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Original article

Traffic crash accidents in Tehran, Iran: Its relation with circadian rhythm of sleepiness

Khosro Sadeghniiat-Haghighi [a], Zohreh Yazdi [b, *], Mohsen Moradinia [a], Omid Aminian [a], Alireza Esmaili [c]

[a] Occupational Sleep Research Center, Tehran University of Medical Sciences, Tehran, Iran
[b] Metabolic Disease Research Center, Qazvin University of Medical Sciences, Qazvin, Iran
[c] Traffic Police University, Tehran, Iran

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ABSTRACT

Purpose: Road traffic accidents are one of main problems in Iran. Multiple factors cause traffic accidents and the most important one is sleepiness. This factor, however, is given less attention in our country. Road traffic accidents relevant to sleepiness are studied.
Methods: In this cross-sectional study, all road traffic accidents relevant to sleepiness, which were reported by police, were studied in Tehran province in 2009.
Results: The risk of road traffic accidents due to sleepiness was increased by more than sevenfold (odds ratio = 7.33) in low alertness hours (0:00–6:00) compared to other time of day. The risk of road traffic accidents due to sleepiness was decreased by 0.15-fold (odds ratio = 0.15) in hours with maximum of alertness (18:00–22:00) of circadian rhythm compared to other time of day.
Conclusion: The occurrence of road traffic accidents due to sleepiness has significant statistical relations with driving during lowest point of alertness of circadian rhythm.

1. Introduction

Iran is one of the countries with the highest mortality of road traffic accidents in the world. Currently, less than 1% of the world's population live in Iran, but more than 1/40 of traffic accidents occurred in Iran.[1,2] In 2006, the World Health Organization reported that in 2002, traffic accidents caused 11% of the total deaths in Iran and was considered as the second leading cause of death after cardiovascular diseases. According to this report, traffic accidents are the first cause of Years of Life Lost (YLL) in Iran and estimated that 16% of YLL are due to traffic accidents. Also, the annual report by the WHO in 2006 stated that Iran had 133 road accident injuries per 100,000 population and it has been ranked the fifth after Somalia, Sudan, Iraq and Afghanistan.[3–5]

It is predicted that by 2020 a tremendous increase in mortality due to traffic accidents will be seen.[6] Traffic accidents are a huge problem for health in our country. In 2009, more than 800,000 cases of accidents occurred in Iran, in which more than 23,000 people have been killed and 270,000 people injured. The cost of accidents in 2009 has been estimated about 64,000 billion rials that is accounted about 6.4% of GDP.[7–9]

It is estimated that up to 20% of traffic accidents are due to sleepiness in industrialized countries.[10] A study showed that the risk of traffic accidents due to automobile driving between 2:00 and 5:00 is 6.5 times higher.[11] Another study reported that the peak time of accidents was at 3:00. Also, there is a smaller increase between 14:00 and 16:00.[12] Horne et al[13] in the UK reported an increase of about 10 times for the risk of accidents occurring during 2:00–3:00 compared with other hours.

Sleep and many other physiological activities are regulated by the circadian rhythm in the brain. The circadian rhythm makes two peaks of sleepiness during a period of 24 h. The strongest level of sleepiness occurred during the night (between midnight and 6:00 am). The second peak, which has less severe sleepiness, occurred in the afternoon between the hours of 13:00 and 16:00. Also, the time of maximum alertness and little desire to sleep is between 18:00 and 22:00.[14]

Another important point is that in traffic crashes caused by sleepiness usually only one vehicle is involved (single vehicle crashes). In these cases, the accidents often occur as the overturning

* Corresponding author. Tel.: +98 28 33359503.
E-mail address: zyazdi@qums.ac.ir
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Table 1
Baseline characteristics of drivers and condition of accidents.

	n	%
Sex		
Male	20,374	98
Female	423	2
Education		
Uneducated	2718	13.1
Below diploma	7799	37.5
Diploma	6437	30.9
Technician	1300	6.2
Bachelor	1685	8.1
Masters	858	4.1
Type of certificate		
One class	3171	15.2
Two class	15,004	72.1
No seen	2429	11.7
None	193	1
Type of roads		
Freeway	5142	24.7
Highway	1080	5.2
Main road	11,810	56.8
Byway	2765	13.3
Hours of accidents		
0:00–6:00	1815	8.7
7:00–12:00	4743	22.8
13:00–18:00	6859	32.9
19:00–24:00	7380	35.5
Type of accidents		
With vehicle	15,341	73.8
Among multi-vehicle	1979	9.5
Roadside features	1456	7
Overturning	1253	6
Others	768	3.7
Cause of accidents		
Inattention to law	18,553	89.2
Sleepiness	715	3.4
Addiction	4	0
Alcohol	43	0.2
None	1482	7.1

of the vehicle or hitting with various roadside features (guardrails, trees, sign supports, poles, etc).[15] In the Gallup survey in 2002, 37% of US drivers have reported at least once napping or sleeping period during driving.[16] Another study in the UK has shown that 17% of accidents resulting in death or injury are associated with driver's sleepiness. This percentage varied between 3% and 30% depending on the road type.[17]

In Spain, the cost of road accidents due to sleepiness in 1988 was estimated at about 43–56 billion dollars. Also, sleepiness

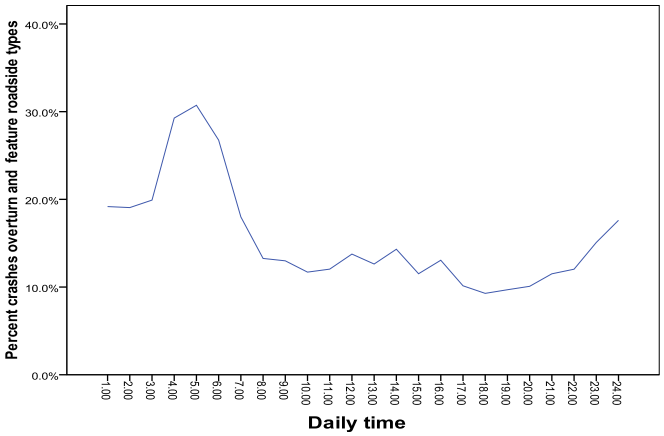

Fig. 1. Hourly distribution of car accidents due to overturning of vehicle or hitting with various roadside features in Tehran province in 2009.

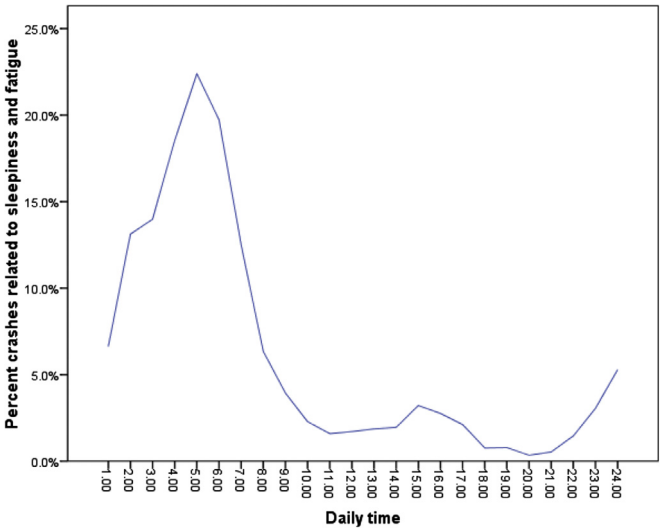

Fig. 2. Hourly distribution of car accidents due to sleepiness in Tehran province in 2009.

contributed to the occurrence of 36% of fatal crash accidents and 42%–54% of total accidents.[18] In the US, annually there are at least 100,000 automobile crashes, 40,000 people injured and 1550 deaths from sleepiness and falling asleep behind the wheel.[19]

Many studies have been done for exploring the causes of accidents in Iran. But, survey about the role and importance of circadian rhythms of sleepiness as a cause of car accidents has not been carried out. This study was performed to evaluate the pattern of traffic accidents on the highway of Tehran province and examine the role of circadian rhythm of sleepiness in causing the accidents.

2. Materials and methods

This cross-sectional study was conducted in Tehran province. All data on road accidents occurred in Tehran province in 2009 had been collected. These data were collected by the police officers and were used after coordination with the relevant authorities. Information about the car drivers (age, gender, education level and type of certification) and road accidents (location of road accidents, time of crashes, type of collision and the reason of accidents) were collected. Time of day traffic distribution was obtained from the Ministry of Transportation. Due to the effect of time of day traffic distribution on car accidents, one of the roads in Tehran province (Karaj–Chalus road) was selected and car accidents based on traffic distribution were studied. The cause of car accidents was identified by police officers and the time of occurrence of accidents caused by sleepiness were recorded. Sleepiness was considered the cause of accidents in single vehicle crashes, overturning of the vehicle or hitting with various roadside features. The cause of these accidents was investigated. Also, the cause of car accidents in hours with maximum desire for sleep (0:00–6:00) was examined. Data was analyzed by SPSS version 17 software. To investigate the relationship between two qualitative variables, X^2 test and Odds Ratio were used.

3. Results

A total of 20,797 traffic accidents were studied, in which 20,374 (98%) accidents were involved male drivers and 423 (2%) female drivers. Table 1 shows baseline characteristics of drivers and condition of accidents.