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ORIGINAL ARTICLE

Do the Occupational Health Factors Affect the Road Accidents: A Survey of Heavy Vehicles' Drivers in Iran

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ABSTRACT

A driver's health status may have a crucial impact on the prevention of road accidents. This study was conducted to investigate drivers' health status and its effects on road accidents among drivers of heavy vehicles in Iran. A cross-sectional study was conducted to examine the health status of 200 heavy vehicle drivers selected via a two-stage cluster sampling approach from occupational medical centers in Tehran Province, Iran. The related data were collected using the standard drivers' safety and ergonomics questionnaire, body map work-related musculoskeletal disorders (WMSDs) questionnaire, and drivers' medical records at occupational medical centers. Data were statistically analyzed by SPSS v.21 and Microsoft Excel 2016. Body mass index results classified 69% of drivers as overweight, and 19.5% as obese. 88% of drivers were stressed out and 35% were dissatisfied with their jobs. On average, 63% of drivers showed unsafe behavior while driving, and 80% had levels of WMSDs in 9 body regions. For the drivers with and without accidents, the mean and standard deviation values of hearing loss were 18.20±14.84 dB and 35.45±18.65 dB, respectively. In 79.3% and 75.9% of drivers who had accidents, respectively, their right and left visual acuities were smaller than 10:10. In 55% of the drivers, the status of the main pulmonary function variables was abnormal. The study group had high levels of fasting blood sugar (FBS), total cholesterol, and triglyceride, by 22.5%, 29%, and 26%. There was a significant positive relationship between the number of accidents and loss of hearing and drivers' age. There was also a significant negative connection between the number of accidents and visual acuity, respiratory health, exercise hours, safety, and health training. The results of the present study showed that occupational stress, unsafe behaviors, ergonomic factors, loss of hearing, visual acuity, high blood FBS values, weak respiratory system, and lack of safety and occupational health training were among significant contributors to road accidents. Hence, given the importance of heavy vehicle driving, it is suggested to check out drivers' occupational health and safety more often that ever.

KEYWORDS: *Accidents, Drivers, Heavy Vehicles, Occupational Health*

INTRODUCTION

Road accidents are one of the most important causes of loss of life and financial losses in Iran and around the world. Based on the statistics reported by WHO, the road accident death rate in Iran was 20.5 deaths per 100,000 populations, and about 800,000 driving accidents occur annually, leading to 43 deaths per day. Meanwhile, based on the WHO reports in 2018, the number of motor-vehicle death rates were 1.35 million people; in other words, one death occurs every 24 seconds in the world [1]. Now, if we compare these statistics and digits with the global disasters such as COVID-19 and related death rate [2], we will find out that despite its high importance, the dilemma of road accidents has not been taken seriously as it should be.

Four factors play a critical role in road accidents, including human factors, road, vehicle, and environment. Although the contribution of human factors is not well-defined against other factors, the driver's health status, arguably, can play a critical role in road accidents, as investigated by some studies. Results of these studies have indicated that the behavioral factors, lifestyle, hearing problems, high speed, fatigue and drowsiness, respiratory problems, alcohol drinking, adventure, drug abuse, using a mobile, stress, aggressive behavior, and anxiety are among the factors resulting in accidents [3, 4]. It was also determined that drivers, as the high-risk groups of society, face numerous stresses such as decreased physical activities due to their full-time sitting jobs, unhealthy nutrition because of long travels, and problems with sleep.

On the other hand, since over 90% of the brain inputs needed for observation, assessment of the situation, and appropriate reaction while driving are provided through visual perception, the drivers' vision health is highly important [5]. The drivers' hearing health, as a key factor, can significantly affect their performance [6]. Next to that, WMSDs are also among the main diseases and occupational complications resulting from poor posture while driving [7]. Another issue is the physical and psychological stresses, particularly for the heavy vehicles' drivers. Hence, heavy vehicle driving has turned into a stressful and risky occupation that needs a higher level of skill, accuracy, attention, and physical health [8]. Based on the Iranian Urban Transportation Organization report, there are 395,200 and 91,800 vehicles for goods and public transportation, respectively. These vehicles transport 621 million tons of goods and 388 million passengers per year [9].

Similarly, heavy vehicles have the most contribution to the transportation of goods and passengers across the country. Therefore, in order to prevent big losses both economically and socially, drivers' health should be taken into account more seriously than other working groups (10)]. Thus, we had very high hope that the results of the present study may increase the awareness of the managers and decision-makers into the occupational health of drivers and their health.

Thus, in the current study, we aimed to investigate the status of drivers' occupational health criteria (i.e. status of vision, hearing, respiratory, ergonomic health, and blood indices) and their impacts on road accidents among the drivers of heavy vehicles.

MATERIALS AND METHODS

This cross-sectional study was conducted in 2018 among the drivers of heavy vehicles in Tehran Province, Iran (mainly trucks and buses). A two-stage cluster random sampling method was used to select 200 heavy vehicle drivers from occupational medical centers. Firstly, each occupational health center was considered as a cluster, from which we randomly selected 6 clusters and subsequently randomly selected 40 drivers from each cluster. Thus, 240 drivers were selected and their medical records were reviewed.

The criteria for inclusion and exclusion were gender (only male drivers), health certificate, validated driving license (over two years), contact information as well as data related to testing in the drivers' profiles, and their willingness to participate in the study and complete the questionnaire. Consequently, we excluded 40 drivers who did not qualify for the study

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based on our investigations and inclusion and exclusion criteria.

To conduct the study, a checklist of background and demographic factors, a standardized drivers' safety and ergonomics questionnaire with a pilot test, a body mapping questionnaire for work-related musculoskeletal disorders (WMSDs), and medical records of drivers in occupational medical centers were used. As soon as the qualified individuals were identified, we asked them to fill out the questionnaires in person. During the interviews, the subjects were taught how to complete the questionnaires. We obtained informed consent from all subjects, and they were assured that their information would be confidential. On the basis of the specific ID assigned to each driver, data was extracted from the medical records of the drivers.

Checklist of background and demographic characteristics:

The participants' characteristics and lifestyles data, such as age, weight, height, BMI, the status of smoking and exercise, and information on their occupations, e.g., driving hours per 24 hours, continuous driving times, sleep and rest times as well as the job satisfaction and occupational stress (based on the rating scale of 0 to 10), were provided within the researcher-made checklist and given to the participants.

Drivers' safety and ergonomics questionnaire:

This questionnaire included three general sections. The first section assessed the ergonomic risk factors such goods handling and heavy materials relocation, hunched back, repetitive movements, flexion and abduction movements of hand and arm, and sitting or standing for a long time within a rating scale of 0-10. The second part investigated the unsafe behaviors and destructive factors for sleep and derivers' activity such as eating, drinking, going to sleep, calling, sending messages while driving, developing tinnitus due to the working condition among the drivers. The final question in this section assessed the training on safety and occupational health of drivers. The third section included the number and type of road accidents for drivers (i.e. car collision, passenger accident, collision with the barrier, or vehicle rollover) during the last 5 years.

The drivers roles based on their share in accidents were also asked. The safety and ergonomics questionnaire was designed based on the specialized information and previous studies [12, 15]. To determine the validity of the questionnaire, before starting the study, 15 participants were asked to complete the questionnaire. After two weeks, the same questionnaire was filled out by the same participants and their answers were compared. Then the correlation test was performed based on test-retest. The correlation coefficient (reliability) was set at 0.75, which showed the similarity rate of 75% answers. The validity of the questionnaire was also confirmed by 5 experts after the necessary corrections.

Body map of WMSDs questionnaire:

We used a body map questionnaire to investigate the prevalence of WMSDs. The questionnaire was designed based on a 0-10 rating scale to indicate the degree of pain and discomfort experienced in different body regions, where 0 and 10 represent no pain or discomfort and severe pain, respectively. Body map questionnaire is a widely used tool in this field whose validity and reliability have been established in literature [11]. Due to its visual representation of the state of body organs, this questionnaire can help participants better understand and report the prevalence and severity of pain and discomfort in different organs. Based on the ease of data management, a better understanding of drivers, and the possibility of statistical analysis, the numerical rating scale was used. Drivers completed the questionnaire all at once, and they expressed pain in nine areas, including neck, shoulder, upper back, elbow, low back, wrist and hand, hip and thigh, knee and ankle, and feet during the last year.

Drivers' medical records:

The medical records of drivers were reviewed in occupational medical centers to examine vision, hearing, respiratory health, and blood indices. Hence, the visual acuities data on the right and left eyes taken from Snellen Chart were extracted to assess the drivers' vision health; data related to the audiometry test in reviewing the hearing thresholds and loss of hearing in each center frequency (500-8000 Hz) in both ears to assess the drivers' hearing health; data related to the most valuable spirometry variables such as forced vital capacity (FVC), forced expiratory

volume in 1 second (FEV1) and FVC/FEV1 ratio to assess the drivers' pulmonary function [12] and values related to fasting blood sugar (FBS) and total cholesterol and triglyceride (TG) (mg per dl blood) to assess the drivers' status in terms of blood indices; then all information was transferred to the data analysis software. The standardized and calibrated devices approved by the occupational medical centers were used to investigate assessment methods and instructions. The drivers whose vision was assessed with glasses were also measured for their visual acuities.

Statistical analysis:

An analysis of the data was performed using both descriptive and inferential statistics. A descriptive analysis was conducted to examine frequency distributions and indices of central tendency of research variables (demographic information, as well as data related to the drivers' occupational health). Additionally, inferential statistics were used to learn more about how the variables in the study affected the accidents. The Kruskal-Wallis, Mann-Whitney, Chi-square, and Spearman correlation tests were used. The Kolmogorov–Smirnov test was also applied to evaluate the normal distribution of research data. The level of significance for all tests was 0.05. Data were analyzed statistically using SPSS v.21 and Microsoft Excel 2016.

RESULTS

The results of the present study would be divided into four general categories: (1) describing the demographic and background characteristics and unsafe behaviors among the drivers; (2) describing the status of drivers' occupational health in terms of WMSDs, hearing health, vision and respiratory health, and blood indices; (3) describing the status of road accidents and their types during the last five years, and (4) correlation between the number of road accidents and the research variables.

Demographic and background characteristics and unsafe behaviors:

Mean, and SD of age, height, weight, and BMI of drivers were 47.5±9 years old, 173±6.6 cm, 83.7±11.7 kg, and 27.9±2.99 km/m2, respectively. Classification of drivers' BMI based on the definition of the National Institute of Health [13] showed that 11.5%, 69%, and 19.5% of them were categorized as normal (18.5<BMI<24.9), overweighed (25<BMI<29.9) and obese (BMI<30), respectively (no driver had BMI < 18.5). The mean and SD of working hours of drivers per 24 hours were 10.66±2.52 and 5.82±1.87, respectively. Classification of working hours also revealed that 22%, 35.5%, 20.5%, and 24% of drivers were working less than 8 hours, between 8 and 10 hours, between 10 and 12 hours, and more than 12 hours (maximally 16 hours) round the clock. The mean and SD of rest hours were 8.7±1.12 hours, ranging within 6-12 hours. The status of exercise hours per week for most drivers was undesired, and only 9.5% of them stated that they have exercise activity for 3-5 hours per week. While 46% of subjects allocated 1-2 hours per week to exercise, and 44.5% allocated no time to exercise. 67.5% of the studied drivers were smokers (on average five and a maximum of 10 cigarettes).

The status of occupational stress and job satisfaction among the drivers showed that 19% of them had no occupational stress, while 81% of drivers pointed out some degrees of occupational stress. 3.5% of drivers were fully dissatisfied with their occupation, while 96.5% stated a degree of occupational satisfaction. On the other hand, investigating the severity of occupational stress and job satisfaction among the drivers based on the numerical rating scale (0-10) showed that the mean and SD of these two indicators were 3.42±2.76 and 4.53±2.09, respectively, such that 23% and 71.5% of drivers reported high and low levels of job satisfaction.

The results of connection between drivers' demographics factors and accidents showed that there was only significant relationship between the number of cigarettes and stress severity of drivers and the occurrence of accidents ($P \leq 0.01$). While the status of using cigarettes had no impact on the accidents and their frequency (P-value = 0.532). But, there was a statistically significant relationship between the number of cigarettes per day and the occurrence of accidents ($P \leq 0.05$).

The results of unsafe behaviors and destructive factors for sleep among the studied drivers have been presented in Table 1. As seen in this table, majority of drivers reported eating the nuts such as pumpkin seeds, pistachios, etc. (78%), drinking tea (93%), calling (42.5%), and sending messages (42.5%). The frequency of all unsafe behaviors among the drivers with accident records was higher than those without such record. Meanwhile, there was a statistically significant difference between the two groups of drivers with and without accident records in terms of calling while driving and receiving safety and health training.

Status of drivers' occupational health:

Musculoskeletal disorders (WMSDs):

The prevalence of musculoskeletal disorders during the last 12 months in 9 body regions has been shown in Figure 1 for the accidents experienced by the drivers. As shown in this figure, almost for every three groups of drivers (without accidents, with 1 accident, with 2, and more accidents), the most complaints were reported for low back, knee, shoulder, feet and ankle, neck, upper back, hand and wrist, hip and thigh and elbows, in order. The results of pain severity and discomfort within the last year in 9 body regions of drivers were summarized in Table 2. The highest discomfort severities were 7.02 and 6.98 which were related to knees and low back and the lowest values were 0.79 and 0.99 for elbows and wrists/hands, respectively. Classification of discomfort severity felt by the drivers showed that in total, 74% and 68% of drivers had experienced severe and very severe pain and discomfort on low back and knees. While 45.5%, 39%, and 36% of drivers had no feeling of pain and discomfort in elbows, hips/thighs, and wrists/hands. The statistical relationship between pain severity in different body regions in three groups of drivers as cross-hatching has been shown in Figure 1. There iwass a significant difference in terms of pain between the low back ($P \leq 0.05$), knees ($P \leq 0.05$), wrists/hands ($P \leq 0.05$) and feet/ankles (P-value = 0.05), and the accidents and their frequency.

Ergonomic risk factors:

The results of ergonomic risk factors have been presented in Table 3. In this table, the largest mean was related to sitting or standing for a long time and the smallest one was connected to manual material handling. Based on the results, 60.5%, 27.5%, and 4.5% of drivers reported high and very high severity for each risk factor of sitting or standing for a long time, flection movements of hand and arm, hunched back, repetitive movements, and hand abduction movements. The connection of each ergonomic risk factor with the occurrence of accidents and their frequency was investigated using the Kruskal-Wallis test where the results indicated that only sitting or standing for a long time affected the occurrence of accidents and their frequency ($P \leq 0.05$).

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Table 1. Unsafe behaviors and annoying factors during driving in drivers (n = 200)

	Unsafe behaviors	Experienced accident		Experienced no accident		Total		P-value
		n	**%**	**n**	**%**	**n**	**%**	
Unsafe behaviors	Eating during driving (snacks, etc.)	115	73.7	41	26.3	156	78	0.864
	Drinking (tea, etc.)	138	74.2	48	25.8	186	93	0.821
	Falling asleep	32	71.1	13	28.9	45	22.5	0.617
	Calling	112	70.4	47	29.6	159	79.5	0.024
Annoying factors	Sending a text messaging	63	74.1	22	25.9	85	42.5	0.974
	Vehicle noise	39	78	11	22	50	25	0.458
	Tinnitus vehicle noise	33	75	11	25	44	22	0.864
	Occupational health/safety training	1	20	4	80	5	2.5	0.005

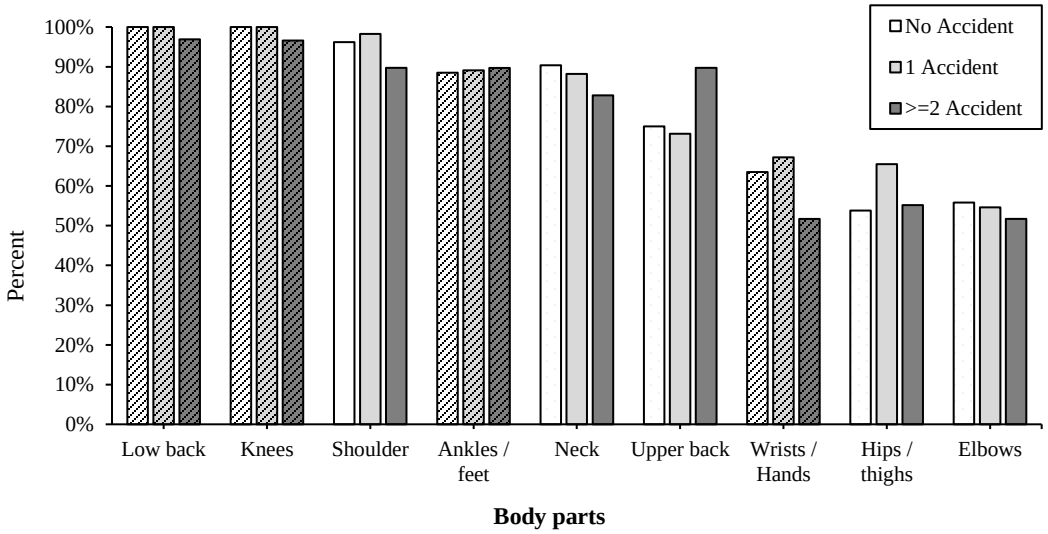

Figure 1. The prevalence and severity of musculoskeletal disorders according to the number of accidents among the studied drivers during last 12 months (hatchings: P-value<0.05)

Table 2. The intensity of pain in different areas of the studied drivers' bodies (n = 200)

Areas of the body	Mean ± SD	Iintensity of pain (%)				
		No pain (0)	Low (1-2)	Medium (3-5)	High (6-8)	Very high (9-10)
Neck	2.98 ± 2.48	12	39.5	36.5	5.5	6.5
Shoulder	3.68 ± 1.91	3.5	25.5	58.5	10.5	2
Upper back	1.44 ± 1.28	24	58	18	0	0
Elbows	0.79 ± 1	45.5	48	6.5	0	0
Low back	6.98 ± 2.14	0.5	0.5	25	44	30
Wrists / Hands	0.99 ± 1.01	36	56.5	7	0.5	0
Hips / thighs	1 ± 1.20	39	51	9.5	0.5	0
Knees	7.02 ± 2.39	0.5	3	28.5	33.5	34.5
Ankles / feet	2.15 ± 1.45	11	52.5	36	0	0.5

Table 3. Ergonomic risk factors in drivers (n = 200)

Risk factors	Mean ± SD	Risk factor intensity (%)			
		Low (0-2)	Medium (3-5)	High (6-8)	Very high (9-10)
Carrying and loading heavy equipment	1.33 ± 1.37	80	20	0	0
Bending and twisting the waist	4.34 ± 2.16	24.5	48	25	2.5
Repetitive motions	4.07 ± 2.58	33	42	19	6
Hand and arm flection	5.71 ± 2.26	12	38	38.5	11.5
Sitting or standing up for a long time	6.47 ± 1.73	1	38.5	44	16.5
Abduction movements of the hand/arms	3.14 ± 1.61	37	58.5	4.5	0

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Hearing health of drivers:

The results of hearing thresholds in each central frequency (500 to 8000 Hz), risk levels, and values of loss of hearing for both ears have been given in Table 4. The mean and SD of hearing thresholds and values of loss of hearing in three groups of drivers were presented in terms of the number of accidents (without accident, 1 accident, 2 and more accidents) and total values. The highest hearing threshold in all three groups was related to 4000 Hz frequency where mean and SD for right and left ears were 25±15.74 and 25±17.43 dB for drivers with no accident record and 42.93±14.91 and 43.10±19.15 dB for drivers with more accidents, respectively. A majority of drivers' hearing threshold compared to other frequencies deviated from the normal status and was classified within the risk levels in this frequency (4000 Hz). An assessment of the relationship between the values of hearing thresholds and loss of hearing among the drivers and the occurrence of accidents showed that this connection was significant for both ears in all central frequencies (P-value < 0.001).

Vision health of drivers:

The mean and SD of visual acuity in the right and left eyes were 9.16±1.04 and 9.20±1.07, respectively. The frequency percentage of different values of the visual acuity of right and left eyes (≤ 7, 8-9 & 10), has been shown in Figure 2 for three groups of drivers in terms of the number of accidents together with the mean and SD of each group. Among drivers with no accident record and those with only one accident, the visual acuity of over 50% of them was 10/10 (healthy), while this criterion for drivers with more accidents was 20.7% and 24.1% in right and left eyes, respectively. On the other hand, there was a significant connection between vision health and the occurrence of accidents (P<0.001). It was also found that the binocular vision of 5% of drivers (10 persons) was less than 14 and none of them had vision less than 5.

Respiratory health of drivers:

The results of measuring the most important spirometry variables to investigate the pulmonary function of drivers has been presented in Table 5. We compared the status of variables of FVC, FEV1, and FVC/FEV1 to the normal values. We also determined the values of FVC, FEV1 > 80% and FVC/FEV1 > 70% representing individuals' respiratory health. Therefore, 44.5% and 55.5% of drivers were in normal and abnormal statuses. The values of each parameter in three groups of drivers with a different number of accidents' record showed that there was a significant difference between the values of FVC, FEV1, and the respiratory health of drivers and the occurrence of accidents.

Blood indices of drivers:

The results of drivers' blood indices, including FBS, total cholesterol, and TG was assessed of which the results on mean, SD, and frequency distribution of subjects have been given in Table 6 compared to the reference values. Of 22.5%, 29%, and 26% subjects suffered abnormal statuses of FBS, cholesterol, and TG. FBS, total cholesterol. TG mean and SD were 107.9±17.7, 185.6±46.4, and 160.31±45.8, respectively. There was no significant relationship between the occurrence or non-occurrence of accidents and these indices (P-value > 0.05). However, we found a significant relationship between the number of accidents and the FBS index (P-value = 0.006).

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Table 4. Hearing thresholds (dB), risk levels, and hearing loss of drivers in the study (n=200)

Auditory frequencies		Hearing threshold (Mean ± SD) **				Risk level (%)			P-value
		No Accident	**1 Accident**	**≥ 2 Accident**	**Total**	**Norm***	**Low Risk‡**	**High Risk†**	
500	Right	15.78±13.76	14.36±11.22	32.06±17.70	17.22±14.32	80	12	8	<0.001
	Left	16.82±14.98	14.78±12.20	33.62±21.70	18.05±15.94	79	11.5	9.5	<0.001
1000	Right	17.30±16.22	15.75±12.83	35.34±20.61	19.0±16.45	78	10	12	<0.001
	Left	16.82±13.93	15.84±13.07	32.06±17.70	18.45±15.06	76.5	13	10.5	<0.001
2000	Right	16.34±15.2	15.75±13.20	36.55±20.31	18.92±16.66	75	12.5	12.5	<0.001
	Left	19.03±15.90	18.02±13.53	36.72±20.79	21.0±16.63	75.5	8.5	16	<0.001
4000	Right	25.00±15.74	25.37±14.21	42.93±14.91	27.82±15.92	58	20.5	21.5	<0.001
	Left	25.00±17.43	24.49±16.02	43.10±19.15	27.32±18.0	61.5	15	23.5	<0.001
6000	Right	22.40±16.70	22.43±15.29	40.68±16.29	25.07±17.0	64	15.5	20.5	<0.001
	Left	22.98±17.80	21.59±16.33	41.89±20.89	24.90±18.72	71	7	22	<0.001
8000	Right	20.67±19.14	19.91±16.41	41.37±20.52	23.22±19.21	68	11	21	<0.001
	Left	20.67±18.57	19.20±16.82	41.37±23.18	22.80±19.77	74	4.5	21.5	<0.001
Hearing loss (dB)	Right	18.53±15.05	17.81±12.60	36.72±17.85	20.74±15.51	(1.25 - 68.75) **			<0.001
	Left	19.42±15.13	18.28±13.28	36.37±19.26	21.20±15.96	(3.75 - 70.00) **			<0.001
	Total	18.20±14.84	17.18±12.57	35.45±18.65	20.09±15.47	(1.67 - 68.96) **			<0.001

* Hearing threshold<25 dB ‡ 25< Hearing threshold<40 † Hearing threshold>40 ** (Minimum-maximum) ** Hearing thresholds in drivers experienced accidents (1 accident and 2 or more accidents), experienced no accidents and total drivers.

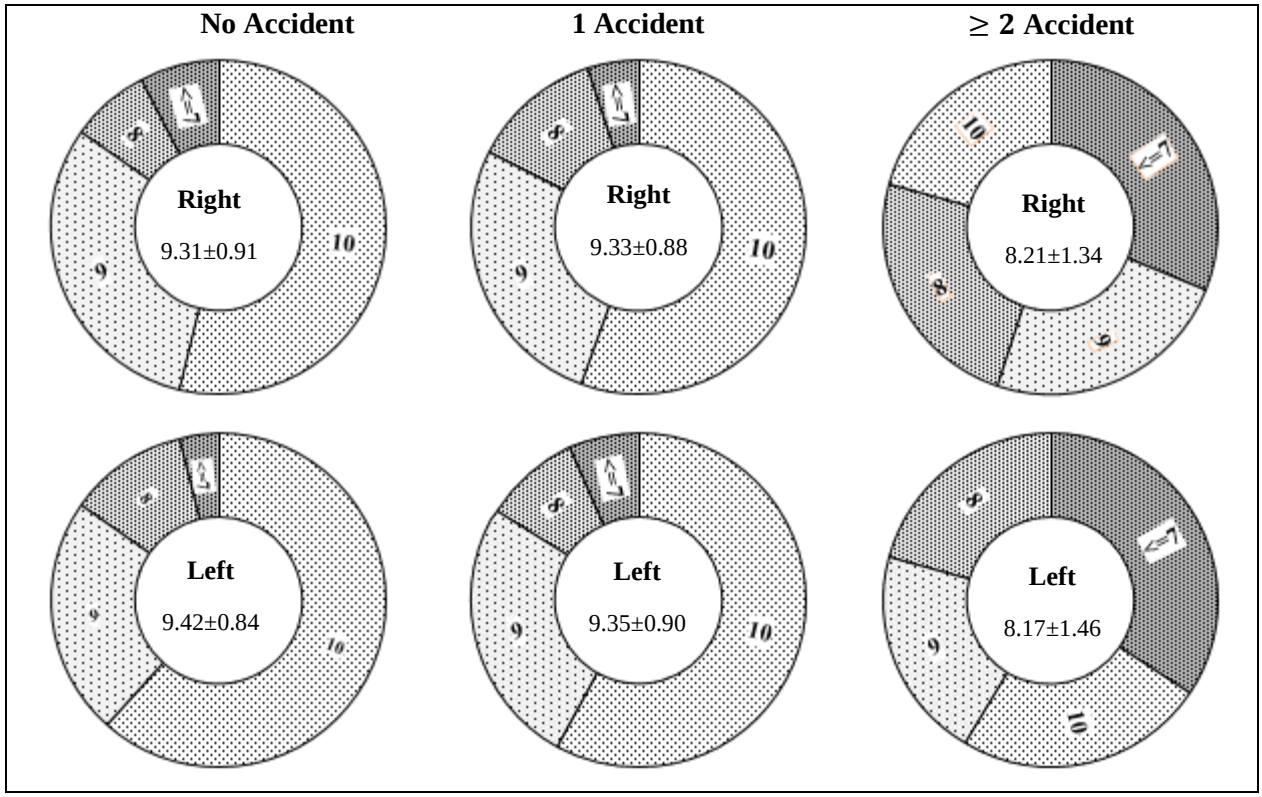

Figure 2. Visual acuity of drivers according to number of accidents in the study (P-value<0.001)

Status of road accidents:

The results of road accidents showed that 74% of drivers had a car accident leading to injury during past 5 years. The total number of road accidents was 219. The contribution of each type of accident was indicated in Figure 3. It can be concluded that collusion with another car was responsible for the highest number of accidents. The results of drivers' point of view on blaming themselves have been shown as a pie chart on the upper right corner of Figure 3. On average, 12.5% of drivers believed that their decision lead to accident occurrence, and 9.1% said they had no role in the accidents' occurrence. It should be noted that not all drivers answered this question. Investigating the number of accidents among drivers also showed that 26%, 59.9%, and 14.5% of them had no accident, one accident, and more than one accident (up to 6), respectively. The number of accidents per driver was 1.1 on average within a 5-year interval.

Table 5. Pulmonary function tests and respiratory health of drivers in the study (n=200)

Spirometry test	Normal values	Percentage (%)		Mean±SD				P-value
		Normal	**Abnormal**	**No Accident**	**1 Accident**	**≥ 2 Accident**	**Total**	
FVC%	80 <	78	22	85.96±8.19	85.65±9.43	78.86±11.67	84.75±9.75	**0.009**
FEV1%	80 <	50.5	49.5	79.38±13.52	78.42±15.83	67.55±14.27	77.09±15.49	**0.003**
FEV1/FVC%	70 <	86.5	13.5	92.23±15.46	91.59±17.80	86.51±19.30	91.02±17.47	0.560
Respiratory health		44.5	55.5					**0.006**

Table 6. FBS, Total Cholesterol and Triglycerides levels of drivers in the study (n=200)

Hematological parameters	References Value	Percentage (%)		Mean±SD			P-value†
		Normal	**Abnormal**	**No Accident**	**Accident**	**Total**	
FBS* (mg/dl)	< 125	77.5	22.5	108.3±16.1	107.8±18.3	107.9±17.7	**0.006**
Total Cholesterol (mg/dl)	< 200	71	29	186.4±43.3	185.3±47.6	185.6±46.4	0.589
Triglycerides (mg/dl)	< 200	74	26	160.7±43.8	160.1±46.7	160.31±45.8	0.487

* FBS: Fasting blood sugar; †Significant values between the number of accidents and FBS, total cholesterol and TG

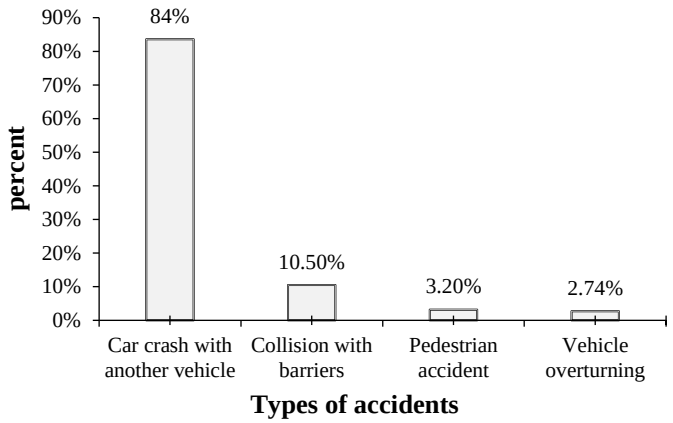

Figure 3. Types of road accidents in the last 5 years (n=219)

Correlation between the number of road accidents and research variables:

The results of Spearman correlation analysis to assess the correlation between the number of accidents and research variables, particularly drivers' occupational health factors have been presented in Table 7. There was a significant positive relationship between the number of accidents and loss of hearing and drivers' age. There was also a significant negative connection between the number of accidents and visual acuity, respiratory health, exercise hours, safety, and health training.

Table 7. Spearman correlation between the number of accidents and variables in the study

Variables	R	P-value
Hearing Loss	0.255	<0.001
Visual acuity	-0.261	<0.001
Respiratory Health	-0.170	0.016
Age	0.312	<0.001
Exercise hours	-0.144	0.041
Vehicle noise	0.222	0.002
Occupational health/safety training	-0.180	0.011

DISCUSSION

Due to the great share of road accidents in mortality rate in Iran and world, it is of particular importance to analyze the occupational factors affecting the occurrence of road accidents.

In the present study, the demographic data and the occupational factors of drivers indicated the high prevalence of obesity (88.5%), high occupational stress (23%), long working hours (78%), long continuous driving hours (75.5%), limited physical activity (9.5%) and smoking (67.5%) which were consistent with the similar studies. Varmazyar et al. [14], Jahangiri et al. [15], Seyyed-Mehdi et al. [16], and Yazdi et al. [17] reported the destructive habits among the heavy vehicles' drivers were equal to 63.9% of obesity and overweight prevalence, 31.7% of severe occupational stress prevalence, long driving hours (in average, 10±2.8 hours), limited physical activity (only 4%) and 69.8% of smoking prevalence, respectively. It can be concluded that the aforementioned problems prevalence among drivers in many cases would be due to different causes, including the essence of driving occupation, encountering the various occupational and environmental stresses, such as sedentary lifestyle, full-time sitting job, unhealthy nutrition, long travels, sleep problems, shift working, and smoking [15, 18-19]. Similar to the study of Jahangiri et al. [15], the impact of occupational stress on the occurrence of accidents was statistically significant. It can be addressed due to the stressful nature of driving which can lead to the accident by interfering drivers' safe performance. It was also

found that driving accidents among smokers were significantly more than other drivers, as other studies have shown a same result [20]. For example, Ansari-Moghaddam et al. stated that smoking was the most important cause of accidents and death among drivers [21]. While the joint impact of occupational stress and smoking can increasingly affect the unsafe behaviors of people [22].

Based on the results, the impact of calling during driving was significant in accidents' occurance. As Abbaszadeh et al., in their study, revealed that calling as a secondary auditory-verbal task in driving can affect the situational awareness and braking reaction time. This influences the level of drivers' understanding (level 1 of situational awareness) and perception (level 2 of situational awareness) about the conditions of road environment and enables them to predict the future conditions (level 3 of situational awareness). On the other hand, it increases the braking reaction time by 0.19 seconds. These factors interfere with driving and lead to deficiency in their safe performance [23].

Moreover, the impact of safety and health training on the reduction of accidents was proved. Although, only a few drivers received the safety and health training, it was observed that there was a statistically significant difference in the accidents between the trained drivers with others, such that 80% of trained drivers had no accident record. Therefore, the related safety and occupational health course help drivers attain a safer and healthier working condition.

The WMSDs are among the most common discomforts associated with driving job (24)]. In the present study, the prevalence and severity of discomfort in various body regions showed 99.5% of the low back and knee, 96.5% of shoulder, 89% of feet/ankle, and 88% of neck. These findings were in line with the findings of Arghami's et al. (2015) and Yarmohammadi et al. (2019). A systematic review and meta-analysis estimated the high prevalence of WMSDs in the back, neck, and shoulder regions [24]. The results of different studies showed the high prevalence of WMSDs among the drivers between 49% and 97% (26, 27). WMSDs among the professional drivers are along with numerous ergonomic risk and background factors, including static posture and long term sitting, hips discomfort, **inconsistent** anthropometric measurements (particularly improper cabin design), manual material handling, repetitive movements, bending and rotating, and inappropriate posture [24, 28]. These factors and risk factors negatively influenced the musculoskeletal body structure (cartilage, joint, ligament, bone, and muscular structure), decreased range of motion, increased reaction time, reduced mass and body muscular power as well as the pain and discomfort in body organs and consequently. Therefore, all these factors finally leads to the increased possibility of accidents [(29)]. Next to that, it can be concluded that WMSDs always play a significant role in the occurrence of accidents by intensifying the prevalence of disorders in the low back, knees, wrists, and ankles and also between the risk factor of sitting and standing for a long time. Thus, improving drivers' health and working conditions would decrease the number of accidents.

Due to the high level of noise among heavy vehicles drivers environments, it develops hearing problems and results in accidents [6, 30]. The results of previous studies showed that permanent noise would be the main reasons for hearing disorders among the heavy vehicles drivers (31, 32). Thus, the present study showed a considerable increase in the hearing threshold among some drivers (up to 70 dB), particularly in 406 kHz frequencies, and the average loss of hearing of 20 dB for all drivers and 36 dB for the drivers with a higher accidents records. There was also a significant relationship between central frequencies and the occurrence of accidents. Thus, it can be considered as a severe risk factor for road accidents. Safe driving entails the driver's ability to receive the messages from the environment and comply with them and take important information (e.g. noise of other cars approaching, horn noise, and noise of motor and tires deficiencies) through the sense of hearing from the environment. The average hearing threshold, especially in the frequency of 4 kHz, was similar to the study of Berjis et al. (27.99 dB) [31] and risk levels of higher thresholds over 25 dB was also more than the value found by Purshafie' et al. (23% frequency in 4 kHz) [32], the value found by Alizadeh et al. 37% , and 41% for right and left ears [33]. The central frequencies of 4 kHz were related to drivers' hearing thresholds, and the hearing threshold of

drivers with no accident's record and those only with one accident, were highly close to each other. However, a considerable change was observed among the drivers who had more accident records (25 dB vs. 43.1 dB in left ear, 4000 Hz) which was statistically significant. Unlike the results of this study, Jahangiri et al. reported no significant difference between two groups of drivers (with and without accident record) in terms of hearing. But they stated that drivers with previous record of an accident have a higher hearing threshold than those with such experience [15].

Vision health is so important as drivers get over 90% of information by the sense of vision [34]. Investigating the status of vision health among the studied drivers showed that generally, 50% to 54% of drivers had a healthy vision in right and left eyes while there were degrees of visual impairment in both eyes. The results showed a minimum visual acuity of 5 and drivers' binocular vision sum of 95% was more than 14 (legal obligation of article 23 of Driving Regulations). In many previous researches, there were a direct relationship between vision and driving performance. Therefore, there was a strong correlation and connection between vision health and drivers' inability. Lamble et al. in their study, found that the middle-aged drivers with abnormal central vision were vulnerable to the risk by slower braking time (0.2 seconds) compared to other drivers with normal vision ability [35]. In other words, driver's weak vision ability results in higher reaction time and lower control ability. On the other hand, in the case of vision disorders, there would be higher chance for accident and fatigue (36)]. Figure 2 present a significant direct relationship with the number of accident and visual acuity. Therefore, it was found that drivers with visual acuity of 7/10 experienced 34/4% more accidents than drivers with visual acuity of 10/10 which was 3.8%. Similarly, Higgins et al. simulated the visual acuity disorder with the optical blur among drivers with accident records. Their findings showed that visual acuity disorder decrease drivers' ability to identify road sings properly which ultimately increase road accidents (37, 38)]. Therefore, it can be concluded that vision impairment among drivers would be a main cause in accidents.

Investigating the status of drivers' respiratory health in terms of pulmonary function variables, as the first warning factor for weakness and discomfort in the respiratory system, showed that FVC and FEV1 values in 22% and 49.5% of drivers were less than 80% and FVC/FEV1 ration in 13.5% of them was less than 70%. Such reduction in drivers' pulmonary capacity can be attributed to their exposure to pollutant compounds. The studies conducted in Iran and other countries demonstrated that drivers, particularly heavy vehicle drivers were generally exposed to high concentrations of inhalable particles (PM10 and PM2.5), CO, NOx, VOCs and other pollutants. These pollutants can affect their respiratory system function and respiratory health leading to various complications and diseases [39-41]. In a study conducted by Jones et al. FVC, FEV1, and FVC/FEV1 values among autobus drivers in Hong Kong with a high level of exposure to the respiratory pollutants were less than the control group (42)]. This study showed a significant relationship between drivers' respiratory health and the occurrence of accidents. FVC and FEV1 values among three groups of drivers showed that drivers with more accidents were significantly less than others (80%) (see Table 5). Therefore, it can be concluded that drivers' respiratory health can affect their performance and increase their accident proneness, (43)].

The problems of high FBS values, total cholesterol, and TG among drivers were widely verified in different studies (15, 18, 21)]. For example, in their study, Yazdi et al. reported the prevalence of high FBS values of 19.5% , 27% of total cholesterol, and 29% of TC among heavy vehicles drivers (17)]. In the present study, one-third of drivers had high values of these indices. It can be linked to poor diet, and sleep problems which leads to high prevalence of FBS, cholesterol, and TG in drivers (18, 19)]. Based on the results, it was found that higher the FBS index, the number of accidents increases significantly (see Table 6). High values of FBS can disrupt necessary skills for safe performance such as reaction time and visual acuity, and consequently increase the possible risk of road accidents (44)].

Finally, the results of Spearman correlation analysis showed a direct relationship between the number of accidents and the impact of occupational health factors, including the increased loss of hearing ($r = 0.255$), decreased visual acuity ($r = -0.261$), poor

respiratory health (r = -0.170), increased age of drivers (r = 0.312), decreased exercise hours per week (r = -0.144), increased annoyance due to vehicles noise (r = 0.222) and decreased safety and health training for drivers (r = -0.180). However, no significant correlation was found between ergonomic risk factors and drivers' blood indices and road accidents, indicating that more impact of hearing health, vision health, and respiratory health of drivers on the accident proneness and frequency of accidents.

In the present cross-section study, we could not verify cause and effect relationship. So, it is recommended that in future studies the impact of other health factors on traffic accidents and their cause and effect relationship would be an interesting case.

CONCLUSION

In the present study, we aimed to investigate the impact of drivers' occupational health factors on road accidents. The results showed a significant impact of occupational stress, unsafe behaviors (i.e. smoking and talking to mobile), WMSDs in the low back, knees, wrist/hand, and feet/ankles as well as the risk factor of sitting and standing for a long time, loss of hearing and increased values of hearing thresholds, decreased visual acuity, increased values of blood FBS, impaired respiratory system (reduction of FVC and FEV1) and lack of safety and professional health training on the occurrence of road accidents and their frequencies. Furthermore, a significant correlation was found between the status of hearing, vision, and respiratory health of drivers and the number of continuous accidents. Therefore, due to the importance of drivers, particularly heavy vehicles drivers in passengers and goods transportation, and also given the impact of occupational health factors on the road accidents, the issues of professional health and safety among drivers need to be taken into consideration more than ever.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the student research committee of the Tehran University of Medical Sciences (Tehran, Iran), and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

REFERENCES

1. Statistical Research and Training Center. . Investigation of statistics of road accidents and casualties. 2019. https://srtc.ac.ir/en.
2. CDC. Centers for Disease Control and Prevention COVID Data Tracker 2021. https://covid.cdc.gov/covid-data-tracker.
3. Karimi A, Honarbakhsh M. Dimensions of occupational fatigue in heavy vehicle drivers. Journal of Mazandaran University of Medical Sciences. 2016;26(140):156-66.
4. Papadakaki M, Kontogiannis T, Tzamalouka G, Darviri C, Chliaoutakis J. Exploring the effects of lifestyle, sleep factors and driving behaviors on sleep-related road risk: A study of Greek drivers. Accident Analysis & Prevention. 2008;40(6):2029-36.
5. Rahimi-kolur A, Rahimi A. Investigation of the effect of colorblindness in road traffic accidents. Safety promotion and injury prevention (Tehran). 2016;4(3):167-74.
6. Nassiri P, Monazam Esmaeelpour M, Rahimi Foroushani A, Ebrahimi H, Salimi Y. Occupational Noise Exposure Evaluation in Drivers of Bus Transportation of Tehran City. Iranian Journal of Health and Environment. 2009;2(2):124-31.
7. Sadri G-H. Risk factors of musculoskeletal disorders in bus drivers. Archives of Iranian Medicine. 2003;6(3):214-5.
8. Karimi A, Eslamizad S, Mostafaee M, Haghshenas M, Malakoutikhah M. Road accident modeling by fuzzy logic based on physical and mental health of drivers. International Journal of Occupational Hygiene. 2016;8(4):208-16.
9. Statistical Yearbook of the Roads and Transportation Organization, 1392-1386 . file:///C:/Users/fatemeh/AppData/Local/Temp/14646.pdf. 2014.
10. Mooren L, Grzebieta R, Williamson A, Olivier J, Friswell R. Safety management for heavy vehicle transport: A review of the literature. Safety science. 2014;62:79-89.
11. Southerst D, Côté P, Stupar M, Stern P, Mior S. The reliability of body pain diagrams in the quantitative measurement of pain distribution and location in patients with musculoskeletal pain: a systematic review. Journal of manipulative and physiological therapeutics. 2013;36(7):450-9.
12. Karamifar K, Mirmohammadi S. Spirometry: A practical guide to the conduct and interpretation of clinical. 2 ed. Tehran: Andishmand. 2006. [In Persian].
13. Field AE, Coakley EH, Must A, Spadano JL, Laird N, Dietz WH, et al. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. Archives of internal medicine. 2001;161(13):1581-6.
14. Varmazyar S, Mortazavi B, Hajizadeh I, Arghami S. Evaluation of the Status of Severe Occupational Stress and Its Associated Factors among Public Transportation Bus Drivers in Tehran, 2012, Iran. Qom Univ Med Sci J. 2013;7(5):73-82.
15. Jahangiri M, Karimi A, Eslamizad S. Influence of Blood Biochemistry, Auditory and Musculoskeletal Well-being of Professional Drivers on Road Accidents. JOJ Pub Health. 2017;1(4):1-8.
16. Seyedmehdi SM, Dehghan F, Mohammadi S, Attarchi MS. Assessment of ischemic heart diseases and related risk factors in professional drivers. Iran Occupational Health Journal. 2010;7(3):46-52.
17. Z Yazdi Z, Sareshtehdary M, Tayefi M. Prevalence of Metabolic Syndrome among Truck Drivers and Its Relation to Shift Work. Qom Univ Med Sci J. 2012;5(4):68-72.
18. Farshidi H, Zarenezhad M, Zare S, Mousavi S, Mozafari S. Coronary Artery Disease Risk Factors in Truck Drivers, BandarAbbas, Iran (2009-2010). Journal of Rafsanjan University of Medical Sciences. 2013;12(3):195-204.
19. Emkani M, Khanjani N. The quality of sleep and its related factors among truck drivers in Kerman. Health and Development Journal. 2013;2(1):44-53.
20. Ryb GE, Dischinger P, Kufera J, Soderstrom C. Smoking is a marker of risky behaviors independent of substance abuse in injured drivers. Traffic injury prevention. 2007;8(3):248-52.
21. Ansari-Moghaddam A, Ansari H, Mohammadi M, Tabatabaei SM, Pishevare-Mofrad M, Miri-Bonjar M. Prevalence of addiction and smoking and their relationship with blood parameters

among drivers in Zahedan. International journal of high risk behaviors & addiction. 2016;5(3).
22. Fasih-Ramandi F, F N, Atif Kh, Boghsani Gh, Nadri H. Do occupational stress and cigarette smoking abet each other: survey of a steel industry in Iran. Russian Open Medical Journal. 2019;8(1).
23. Abbaszadeh M, Zakerian S, Nasl Seraji J, Nahvi A, Niknejad M, Ashori M. Investigating the effect of auditory-verbal task on drivers' situation awareness and brake reaction time in bus driving simulator. Iran Occupational Health. 2014;11(6).
24. Yarmohammadi H, Niksima SH, Yarmohammadi S, Khammar A, Marioryad H, Poursadeqiyan M. Evaluating the Prevalence of Musculoskeletal Disorders in Drivers Systematic Review and Meta-analysis. Journal of Health and Safety at Work. 2019;9(3):221-30.
25. Arghami Sh, Kamali K , M N. A Survey on Musculoskeletal Pain in Suburban Bus Drivers. Journal of Occupational Hygiene Engineering. 2015;2(2):72-81.
26. Feng Z, Zhan J, Wang C, Ma C, Huang Z. The association between musculoskeletal disorders and driver behaviors among professional drivers in China. International journal of occupational safety and ergonomics. 2020;26(3):551-61.
27. Kumar HP, Sakthivel G, Shankar S. Prevalence of work related musculoskeletal disorders among occupational bus drivers of Karnataka, South India. Work. 2020(Preprint):1-12.
28. Yasobant u, Ch M, Reddy EM. Are Bus Drivers at an Increased Risk for Developing Musculoskeletal Disorders?An Ergonomic Risk Assessment Study. Journal of ergonomics. 2015;2015:1-5.
29. McGwin Jr G, Sims RV, Pulley L, Roseman JM. Relations among chronic medical conditions, medications, and automobile crashes in the elderly: a population-based case-control study. American journal of epidemiology. 2000;152(5):424-31.
30. Karimi A, Nasiri S, Kazerooni FK, Oliaei M. Noise induced hearing loss risk assessment in truck drivers. Noise and health. 2010;12(46):49.
31. Nezamoddin Berjis MD, Saeid Soheilipoor MD, Siamak Poorabdian, Shirin Akbari. Evaluating the Relative Frequency or Hearing Loss on Heavy Vehicles Drivers. Journal of Isfahan Medical School. 2011;28(120):1471-76.
32. Pourshafie S, Izadfard Z, Jafarzadeh S. The Effect of Vehicle Noise on Hearing Thresholds in Heavy Vehicle Drivers. Iranian South Medical Journal. 2019;21(6):472-80.
33. Alizadeh A, Etemadinezhad S, Charati JY, Mohamadiyan M. Noise-induced hearing loss in bus and truck drivers in Mazandaran province, 2011. International journal of occupational safety and ergonomics : JOSE. 2016;22(2):193-8.
34. Fallah Karkan M, Behboudi H, Taeefe N, Soltani Moghaddam R, Khoshbakht Pishkhani M. Visual Disorders in Drivers Causing Accidents. Journal of Guilan University of Medical Sciences,. 2012;22(85):48-53.
35. Lamble D, Summala H, Hyvärinen L. Driving performance of drivers with impaired central visual field acuity. Accident Analysis & Prevention. 2002;34(5):711-6.
36. Alizadehnia N, SHIRALIVAND E, KANGARI H. Role of Decreased Visual Acuity, Contrast Sensitivity Disorder, and Visual Field Defect in Traffic Accidents and Recommendations to Improve These Factors. 2018.
37. Higgins KE, Wood J, Tait A. Vision and driving: Selective effect of optical blur on different driving tasks. Human Factors. 1998;40(2):224-32.
38. Higgins KE, Wood JM. Predicting components of closed road driving performance from vision tests. Optometry and vision science. 2005;82(8):647-56.
39. Chan L, Lau W, Zou S, Cao Z, Lai S. Exposure level of carbon monoxide and respirable suspended particulate in public transportation modes while commuting in urban area of Guangzhou, China. Atmospheric Environment. 2002;36(38):5831-40.
40. Żak M, Melaniuk-Wolny E, Widziewicz K. The exposure of pedestrians, drivers and road transport passengers to nitrogen dioxide. Atmospheric Pollution Research. 2017;8(4):781-90.
41. Kermani M, Jonidi Jafari A, Aalamolhoda AA, Jajarmi F, Dana E, Shahsavani A. Source Identification and risk assessment of BTEX compounds in occupational exposure of Bus Rapid Transit (BRT) drivers in limited traffic zone of Tehran in 2015-2016. Iran Occupational Health Journal. 2018;15(5):48-58.

42. Jones A, Lam P, Dean E. Respiratory health of bus drivers in Hong Kong. International archives of occupational and environmental health. 2006;79(5):414-8.
43. Siedlecka J, Bortkiewicz A. Driving simulators in risk assessment of traffic accident among drivers with obstructive sleep apnea. Medycyna pracy. 2012;63(2):229-36.
44. McGwin G, Sims RV, Pulley L, Roseman JM. Diabetes and automobile crashes in the elderly. A population-based case-control study. Diabetes care. 1999;22(2):220-7.