

The Effect of Fatigue and Sleepiness upon Driver Behaviors

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Abstract

Human factor has appeared as the most important factor in traffic accidents. It has statistically been revealed that the rate of defect in death and injuries of drivers, passengers and pedestrians has reached up to 99%. This has necessitated the analysis of human behaviors in traffic accidents as driver, pedestrian and passengers.

In this study, the effect of fatigue and sleeplessness upon behaviors of drivers was investigated. Even driving and resting periods' being determined with legal regulations could not provide drivers to display adequate level of sensitivity. And this caused drivers to drive until service points or their destination, and therefore the possibility of their being involved in an accident due to sleeplessness and fatigue increased. Suggestions were offered to prevent and decrease these considering the fatal results of traffic accidents.

Keywords: Fatal traffic accidents, fatigue, driver sleepiness, sleep disorders, alcohol

Yorgunluk ve Uykusuzluğun Sürücü Davranışları Üzerine Etkisi

Öz

Trafik kazalarında insan faktörü, en önemli unsur olarak karşımıza çıkmaktadır. Araç kullananların, yolcuların ve yayaların ölüm ve yaralanmalarındaki kusur payının %99'a ulaştığı istatistiksel olarak ortaya konulmaktadır. Bu durum trafik kazalarındaki sürücü, yaya ve yolcu olarak insan davranışlarının incelenmesini zorunlu kılmaktadır.

Bu çalışmada, yorgunluk ve uykusuzluğun sürücülerin davranışları üzerinde oluşturduğu etki araştırılmıştır. Araç kullanma ve dinlenme sürelerinin yasal düzenlemeler ile belirlenmiş olması bile araç sürücülerinin yeterince hassasiyet göstermesini sağlayamamaktadır. Bu durum ise sürücülerin, mola veya varış noktalarına kadar araçlarını kullanmalarına, dolayısıyla uyku ve yorgunluk nedenli kazaya karışma ihtimallerini artırmaktadır. Trafik kazalarının ölümcül sonuçları göz önünde bulundurularak, önlenmesi ve azaltılabilmesi için öneriler getirilmiştir.

Anahtar Kelimeler: Ölümlü trafik kazaları, yorgunluk, uykusuzluk, uyku hastalıkları, alkol

1. Introduction

The main factors that cause traffic accidents are humans, vehicles and roads. Even the latest developments in vehicle and road engineering are not possible to reach highway safety to the needed levels due to humans' not displaying safe behaviors.

Traffic accidents are the leading of the problems of a country due to the physical losses they cause. Traffic accidents happen as result of the interaction of human factor and environmental factors such as road and vehicle features. Human factors sometimes play role in traffic accidents as an active factor such as improper passing or disregard of rules

and sometimes as a passive factor such as driving as exhausted, sleepy or recklessly. Psychomotor ability, personal features and frequency of driving are regarded as the factors affecting the human factor directly. Therefore, all these factors affect traffic accidents at different rates (Sümer, 2002).

The basic characteristics of human as the one using the road are normal physical condition, temporary physical condition, mental features and psychological features. Temporary physical conditions can be listed as sleepiness and fatigue, medication, drinking alcohol, and diseases that cause excessive daytime sleepiness. Fatigue is the indicator of body's need for stopping, resting or sleeping. The biological rhythm of human body is one of the main causes for fatigue and sleeplessness, and only thing to overcome this is sleeping and resting.

Driving sleeplessly that is as dangerous as driving under the influence of alcohol is one of the most important reasons for accidents. Use of alcohol and drugs affecting driving performance causes fatal traffic accidents to happen. It has been considered that accidents can be prevented avoiding to drive under the influence of alcohol emphasizing the possibility of drivers' being having alcohol in traffic accidents (Aldrich, 1986). Seventeen-hour permanent sleeplessness causes disorders in cognitive functions such as comprehension and realization abilities at 0.05% or higher disorders in blood-alcohol levels. The sleeplessness lasting for 20 to 28 hours has been revealed to cause an effect equal to 0.10% blood-alcohol rate. In several countries, the legal limit for blood-alcohol rate is accepted to be at 0.05% and 0.08% interval (Lamond and Dawson, 1999). Attention deficits in drivers for every 90 to 120 minutes no matter what their ages and

physical conditions. One of the most important factors for attention deficit is sleeplessness. Depending upon the increase at the level of sleeplessness, performance decreases in functions such as driving carefully and increase at reaction time (Dinges and Kribs, 1991). Sleeplessness can cause the decrease at attention in time and driver to fall asleep while driving feeling exhausted fast.

Excessive daytime sleepiness is one of the most important reasons for falling asleep at the wheel. Sleep apnea, narcolepsy, insomnia, parasomnia, depression, restless leg syndrome and periodical leg movements are the diseases that cause excessive daytime sleepiness. Most of the individuals who experience disorders cannot notice or regard their diseases and this causes them to be away from treatment due to lack of diagnosis. The individuals with sleeping sickness are the ones who have high risk for causing accidents having bad driving experiences (Aldrich, 1986). Sleep disorders cause young individuals to have excessive daytime sleepiness, psychological problems and personality disorders and cause drivers to have more risk for doing accidents (Dement and Mitler, 1993).

The drivers who drive alone, sleepy and exhausted in long roads in the afternoon, at nights or during the normal sleeping time without resting for a long time and the ones who uses alcohol or medication inducing sleep have the most risk in terms of accidents.

The basic factors used for determining the sleeplessness and fatigue are the driving hours and duration. Driving exceeding 8 to 9 hours negatively affects driving performance creating fatigue and attention deficit. And this remarkably increases the possibility of causing an accident. Truck drivers are the ones have the high risk for causing accidents

due to fatigue and sleeplessness (NTSB, 1995). Truck drivers mostly drive at night hours when they are really sleepy and exhausted.

Objective measuring methods such as blood and breathing test are used in the scene of the accident for determining the alcohol-induced traffic accidents. However, the accidents caused by sleepless are evaluated with subjective findings such as accident reports or driver acknowledgment because there are no objective measuring methods for determining the sleeplessness-induced traffic accidents. The indicators such as vehicle's getting out of the road, driver's being alone in the car, seeing no brake mark, accident's being at early hours of the day or at about three in the afternoon prove the accident to happen due to sleeplessness. Death and severe injury are more common due to the combination of high speed and late driver reaction time in sleep-induced traffic accidents. Most of the fatal accidents are concluded to happen as result of sleeplessness (Horne and Reyner, 1995).

Some difficulties are experienced in determining whether a traffic accident happens due to fatigue and sleeplessness. The reason for this is having no simple and reliable measuring method for gendarmerie or police investigation determining whether fatigue causes the accident to happen or not, and if yes, the degree of fatigue. Although driving as sleepy, exhausted, ill, and driver secondary flaws have previously been included in statistical accident reports prepared until 2000 by General Directorate of Police, these have been excluded in accident reports due to the aforementioned difficulties. For that reason, in this study, it was aimed to investigate the driving conditions of drivers in terms of sleeplessness and fatigue. In this sense, the

questionnaires were prepared, and performed to 493 drivers in Erzincan province.

2. Material and Method

The statistical data obtained from accident reports revealed that the main reason for the traffic accidents happened in our country was human factor (driver, pedestrian and passenger). When the traffic accidents happened between 1995-2017 were analyzed, the rate for flaw as human factor was noticed to be above 98% (TKÖ, 2017).

When the conditions of the accidents happened between 1997 and 2000 in terms of being dependent on temporary physical features such as sleeplessness and alcohol were analyzed, whereas the flaw rate for driving as ill, abstracted, fatigue and sleepless was 65.65% in 1997, the rate was 70.27% and 74.04% in 1998 and 1999, respectively. The flaw rates for driving under the influence of alcohol were 6.61%, 5.77% and 5.75% in 1997, 1998 and 1999, respectively. In the light of these data, the total for the flaws of driving under the influence of sleep and alcohol was 72.26%, 76.04% and 79.79% in 1997, 1998 and 1999, respectively (Baş, 2015). This proved that drivers played the primary role for accidents to happen.

Determining the accidents happened due to temporary physical conditions depends only upon reports and experiences of gendarmeries and police officers who determined the statements and level of fatigue. Therefore, difficulties are experienced in determining such types of accidents. That's what the questionnaire table presented in Table 1 was prepared in order to investigate the individuals' driving with the temporary physical conditions such as sleepless and exhausted.

Table 1. Questionnaire table

How old are you?										
Is driving your main means of living or do you drive as a side job?	Main means of living	Side job								
For how many years have you driven?										
What is your educational status?	Elementary	Secondary	High School	University						
What type of vehicle do you drive?	Automobile	Bus	Truck	Pickup	Semi-trailer truck	Tow truck				
Do you have alcohol addiction?	Yes	No								
Do you generally drive during the daytime or night?	During the night	During the daytime	Both during the daytime and night							
Are you alone while travelling?	I am alone	I am not alone								
During the break period, do you sleep in your vehicle or in a motel or somewhere like this?	In the vehicle	In a motel or somewhere like this	In stopovers	I do not need resting						
Have you ever experienced sleep attack (uncontrollable falling asleep) at the wheel during the last one year?	Yes	No								
Have you ever experienced sleep attack (uncontrollable falling asleep) at the wheel in your life?	Yes	No								
Do you drive when you feel exhausted?	Never	Rarely	Sometimes	Generally	Always					
What are the type of roads you mostly feel sleepy while driving?	Rural roads	Long and Monotonous	Highway	Urban roads						
What are the hours you mostly feel sleepy while driving?	02:00-05:59	06:00-09:59	10:00-13:59	14:00-17:59	18:00-21:59	22:00-01:59				
What do you do when you feel sleepy while driving?	I have a break for 30 minutes	I sleep for 15 min stopping the vehicle	I open the window	I turn on air conditioning	I turn on the radio	I drink coffee	I go on driving until the stopover	I go on driving	The other driver starts to drive the vehicle	
Have you ever done an accident due to sleeping before, if yes, please mention the way how the accident occurred?										

The province of Erzincan is connected to Sivas province on the west and Erzurum province on the east with E-80 international highway. This is connected to Tunceli province on the south and Bayburt and Gümüşhane provinces on the north. According to Turkish Statistical Institute Address-Based Population Registration System data, the population of the province is 226.032. The questionnaires were performed with the drivers in entry and departure control points of the province. All drivers were informed about the purpose of the research before the questionnaire, and the questionnaire is finalized with the participation of 493 drivers.

The answers of the drivers to the questions in the questionnaire tables were collected, transferred onto the electronic environment, and subsequently, the data were coded for making the statistical analysis.

3. Research Findings

According to Traffic Regulation, Fundamentals of Obeying and Supervising the Driving Periods, it is prohibited for drivers to drive for more than totally 9 hours in a 24-hour time period and to drive for more than permanent 4,5 hours. However, these legal regulations do not regard the body rhythms of drivers such as sleep-wakefulness cycle, let individuals drive at periods when they feel sleepy and have a break at hours when they are fully awake. The individuals who drive as a profession may drive for longer periods in order to complete their program on time, and they may even exceed the legal speed limit. Therefore, the risk for individuals who drive as a profession to cause an accident increases. As presented in Figure 1, 76% of the drivers who filled in the questionnaire form earned their living from driving profession, and 24% drove as a secondary job.

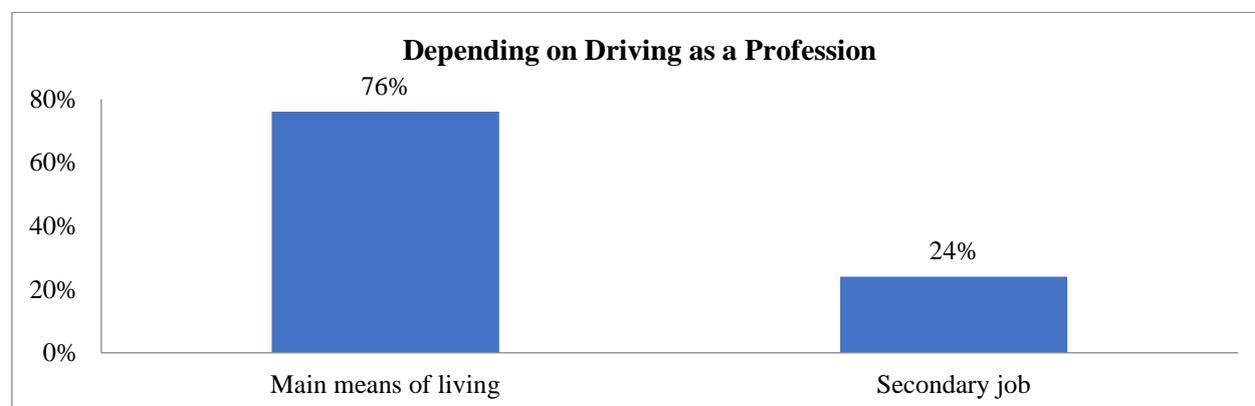


Figure 1. Depending on driving as a profession

Alcohol causes various psychological and physical effects in human body. Under the influence of the alcohol, the drivers feel more confidence in them, drive in a riskier way, have late driver reaction time, and their

attention deficits, and therefore the risk for them to have an accident increases. As presented in Figure 2, whereas 11% of the drivers who filled in the questionnaire used alcohol, 89% did not use.

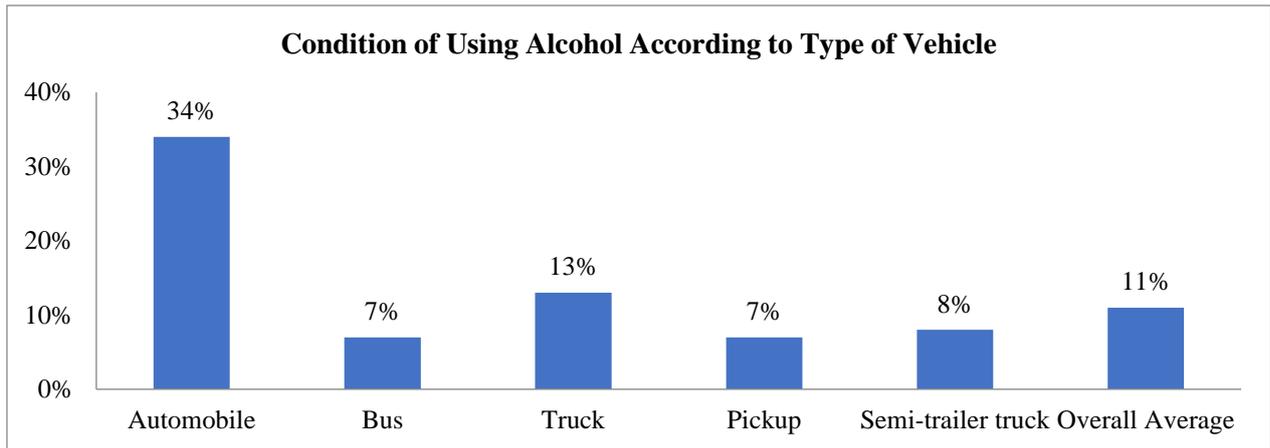


Figure 2. Drivers’ condition of using alcohol according to the type of vehicle

Heavy vehicle driving is generally a profession for the individuals who have generally finalized compulsory education process, but have had no opportunity for the higher education. As presented in Figure 3,

37% of the drivers who filled in the questionnaire form graduated from secondary education, 27% graduated from elementary education and 2% graduated from a university.

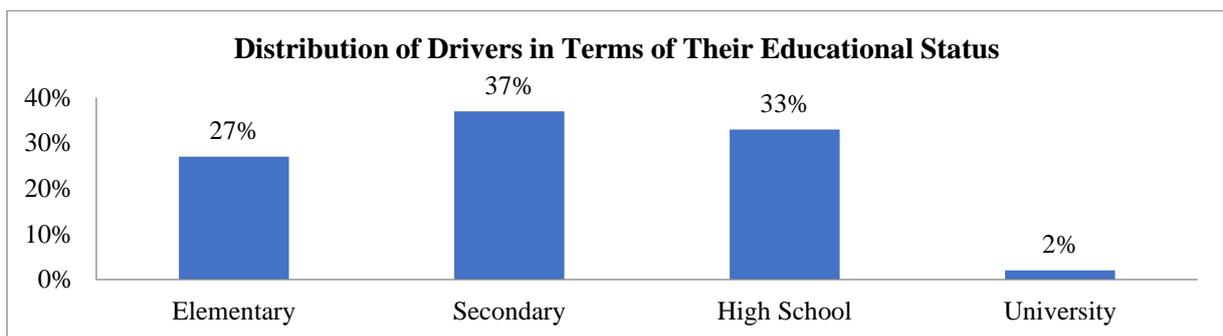


Figure 3. Distribution of drivers in terms of their educational status

The possibility for drivers to have a fatigue and sleepiness-induced fatal traffic accident increases for between 10 p.m. and 6 a.m. due to the increase at melatonin hormone secreted in the body. At these hours, body temperature and blood pressure decreases, and therefore the ability for performing including the driving ability of the driver are limited. That’s

why, the feeling of fatigue increases in case of driving a vehicle at early hours of night and morning. As presented in Figure 4, 82% of the participants who took part in the questionnaire drove during the daytime and night, 6% drove only at night, and 12% drove only during the daytime.

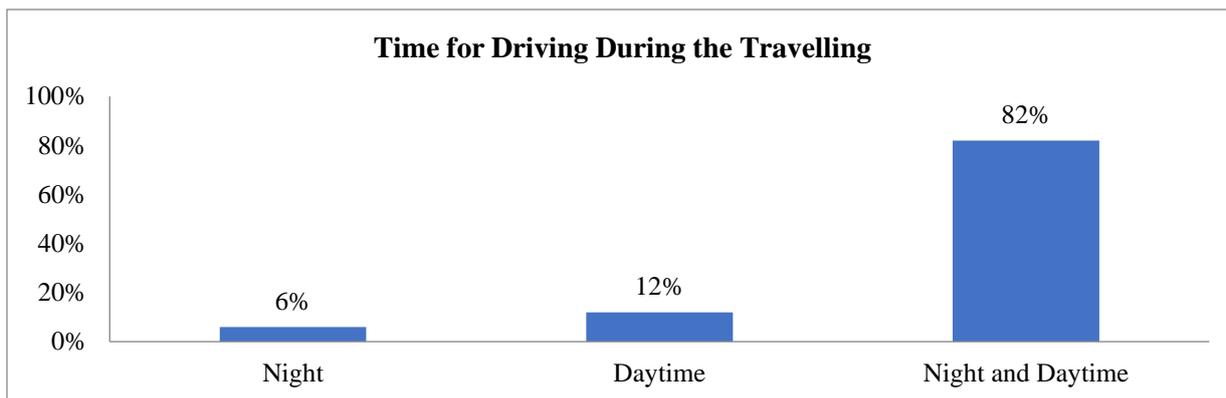


Figure 4. The time for drivers to drive during the travelling

According to previous accident researches, the drivers who had an accident due to sleepiness have mostly been alone in the vehicle. Furthermore, the drivers who have fallen asleep at the wheel and have had no accident were not alone in the car. As

presented in Figure 5, 60% of the drivers filled in the questionnaire form were noticed to be alone while driving. As presented in Figure 6, 94% of the drivers who had an accident due to sleeplessness mentioned themselves to be alone in the vehicle.

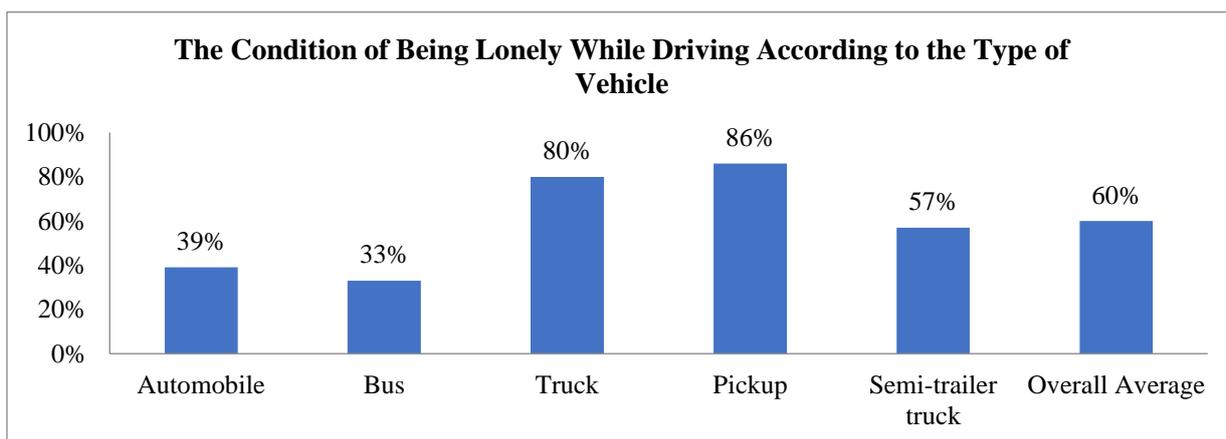


Figure 5. The loneliness of drivers while driving according to the type of vehicle

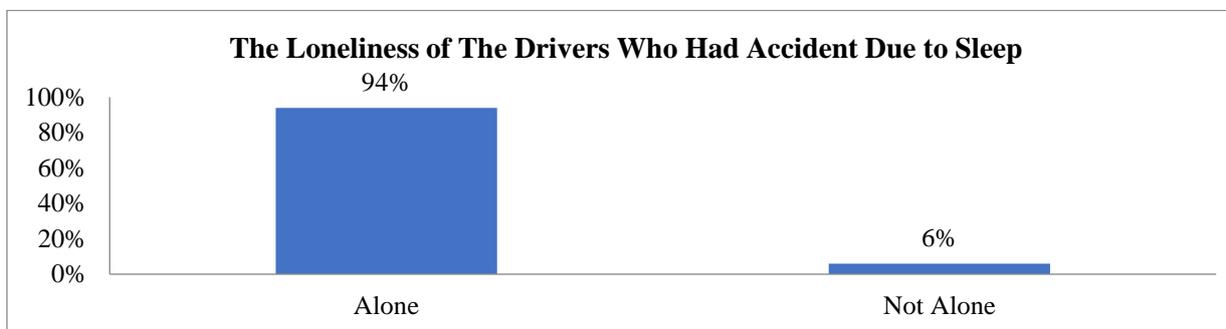


Figure 6. The loneliness of the drivers who had accident due to sleep

As presented in Figure 7, 79% of the drivers who participated into the questionnaire

mentioned that they rested in their own vehicles while travelling, and 11% mentioned

to rest in a motel or similar facilities. Drivers' increase the possibility of having accidents not meeting their personal hygiene and needs caused by sleepiness and fatigue.

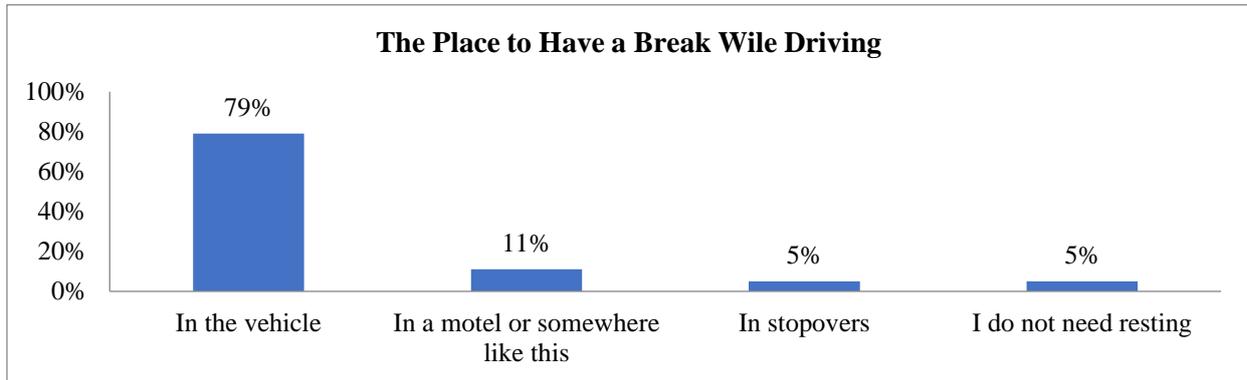


Figure 7. The place to have a break while driving

Sleeplessness is one of the main factors for the fatal traffic accidents happening all around the world causing negative effects upon driving performance (NTSB, 1995). Falling asleep at the wheel is one of the most remarkable factors in fatal accidents, and the main reason

for this is chronic insufficient sleep. As presented in Figure 8, 24% of the drivers who took part in the questionnaire fell asleep at the wheel during the last one year. As presented in Figure 9, 40% of the drivers fell asleep at the wheel for at least once in their whole life.

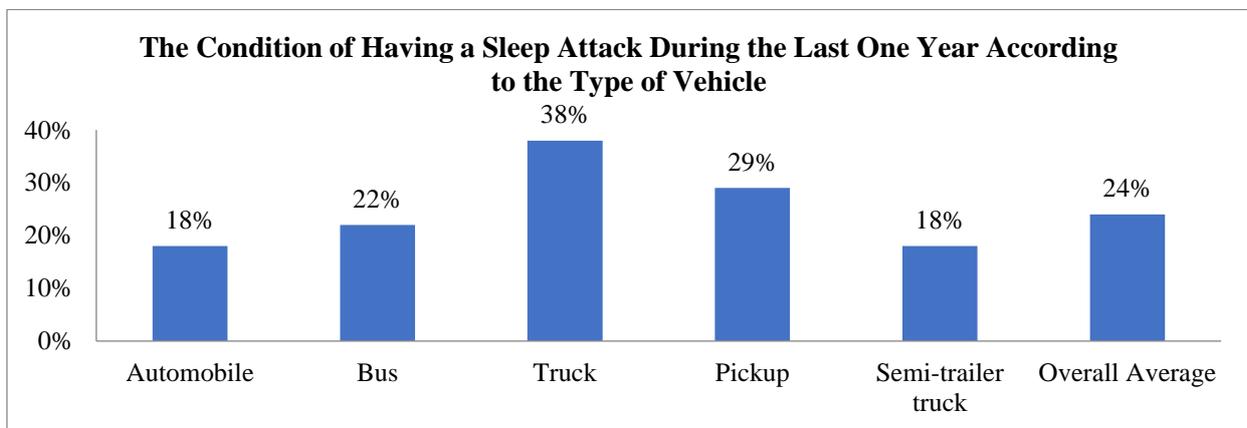


Figure 8. The condition of having a sleep attack during the last one year

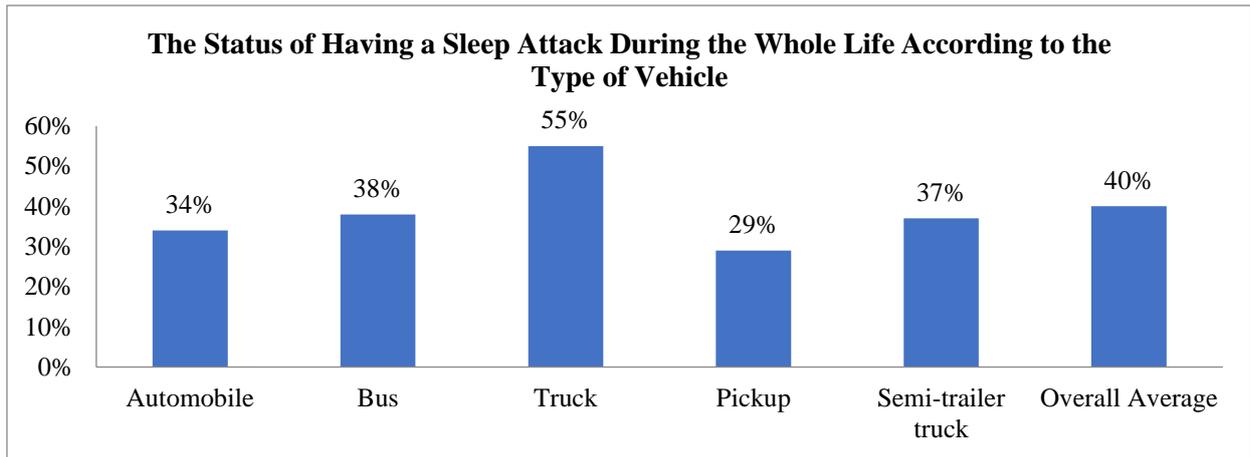


Figure 9. The status of having a sleep attack during the whole life

While driving, all of the drivers are aware of the fact that they are sleepy and their possibility of getting into an accident increases. However, drivers continue driving their vehicle struggling with their sleepiness trying various methods. As presented in

Figure 10, 27% of the drivers who filled in the questionnaire form mentioned that they did not drive when they were sleepy, and 45% mentioned that they drove when they were sleepy even rarely.

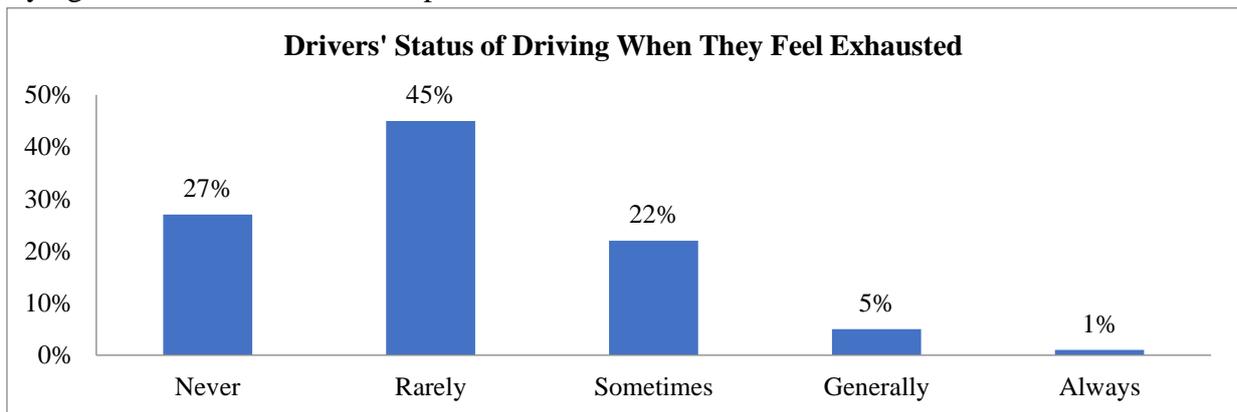


Figure 10. Drivers' status of driving when they feel exhausted

In long and monotonous roads, attentions of drivers on horizontal and vertical road signs decreases, and therefore the possibility for them to have an accident increases. However, in rural roads drivers' level of focusing attention is higher because the road standards are lower and this situation decreases their

possibility of having an accident caused by fatigue. As presented in Figure 11, 60% of the drivers who participated into the questionnaire mentioned that they felt sleepier in highways, 10% in rural roads, and 4% in urban roads.

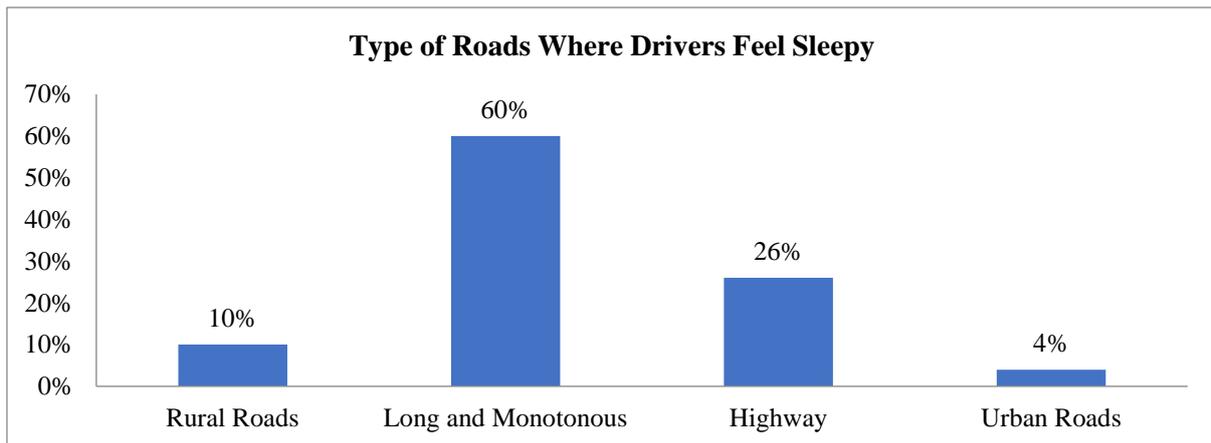


Figure 11. Type of roads where drivers feel sleepier

In Figure 12, behaviors of the drivers when they felt sleepy were presented. As could be seen in the table, 37% of drivers who filled in the questionnaire form mentioned that they had a 30-minute break when they were sleepy, and 11% mentioned to have a 15-minute break stopping their vehicles. Among the drivers, 12% reported to keep them awake by drinking

coffee. In previous researches, it was revealed that short-term sleeping decreased performance and attention deficits; however, the period for effect was short. The duration of caffeine to decrease sleeplessness of drivers was revealed to be nearly 30 minutes (Reyner and Horne, 2000).

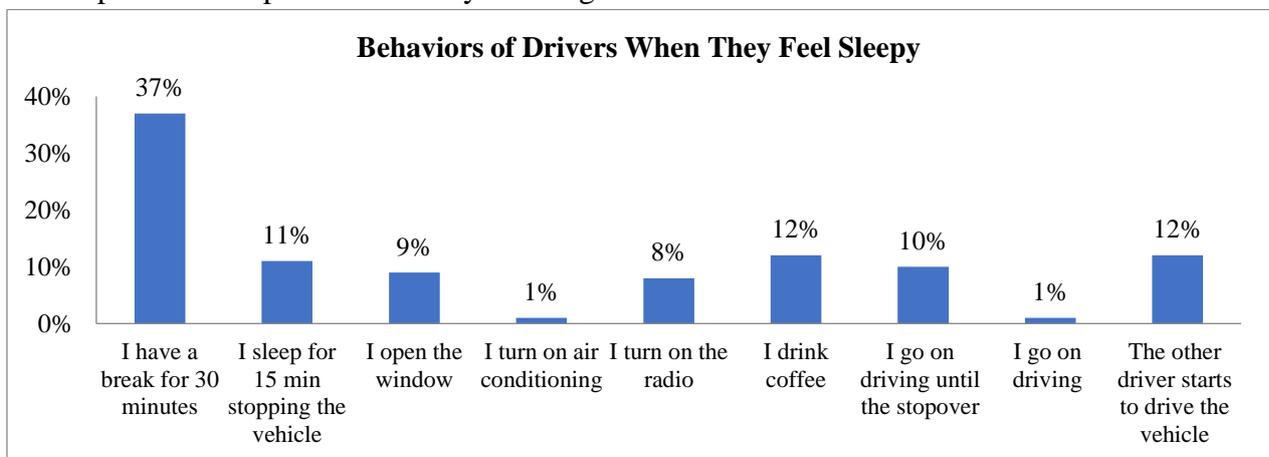


Figure 12. The behaviors drivers display when they feel sleepy.

4. Result and Discussion

Among the drivers who filled in the questionnaire, 76% drove for their main means of living. 79% of the drivers rested in their own vehicles while driving. Sönmez (1999) revealed in his study carried out upon the working conditions of drivers that the main profession for 82% of the drivers was driving. These drivers' being obliged to drive

permanently and resting in their own vehicles increase the risk for them to have accidents due to fatigue.

It was noticed that 11% of the drivers who participated into the questionnaire mentioned that they used alcohol. In reference to Turkish Statistical Institute's consumption expenditure questionnaire micro data, Aydın (2011) determined that alcohol consumption

rate per house in Turkey was approximately 8%.

Among the drivers who filled in the questionnaire form, 37% graduated from secondary education, 33% from high school, 27% from elementary school and 2% from university. According to this, driving is possible to mention as not being regarded suitable for the individuals graduated from university. When the drivers flaws in the accidents happened in Turkey were ranked according to their educational status, it was noticed that 37% graduated from primary education, 15% from secondary education, 1% from elementary education, 29% from high school, 17% from vocational schools, and the educational status of 1% could not be determined (Gökdağ and Atalay, 2015). This revealed that the rate for doing an accident was higher in drivers who graduated from elementary education schools. With the increase at the educational level, the rate for involving in traffic accidents decreases.

It was noticed that 82% of the drivers who took part in the questionnaire drove both during the daytime and night. Drivers' permanent driving both day and night cause disorders in biological rhythms defined as resting and sleeping at nights and maintaining the routine activities during the daytime. This increases the risk for drivers to have traffic accidents causing excessive daytime sleepiness and limitations in abilities of performing several activities including driving skills.

94% of the drivers who had an accident due to sleeplessness mentioned them to be alone while driving. Being alone while driving seriously increases the possibility for traffic accidents causing the increase at micro sleeps developed instantly in drivers. According to

the researches on accidents, the drivers were determined to be alone in nearly 80% of the traffic accidents induced by sleep (Wilkins, 1997).

Among the drivers who filled in the questionnaire, 40% fell asleep at the wheel for at least once during their whole life. In his study upon 3.896 drivers, Arnold (2012) revealed that 46% of the drivers fell asleep at the wheel for at least once in their life. In their laboratory studies, Horne and Reyner (1995) proved that when the individuals who fell asleep were awakened within a few minutes, then they did not remember anything related to their sleeping.

5% of the drivers who performed the questionnaire stated that they generally maintained driving their vehicles even at times when they were exhausted. In the questionnaires performed in stopovers on New York interstate highways with 593 truck drivers, it was reported that nearly 5% of the drivers maintained driving when they were really sleepy and exhausted (TS, 1998).

It was mentioned by the 60% of the drivers who participated into the questionnaires that they felt sleepier in long and monotonous roads. In previous studies, it was noticed that sleeplessness and fatigue of the drivers had a vital importance, and majority of the accidents happened in monotonous roads were sleep and fatigue induced (Reissman, 1996).

It was also reported that 12% of the drivers who filled in the questionnaire that they tried to stay awake by drinking coffee. Maycock (1995) listed the methods drivers used for struggling with sleeplessness. 14% of the drivers mentioned that they tried to struggle with sleeplessness by drinking coffee. All methods drivers used for struggling with their

sleeplessness should only be used for gaining time for finding a safe place to stop and rest.

Every year, thousands of traffic accidents happen due to drivers' sleeplessness and fatigue. Exact number of the fatigue and sleepiness induced accidents cannot be calculated due to the problems in determining whether fatigue is a factor in a traffic accident or not and, if yes, the level of fatigue.

It has been revealed in several studies that the drivers are aware of their feeling sleepy, and they consciously decide on having a break stopping their vehicles or maintaining to drive their vehicle struggling with their sleeplessness. The drivers who consciously maintain driving even they are sleepy are either unaware of the possibility of accident they have to face or they threaten the life of their own and the others like the drivers under the influence of alcohol do underestimate the risk for falling asleep at the wheel.

In periods like festive holidays when the intensity of traffic obviously increases, it is necessary to increase the frequency of traffic controls and to take precautions that will increase traffic safety. The drivers should not drive at their normal sleeping time, when they are ill or are on medication possible to affect driving. Planning the journeys on long and monotonous roads is of vital importance.

Training precautions should be taken as immediate as possible with public service announcements on television and radios in order to raise awareness on possible dangers that sleeplessness and fatigue can cause while driving and impress this awareness upon the society.

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