31.2%) females were referred from December 2015 to February 2016, compared to 559 (69.5%) males and 245 (30.5%) females from December 2016 to February 2017 ($p = 0.762$; Table 2). In terms of accident type, from December 2015 to February 2016, 369 (49.6%) patients were referred because of IVTA; 263 (35.3%) because of EVTA; and 112 (15.1%) because of MA,. From December 2016 to February 2017, 404 (50.2%) patients were referred because of IVTA, 291 (36.2%) because of EVTA, and 109 (13.6%) because of MA. There was no significant difference in accident type proportions between the two periods ($p = 0.699$; Table 2). A statistically significant difference was detected in accident type according to accident occurrence time from December 2015 to February 2016 ($p = 0.001$). IVTA occurred most frequently during the evening and at night (09:01 PM to 03:00 AM, 64.2%; 03:01 AM to 09:00 AM, 63.3%), while EVTA and MA occurred most frequently at day and in the morning (3:01 PM to 09:00 PM, 43.2% and 21.2%; 09:01 AM to 3:00 PM, 36.5% and 15.4%, respectively; Table 3). From December 2016 to February 2017, IVTA occurred most frequently during the evening and at night (09:01 PM to 03:00 AM, 57.1%; 03:01 AM to 09:00 AM, 69.6%), while EVTA occurred most frequently at day and in the morning (3:01 PM to 09:00 PM, 43.3%; 09:01 AM to 3:00 PM, 38.3%) ($p = 0.001$). The MA rate was higher at day and during the evening (3:01 PM to 09:00 PM, 15.8%; 09:01 PM to 03:00 AM, 14.6%; Table 3). In the patients who experienced IVTAs, there was no significant difference in accident occurrence time ($p = 0.222$) between

Table 1. Demographic and clinical characteristics of patients involved in road traffic accidents

Age		Min-Max	Mean±SD
		1-89	31.1±16
		Number (n)	%
Gender; *n (%)*	Male	1071	69.2
	Female	477	30.8
Referral Period (Date range); *n (%)*	December 2015-February 2016	744	48.1
	December 2016-February 2017	804	51.9
Accident occurrence pattern; *n (%)*	IVTA	773	49.9
	ADTK	554	35.8
	MK	221	14.3
Accident Occurrence Time; *n (%)*	9:00 a.m.-3:00 p.m.	414	26.7
	3:01 p.m.-9:00 p.m.	557	36.0
	9:01 p.m.- 3:00 a.m.	385	24.9
	3:01 a.m.-9:00 a.m.	192	12.4

IVTA, in-vehicle traffic accident; EVTA, extravehicular traffic accident; MA, motorcycle accident

Table 2. Characteristics of the referral periods

		Referral Period (Date Interval)		P
		December 2015- February 2016	December 2016- February 2017	
Accident occurrence time; *n (%)*	9:00 a.m.-3:00 p.m.	208 (28)	206 (25.6)	[a]*0.687*
	3:01 p.m.-9:00 p.m.	259 (34.8)	298 (37.1)	
	9:01p.m.-3:00 a.m.	187 (25.1)	198 (24.6)	
	3:01a.m.-9:00a.m.	90 (12.1)	102 (12.7)	
Gender *n (%)*	Male	512 (68.8)	559 (69.5)	[a]*0,762*
	Female	232 (31.2)	245 (30.5)	
Accident occurrence pattern; *n (%)*	IVTA	369 (49.6)	404 (50.2)	[a]*0.699*
	EVTA	263 (35.3)	291 (36.2)	
	MA	112 (15.1)	109 (13.6)	
Age (years)	*Min-Max (Median)*	1-89 (29)	1-85 (29)	[b]*0.728*
	Mean±SD	31.1±15.7	31.1±16.3	

[a] Pearson's chi-squared test; Mann–Whitney U test
IVTA, in-vehicle traffic accident; EVTA, extravehicular traffic accident; MA, motorcycle accident

Table 3. Distribution of accident types by occurrence time

		Accident Occurrence Time				ᵃP
		9:00 a.m.-3:00 p.m.	3:01 p.m.-9:00 p.m.	9:01 p.m.-03:00 a.m.	03:01 a.m.-09:00 a.m.	
Referral Period	IVTA	100 (48.1)	92 (35.5)	120 (64.2)	57 (63.3)	0,001**
(December 2015-February 2016)	EVTA	76 (36.5)	112 (43.2)	47 (25.1)	28 (31.1)	
Accident Occurrence Pattern; *n (%)*	MA	32 (15.4)	55 (21.2)	20 (10.7)	5 (5.6)	
Referral Period	IVTA	98 (47.6)	122 (40.9)	113 (57.1)	71 (69.6)	0,001**
(December 2016-February 2017)	EVTA	79 (38.3)	129 (43.3)	56 (28.3)	27 (26.5)	
Accident Occurrence Pattern; *n (%)*	MA	29 (14.1)	47 (15.8)	29 (14.6)	4 (3.9)	
IVTA; *n(%)*	December 2015-February 2016	100 (50.5)	92 (43)	120 (51.5)	57 (44.5)	0.222
	December 2016-February 2017	98 (49.5)	122 (57)	113 (48.5)	71 (55.5)	
EVTA; *n(%)*	December 2015-February 2016	76 (49.0)	112 (46.5)	47 (45.6)	27 (32.9)	0.885
	December 2016-February 2017	79 (51.0)	129 (53.5)	56 (54.4)	55 (67.1)	
MA; *n(%)*	December 2015-February 2016	32 (52.5)	55 (53.9)	20 (40.8)	5 (55.6)	0.475
	December 2016-February 2017	29 (47.5)	47 (46.1)	29 (59.2)	4 (44.4)	

ᵃPearson's chi-squared test; **p < 0.01
IVTA, in-vehicle traffic accident; EVTA, extravehicular traffic accident; MA, motorcycle accident

the December 2015 to February 2016 and December 2016 to February 2017 periods. Furthermore, there was no significant difference in accident type between the two referral periods in the patients who experienced EVTAs (p = 0.885). In addition, there was no significant difference in accident occurrence time between the two referral periods in the patients who experienced MAs (p = 0.475; Table 3).

DISCUSSION

We found no significant difference in the number of referrals due to road traffic accidents from December 2016 to February 2017, when DST was first implemented, and December 2015 to February 2016, which was the period immediately prior to implementation of DST. DST was introduced with the aim of reducing energy consumption, but inevitably impacted on the daily journeys to and from home of workers and students due to awakening to darkness. The aim of this study was to determine the impact of DST on the frequency of road traffic accidents, which is influenced by myriad variables (Erdogan, 2009). The risk of being involved in a road traffic accident is increased in individuals under the influence of hypnotics, alcohol, benzodiazepines, muscle relaxants, and psychoactive drugs (Gustavsen *et al.,* 2008). Sogut *et al.* reported that the oxidative stress levels of passengers, drivers, and pedestrians involved in road traffic accidents were significantly higher than those of healthy volunteers. Therefore, suppression of the antioxidant response may lead to a severely disturbed oxidant/antioxidant balance, in turn increasing the risk of road traffic accidents (Ozdemir *et al.,* 2012). Huang *et al.* found that DST implementation did not influence the frequency of road traffic accidents in the short term (Huang and Levinson, 2010). Ferguson *et al.* reported that pedestrians are at greater risk of crush injuries than motor-vehicle drivers following the transition from DST to standard time. Furthermore, DST reduced the frequency of traffic accidents from 1987 to 1991 (Ferguson *et al.,* 1995). The numbers of pedestrians and cyclists are significantly higher, by 62% and 38%, respectively, during the day than at night. This suggests the importance of providing adequate light conditions during the transition from daylight to darkness to encourage more travel at night (Jim Uttley *et al.,* 2017). Sood and Ghosh reported that DST decreases the frequency of traffic accidents involving pedestrians and motor-vehicle passengers (Sood and Ghosh, 2007). Coate and Markowitz showed that perennial DST decreases the number of pedestrian deaths at night by 25%; however, it also increases the number of pedestrian deaths in the morning by around 33%.

In addition, pedestrian activity is reportedly higher at night than in the morning, and perennial DST implementation has been suggested to decrease pedestrian deaths (Coate *et al.,* 2004). Huang *et al.* suggested that DST can improve visibility for drivers and thus may reduce the frequency of accidents (Huang and Levinson, 2010). Robb *et al.* reported that DST significantly increases the frequency of traffic accidents, particularly during the first 2 days (Robb and Barnes, 2018). No transition period was included in the present study and human factors (e.g., alcohol consumption) related to traffic accidents were not evaluated. DST did not affect the frequency of traffic accidents involving injury in our study, likely due to industrial and technological developments as well as implementation of road lightning and vehicle security precautions. We analyzed 1.548 patients (1.071 [69.2%] males and 477 [30.8%] females) over a 2-year period. The mean age of the patients was 31.12 ± 16.01 years (range: 1–89 years). In a 10-year study of patients in Turkey referred to an emergency department, 76.3% were males and 23.7% were females, and their average age was 27.04 ± 17.08 years (Kucuker *et al.,* 2003). In the study by Varol *et al.,* 68.2% and 31.8% of the patients were males and females, respectively (Varol *et al.,* 2006). Our findings are similar to these previous reports. In the study by Kucuker *et al.,* 41.8% and 41.2% of the patients had experienced IVTAs and EVTAs, respectively (13). In this study, 49.9% (n = 773), 35.8% (n = 554), and 14.3% (n = 221) of the patients were referred because of IVTAs, EVTAs, and MAs, respectively; the differences may be due to the increased use of vehicles and public transportation. Regarding timing, the highest frequency (36%, n = 557) of traffic accidents was from 3:01 PM to 09:00 PM, followed by 26.7% (n = 414) from 09:01 AM and 3:00 PM and 24.9% (n = 385) from 9:01 PM to 03:00 AM. Traffic accidents occur most frequently from 3:00 PM to 7:00 PM, when daylight intensity is generally decreasing (Sullivan and Flannagan, 2017; Carey and Sarma, 2017). Because this was a retrospective study involving review of patient files, we could not evaluate other factors, such as use of hypnotics, alcohol, benzodiazepines, muscle relaxants, and psychoactive drugs, or a disturbed oxidant/antioxidant balance, in relation to the risk of road traffic accidents. Future studies should focus on the effects of these parameters on the frequency of road traffic accidents. DST does not exert a significant effect on the frequency of road traffic accidents. Further controlled clinical trials involving larger populations are warranted.

Conflict of Interest: Authors declared that there is no conflict of interest.

Key points

- Traffic accidents constituted 2.1% of all global deaths, ranking as the 11th leading cause of death.
- Discussion of the effect of time of day on the occurrence of traffic accidents is ongoing.
- The aim of this study was to determine the impact of DST on the frequency of road traffic accidents, which is influenced by myriad variables
- DST does not exert a significant effect on the frequency of road traffic accidents.

The English in this document has been checked by at least two professional editors, both native speakers of English. For a certificate, please see: http://www.textcheck.com/certificate/DCKg3a

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