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SLEEPINESS AND ACCIDENTS AMONG PROFESSIONAL DRIVERS

SUMMARY: *The aim of this study was to investigate the relation between sleepiness and accidents among professional drivers in Iran. This is a case-control study carried out among 820 professional drivers of whom 300 drivers were assigned to the case group and 520 drivers were as the control group, of whom 104 cases were excluded from the study because their questionnaire was not completed. Finally, the collected data on 716 cases were analyzed. The data relating to road traffic accidents, demographic factors and sleepiness were collected using questionnaire and interview. Data analysis was performed using SPSS16 (Statistical Package for the Social Sciences version 16). The mean of sleepiness score among cases was 6.2 whereas this mean in control group was 4.6. 20.9% of the experimental group had Epworth Sleepiness Scale (ESS)>10 while just 8.2% of the controls had ESS>10. The difference between sleepiness in the case who had precedence of accident and controls without precedence of accident was statistically significant (P<0.001). This study showed that sleepiness in drivers who had precedence of accidents was higher than the drivers without any accidents. Sleepiness can be one of the causes of accidents among the professional drivers in Iran.*

Keywords: *sleepiness, professional drivers, accident, Epworth Questionnaire*

INTRODUCTION

Bus and truck road traffic accidents are one of the major risks threatening the public health and well-being *(Parks et al., 2007)*. It is estimated that half of these accidents end in severe morbidity and mortality. According to World Health Organization (WHO); *(2009)* reports, more than 1.2 million people are annually killed in road traffic

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accidents. It is estimated that road traffic accident cause to nearly 3242 persons losing her/his life each day in the world. WHO *(2009)* also declared that approximately 20 to 50 million people are injured due to nonfatal road traffic accidents. The world rate of mortality due to road traffic accidents is lower (12.6%) in the high-income countries and higher (20.2%) in the low-income countries as Iran *(Suri, Parr, 2004, Segui-Gomez et al., 2007)*. Investigations show that in Iran, more than 26000 people are presently died in road traffic accidents and over 100000 people are injured for the same reason. Damage due to road traffic accidents in the developing countries is estimated to be $ 1.4-2 billion which forms 1-2% of the Gross National Production (GNP), but according to some studies in Iran, this dama-

ge is more than 3% of the GNP *(Haji Hossienlo, Aslani, 2017, Ebrahemzadih et al., 2016)*.

In most road traffic accidents, there are some factors related to the driver, the vehicle, the road, and the environment, so the combination and interaction of these factors lead to consequent events which ultimately cause accidents *(Parks et al., 2007)*. It is estimated that about 20% of the accidents are caused by drivers' carelessness due to their excessive sleepiness *(Lyznicki et al., 1998, Pack et al., 1995)*. A study in Iran revealed that 73.5% of the guilty drivers of road traffic accidents suffered from sleep disturbance *(Hasanzadeh et al., 2008)*. Various investigations worldwide have studied drivers' sleep disturbance and their role in the emergence of road traffic accidents. A study by Mulgrew et al. *(2008)* in Canada showed that of 375 cases of the subjects involved in accidents, 252 cases related to sleepiness. Another study by Mayock et al. revealed that 7% of the accidents related to drivers were because of sleepiness *(1997)*. Furthermore, a study by Connor et al. demonstrated that sleepiness increased the risk of road traffic accidents up to 8.2 times. A sleep amount of 5 hours during 24 hours prior to the accident and driving between 2-5 a.m. were among the major risk factors *(Connor et al., 2001)*. Corfitsen found that one-third of the drivers who drive during the night (considering coincidence with the night shift) reported sleepiness *(Corfitsen, 1993)*.

Also, Epworth Sleepiness Scale (ESS)>10 has been reported in 9-26% of the drivers and ESS >15 has been reported in 1.2-2.5% of them *(MacLean et al., 2003)*. According to a study by Hassanzadeh et al. sleep disturbance as a contributory factor in the accidents is common in Iranian drivers and shows itself in the form of early awakening, the need to the toilet at night, going to sleep late, and an acute feeling of hot or cold. This study also found that the precedence of car accidents is an effective factor on Pittsburgh Sleep Quality Index (PSQI) *(Hasanzadeh et al., 2008)*.

Although many studies have been carried out for reviewing the amount of sleep and factors affecting it, there is, however, a lack of harmony among the relations between accidents and sleepiness. The purpose of the present research was to study and compare the effect of the amount of sleepiness and accidents between the two groups of subjects: drivers with accidents, and drivers without accidents.

METHODS AND MATERIALS

The present research was a retrospective observational case-control study carried out in Yazd, Iran during 2009-2010. The case group consisted of the professional drivers of trucks and buses who were involved in at least one accident over the past three years. The control group consisted of the professional drivers who had never experienced any road traffic accident. The samples were taken from the professional drivers of buses and trucks in Yazd, Iran. All of research population was men. The sample for this study was 820 men of whom 300 cases were assigned to the experimental group and 520 cases were assigned to the control group. Then, the two groups were matched for age, driving distance, and working experience. Sampling was based on the simple non-probabilistic method, i.e., all the drivers referring to the special clinic of occupational medicine for periodic occupational examinations during June-February entered the study. The criteria for entering the study included lack of the presence of diseases as narcolepsy, insomnia, epilepsy, and depression. Patients with a history of drug abuse, alcohol addiction, and psychotropic drugs were excluded from the study *(Mulgrew et al., 2008)*. The purpose of the study was explained to all the subjects entering the study. And all of them signed the written consent. The study was approved by the Committee of Research Ethics at Yazd Shahid Sadoughi University of Medical Sciences.

The data relating to road traffic accidents were collected using interviews. The accidents were categorized into three groups: 1. Minor accidents: in which the amount of the damage was less than $100. 2. Major accidents: in which the amount of damage surpassed $100. 3. Major accidents with mortality: in which there has been death and injury in addition to a financial damage of more than $100. Besides, two questionnaires were completed by interview for each subject. The first questionnaire included demographic information as age, height, weight, education level, marital status, blood pressure, smoking, type of

vehicle, weekly or yearly driving distance, route of driving, type of vehicle possession, time of driving during day or night, and duration of daily sleeping. The second questionnaire was designed to determine the amount of sleepiness. It was an Epworth Sleepiness Scale (ESS) consisting of 8 items which is scored on the basis of Likert Chart and is graded from 0 to 24. Those scoring ESS<10 are considered normal regarding sleepiness, and those scoring Epworth Sleepiness Scale (ESS)≥10 suffer from sleep disturbance. These questionnaires have established validity and reliability (Johns, 1991). The Persian translation of Epworth Sleepiness Scale questionnaires used in this study was confirmed to be valid sadeghniiat et al. studies. Sadeghniiat et al. (2013) in a study showed that the Cronbach's alpha coefficient of the ESS-IR conducted in the Persian language was 0.82.

Data analysis was performed using SPSS16 (Statistical Package for the Social Sciences version 16). The independent relationship between Epworth Sleepiness Scale score and accident was obtained using Chi-square test. The odd ratio (OR) was also calculated. To study the effect of other variables on accidents, use was made of multivariate logistic regression.

RESULTS

A total of 820 subjects participated in the present study of whom 104 cases were excluded from the study because their questionnaire was not completed. Finally, the collected data on 716 cases were analyzed. 254 cases of the research population who had experienced a car accident were included in the experimental group. Table 1 presents accident frequency in the experimental group on the basis of type and cause of accident. Of the total accidents happened to the experimental subjects, 24.6% was minor ones, 49% was major ones, and 26.9% were major accidents with mortality and injuries (Road traffic mortality and injuries data collected based on Yazd traffic police reports). As the table shows, drivers' sleepiness (30.3%) is the most important cause of accidents in the experimental group.

Table 1. Accident frequency in the cases on the basis of type and cause of accident

Tablica 1. Učestalost nesreća u pojedinim skupinama po vrsti i uzroku nesreće

Accident Type / Accident Cause	Minor	Major	Major together with mortality	Total
Sleepiness and Tiredness n(%)	6 (2.4)	38 (15)	45 (17.7)	89 (35)
Inattention of other drivers n(%)	17 (6.7)	24 (9.4)	5 (2.0)	46 (18.1)
Mobile Using n(%)	7 (2.8)	2 (0.8)	0 (0.0)	9 (3.6)
Driving too fast n(%)	0 (0.0)	6 (2.4)	8 (3.2)	14 (5.6)
Carelessness and Lapses n(%)	27 (10.7)	22 (8.7)	4 (1.6)	53 (21)
Driving too close n(%)	1 (0.4)	11 (4.3)	0 (0.0)	12 (4.7)
Listen to music during driving n(%)	0 (0.0)	4 (1.6)	2 (0.8)	6 (2.4)
Technical failure n(%)	2 (0.8)	6 (2.4)	1 (0.4)	9 (3.6)
Bad Weather n(%)	1 (0.4)	5 (2.8)	1 (0.4)	7 (3.6)
Disease Relapse on the wheel n(%)	1 (0.4)	2 (1.6)	2 (0.8)	5 (2.8)

N=254

Also, 44.1% of the accidents occurring among research population happened in the rural roads, 17.7% happened in highways, and 38.2% occurred in the residential areas. The mean of driving distance per week in the experimental group was 3455.5±1125.1 km.

Table 2 presents demographic and other variables information of the cases and control groups. As the table show, the subjects in the experimental and control groups have been matched for the desired variables in this study so that no difference was found with regard to the variables of age, working experience, Body Mass Index (BMI), and driving distance per year. According to the data in this table, 64.6% of the subjects in the case group announced their well-being while 89.9% of the subjects in the control group announced this. The percentage of the unhealthy

cases in the experimental group was higher than that of the control group and there was a statistically significant difference between the two ($P<0.001$). The amount of driving in terms of kilometers per week in the experimental group was 3455.5 km with an SD of 1125.1. This was 3690.26 km for the control group with an SD of 2182.

The amount of sleepiness among the subjects in the experimental and control groups is presented in fig 1. In fact, 20.9% of the experimental subjects had ESS>10 while just 8.2% of the control subjects had ESS>10. The difference between sleepiness in the experimental and control subjects was statistically significant ($P<0.001$). The odd ratio of sleepiness in the experimental and control groups was OR = 0.34 at the confidence level of %95 with CI= 0.217, 0.533.

Table 2.   Demographic characteristics of the case and control groups

Tablica 2. Demografski podaci za eksperimentalnu i kontrolnu skupinu

|		Case	Control	P-Value
Age mean(±SD)		40.72 (8.73)	39.02 (9.89)	0.108
Precedence of Work mean(±SD)		16.22 (6.99)	14.58 (9.14)	0.115
BMI mean(±SD)		25.94 (3.05)	25.87 (3.85)	0.798
Distance in Year mean(±SD)		170114.2 (54487.1)	170080.5 (67659.3)	0.994
Smoking n(%)	Yes	106 (41.7%)	122 (26.4%)	$P< 0.001$
	No	148(56.5%)	340(73.6%)	$P< 0.001$
	No Disease	164(64.6%)	415(89.9%)	$P< 0.001$
	Cardio vascular	7(2.8%)	8(1.7%)	$P< 0.001$
Precedence of Disease n(%)	Lung	10 (3.9%)	3(0.6%)	$P< 0.001$
	Diabetics	21(8.3%)	11(2.4%)	$P< 0.001$
	High Blood Pressure	27(10.7%)	13(2.8%)	$P< 0.001$
	Neural Disease	15(5.9%)	5(1.1%)	$P< 0.001$
	Cardio vascular and High Blood Pressure	8(3.1%)	4(0.9%)	$P< 0.001$
	Liver and Kidney	20(0.8%)	3(0.6%)	$P< 0.001$

N=716
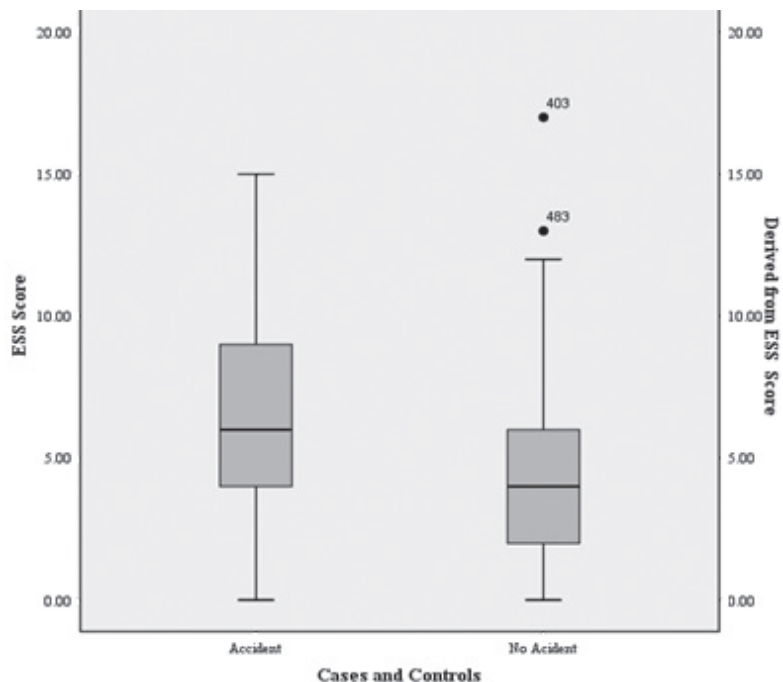
Figure 1. ESS score among case and controls
Slika 1. ESS vrijednosti u promatranoj i kontrolnoj skupini

Table 3 presents the findings on ESS score, percentage of driving at night, and precedence of different diseases among various age groups between the experimental and control groups. The mean of drowsiness between the two groups for all age groups was statistically significant.

Older drivers had a higher percentage of diseases so that a total of 16.4% of the cases in the age group of more than 50 suffered from chronic diseases while 5.9% of the cases in the age group of less than 30 suffered from these diseases. The "multivariate logistic regression" was used to determine the simultaneous effect of other variables on accidents. Table 4 shows that age, chronic diseases, BMI, and sleepiness exerted a simultaneous effect on accident.

Table 3.　ESS score, percentage of driving at night, and precedence of different diseases among various age groups between the cases and controls
Tablica 3. ESS vrijednosti, postotak noćne vožnje, razne postojeće bolesti u različitim dobnim skupinama kod eksperimentalne i kontrolne skupine

Age Group	Precedence of Accidents	Score ESS Mean (SD)	P	Driving at night n(%) Yes	Driving at night n(%) No	P	No Disease	Cardio vascular	Lung	Liver and Kidney	Diabetic	High Blood Pressure	Neural Disease	Cardio vascular and High Blood Pressure
<30	Yes	4.74 (4.2)	0.02	28 (16.5)	6 (3.5)	0.88	27 (15.9)	0 (0.0)	4 (1.8)	0 (0.0)	2 (1.2)	0 (0.0)	5 (2.9)	0 (0.0)
	No	2.89 (2.8)		110 (64.7)	26 (15.3)		133 (78.2)	0 (0.0)	6 (2.6)	0 (0.0)	0 (0.0)	3 (1.8)	0 (0.0)	0 (0.0)
31-40	Yes	5.64 (3.1)	0.00	99 (45.4)	6 (2.8)	0.00	76 (34.9)	1 (0.5)	0 (0.0)	0 (0.0)	10 (4.6)	6 (2.7)	6 (2.8)	0 (0.0)
	No	3.90 (2.9)		86 (39.4)	27 (12.4)		47 (20.5)	0 (0.0)	2 (0.9)	1 (1.0)	1 (0.5)	0 (0.0)	1 (0.5)	0 (0.0)
41-50	Yes	6.68 (2.1)	0.00	65 (28.4)	15 (6.6)	0.29	14 (14.1)	0 (0.0)	1 (0.4)	0 (0.0)	7 (3.1)	12 (5.3)	4 (1.7)	4 (1.7)
	No	4.87 (2.8)		112 (48.9)	37 (16.2)	0.08	108 (49.5)	4 (1.7)	0 (0.0)	2 (1.8)	5 (2.2)	6 (2.6)	4 (1.7)	3 (1.3)
>50	Yes	7.77 (2.5)	0.03	15 (15.2)	20 (20.2)		123 (53.7)	6 (6.0)	4 (1.8)	0 (0.0)	2 (2.0)	6 (2.6)	0 (0.0)	4 (4.0)
	No	6.59 (2.6)		39 (39,4)	25 (25.3)		51 (51.1)	4 (4.0)	6 (2.6)	0 (0.0)	5 (5.1)	3 (3.0)	0 (0.0)	1 (1.0)

Table 4. Variables affected on accident according to binary logistic regression model

Tablica 4. Varijable koje utječu na nesreću prema binarnom logističkom regresijskom modelu

Variable	B	S.E	P-value
Age	0.048	0.017	0.004
Daily driving time	-0.060	0.090	0.502
Disease	0.231	0.041	0.000
Duration of resting after driving	0.101	0.072	0.157
Weekly Distance of Driving	0.000	0.000	0.895
BMI	0.079	0.039	0.041

B: Is the estimated logit regression coefficient

S.E: Is the standard error of the coefficient

BMI: Body Mass Index

DISCUSSION

The present study investigated the sleepiness among the professional drivers and its relation to road traffic accidents. To determine the causative relation between the two variables, a case group consisting of drivers with an accident experience over the past three years and a control group of subjects with no accident were selected. The drivers were asked to report their road traffic accidents over the past three years. Other studies required the drivers to report their accidents and incidences over various years. Maycock had considered the drivers' road traffic accident experience over the past three years in his/her study (1997). Yet, Komada et al. studied drivers' accidents over a period of the 6 past years (2009). Due to self-reporting of the drivers in this study, some of them may not exactly remember the detailed condition of the accidents and their causes. So, to make the research findings more objective, only the accidents relating to the past three years were considered with the criterion that the control subjects had never experienced any road traffic accident. Drowsiness and tiredness were among the most significant causes of accidents reported by the drivers. In a retrospective study carried out on the accidents that occurred over the 6 past years, it was demonstrated that 16% of all the accidents happened due to sleepiness. Further, in a prospective study, it was estimated that 23% of the accidents related to sleepiness and 25% of these accidents led to severe injuries among the drivers (Horne, Reyner, 1999). About 40-70% of the drivers believe that drowsiness is one of their problems while driving (Maycock, 1997). In our study, tiredness and drowsiness are among the most prominent causes of accidents reported by subjects. One reason for the prominence of drowsiness and tiredness as the major causes of accidents in Iran can be the relatively illegal long time of driving among the drivers. Some studies emphasize that sleepiness is a subsidiary cause of accidents added to the main cause (Maycock, 1997). In this study, we were not able to determine or estimate these types of causes of accidents. The drivers, due to low wages, had to drive at different times at night leading to their drowsiness and exhaustion. Other risk factors increasing sleepiness among the drivers included: increased driving time and decreased sleeping time before driving round. McCarty et al. in a study showed that an inappropriate working schedule, excessive working hours, little amount of sleeping, and symptoms of sleep disturbance were the most self-reporting factors leading to falling asleep at the wheel among long distance truck drivers (2000).

The present study also showed that carelessness and lapses were the second leading cause of accidents after drowsiness and tiredness. In Maycock's study, it was shown that carelessness accounted for 24% of the road traffic accidents. Other contributory factors included: wrong judgment, visual disorder or problems, and driving fast (Maycock, 1997). Regarding the fact that the majority of the cases in our study drove mostly in rural roads, the most frequent type of road in Iran, carelessness and tiredness of the drivers coming from the front in long-distance driving was one of the major causes of accidents accounting for 18% of them. Hasanzadeh et al. (2008) also showed that 73% of the Iranian drivers responsible for road traffic accidents lacked a good sleeping pattern.

To eliminate the effect of confounding factors, the subjects in the cases and control groups were matched for these factors so that the subjects were not different in this regard. However, the amount of diseases reported by the drivers who had accident was relatively higher than controls. The multivariate logistic regression revealed that chronic disease accounted for 23% contributing to accidents. Previous research also confirms the probability of the relation between chronic diseases and road traffic accidents. In a cross-sectional study in Iran, it was demonstrated that there was a correlation between chronic diseases and road traffic accidents *(Zare et al., 2010)*. Another study showed that there was a relation between cardiovascular diseases, diabetes, and visual disturbances, and road traffic accidents *(Foley et al., 1995)*. Further research should be done to arrive at a full understanding of the relationship between disease and accidents.

This study showed that the amount of sleepiness among the drivers with precedence of accident was statistically more significant than the control subjects so that the median of the sleepiness score in the experimental group was higher than that of the controls. Also, there were cases with a sleepiness score of >15 in the cases while the maximum sleepiness score of controls was less than 15. Komada's study also revealed that measuring sleepiness in the form of self-reporting can help to distinguish the drivers at the risk of road traffic accidents *(Komada et al., 2009)*. Maycock et al. demonstrated the statistically significant relation between distribution of accident frequency and ESS score. They presented definite evidence on sleepiness as a major factor of accidents for some drivers *(Maycock, 1997)*. In drivers with sleeping disturbance, the amount of accidents relating to sleeping pattern was 1.5-4 times greater than that of the control subjects. Further, 3.6% of the drivers reported their sleepiness and the amount of accidents among these drivers was more than the control group *(Horne, Reyner, 1999)*. A study in Iran showed that the drivers who responsible for accident suffered a poor sleep quality and accidents affected these drivers' sleep quality by 13% *(Hasanzadeh et al., 2008)*. In the present study, about 13% of the whole research population had ESS>10. Previous studies also showed that 9.2-26.2% of the drivers had ESS>10 which confirms

our findings. Also, about 0.5% of our study population had ESS>15 while the previous studies showed that 1.6-2.5% of the drivers had ESS>15 *(Maycock, 1997)*. One of the probable causes of low percentage of the cases with ESS>15 in this study compared to the previous studies was excluding the subjects with narcolepsy and other diseases and also drivers abusing narcotic drugs, opium, and psychotic drugs from the study.

The amount of weekly driving of the cases was less than that of the control subjects. Though the difference between the two groups was not statistically significant, the drivers suffering from sleep disturbance drove less. Previous studies have approved that drivers with sleep problems spent less time driving *(Maycock, 1997)*. Driving distance was one of the important factors contributing to accidents *(Maycock, 1997)* those with less driving had a higher ESS, yet they experienced more accidents. This shows that sleepiness is one of the important contributory factors of accidents.

The older drivers scored higher on sleepiness and experienced more accidents so that drivers with the age of >50 reported the most amount of sleepiness. The findings of logistic regression model showed that age had affected accidents by 4%. Maycock *(1997)* has also demonstrated the point that age can be one of the remarkable predictors of the occurrence of accidents. Carlos reported in his study on old drivers that the probability of sleepiness in these people is high especially during the afternoon hours. Half of the cases under study reported snoring, i.e., signs of sleepiness and apnea. He also showed that the old drivers who remain in this profession may develop sleep disturbance *(Fragoso et al., 2008)*. The regression model of this study showed that sickness, age, Body Mass Index (BMI), driving time and duration, are among the factors that exerted a statistically significant effect on the relation between sleepiness and accidents. Other factors as vehicle type and resting time after driving were the factors that had a smaller statistically insignificant effect on the relation between sleepiness and accident. Maycock *(1997)* reported that age, driving distance, and driving time percentage are important factors of safe driving in highways. One of the limitations of the present study was the self-reporting of the obtained data. Though the previous studies con-

sider ESS as a valuable instrument for measuring *(Parks et al., 2009)*, the Iranian drivers may deny such problems due to job security. Regarding the happened accidents, their results can be corrupted due to the passage of time. All the subjects in this study were male because all the Iranian professional truck drivers are men.

The conclusion of this study is that sleepiness in drivers who had precedence of accidents was higher than the drivers without any accidents. Sleepiness can be one of the causes of accidents among the professional drivers in Iran. Hence, it is advisable to perform periodic examinations of sleepiness on drivers if necessary. It is also advisable to consider the drivers with an ESS of high score as high risk group.

Conflict of interest statement

The authors have no conflict of interests to declare.

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POSPANOST I NESREĆE KOD PROFESIONALNIH VOZAČA

SAŽETAK: Cilj istraživanja bio je ispitati povezanost pospanosti i nesreća kod profesionalnih vozača u Iranu. Studija je provedena na uzorku od 820 profesionalnih vozača, od kojih je 300 bilo u eksperimentalnoj skupini, a 520 u kontrolnoj skupini (104 iz ove skupine je isključeno iz studije jer je upitnik bio manjkavo popunjen). Skupljeni podaci iz 716 slučajeva podvrgnuti su analizi. Podaci povezani s prometnim nesrećama, demografskim čimbenicima i pospanosti prikupljeni su metodom upitnika i intervjua. Analiza je provedena pomoću SPSS16 metode (Statističkog paketa za društvene znanosti 16). Srednja vrijednost za pospanost bila je 6.2 dok je u kontrolnoj skupini ta vrijednost bila 4.6. Oko 20,9 % eksperimentalne skupine imalo je (Epworth Sleepiness Scale) ESS>10 dok je tek 8,2 % kontrolne skupine imalo ESS>10. Razlika pospanosti u slučajevima koji su imali nesreću i kontrolne skupine koji nisu imali nesreću bila je statistički značajna ($P<0.001$). Studija je pokazala da je pospanost vozača koji su doživjeli nesreću veća nego kod vozača koji nisu. Pospanost može biti jedan od uzroka nesreća kod profesionalnih vozača u Iranu.

Ključne riječi: pospanost, profesionalni vozači, nesreća, Epworthov upitnik