



## The study of brain death in Chaharmahal and Bakhtiari province in Iran from 2003 to 2013

Fares Najjari\*, Babak Mostafazadeh, Pantea Ramezan Nejad  
*Shahid Beheshti University of Medical Sciences, Tehran, I.R. Iran.*

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### ABSTRACT

**Background and aims:** There are different causes for brain death including head trauma, cerebrovascular accidents and intracranial space-occupying lesions. The present study was aimed to determine the causes of brain death in Chaharmahal and Bakhtiari province due to high turnover of trauma in this area during 2003 to 2013.

**Methods:** This study was based on routine data and was conducted on all brain death cases of Ayatollah Kashani Hospital in Shahrekord city, the capital of province, from 2003 to 2013. Necessary data was collected using retrospective method and completion of the questionnaire.

**Results:** The results of the study showed that 95 patients were brain dead in Chaharmahal and Bakhtiari province over 10 years study. The mean age of these brain dead patients was  $31 \pm 15.4$  years with the age range of 5 to 78 years. 35.8% (33 patients) of the patients were female. The most common cause of brain death was driving accidents with 44.2% (42 cases). Most of brain deaths were occurred in the summer season with 41.1% (39 patients).

**Conclusion:** The most common causes of brain death in adults and children were trauma due to car accidents. The limited use of safety devices among the population may pose more attention of managers to build the culture of using the safety devices during driving.

**Keywords:** Brain death, Organ transplantation, Brain damage.

### INTRODUCTION

Iran is one of the countries with high prevalence of brain death; according to Iranian Health Ministry statistics, the average number of brain death is 5 to 6 thousands annually, with highest figures in the provinces of Tehran, Fars, Razavi Khorasan and Isfahan as the accident-prone areas.<sup>1</sup> Prior to 1959, cardiac and respiratory arrests were accepted as death without any doubt or ambiguity; however, redefinition of death with title of brain death emerged following the technologic changes.<sup>2</sup> In the brain death, patient loses his/her brain cortex

and stem activity and there is no return possibility.<sup>3</sup> Today, the primary meaning of brain death is stop of all acts of brain and brain stem in a deep coma patient that there are no evidences of using debilitating drugs of central nervous system, hypothermia, metabolic disorders, endocrine and toxic.<sup>4</sup> Brain death consists 0.79% of all deaths, 1-4% of hospital deaths and 8-13% of occurred deaths in intensive care units.<sup>5</sup> There are different causes for brain death in patients such as head trauma; cerebrovascular accident, intracranial space-occupying

**Corresponding author:** Fares Najjari, Shahid Beheshti University of Medical Sciences, Tehran, I.R. Iran. Tel: 00989123195140, E-mail: [fares.hospital@yahoo.com](mailto:fares.hospital@yahoo.com)

lesions (tumors, infections, etc.) and brain hypoxia caused by heart stopping that returned by heart function's revival actions. Brain trauma is one of the most common causes of death in accidents. In Iran, more than 15,000 brain deaths occur annually in the incidents.<sup>3,6</sup>

Also in the conducted study by Pereyra et al. in Argentina, the most common cause of brain death was traumatic brain injuries accounting for 50% brain death cases.<sup>7</sup> Studies have shown that the causes of brain death is different based on patient's age, in the study of Khodami Vishteh, the most common cause of brain death was trauma caused by accident and in other studies again trauma was reported as the main cause of death, hospitalization and disability among other diseases in the first three decades of life.<sup>8,9</sup> Among different causes of trauma, driving accidents are the most common causes of death and disability in the world<sup>10</sup> and in our country have been reported as the second leading cause of death.<sup>10</sup> In a study conducted by Haji Hosseinloo et al. with the aim of investigating the causes of brain death and organ donation in Iran, the cause of brain death in 61% was accident, 13%, cerebrovascular incidents, bullet hit 13%, falling from height 5%, , cerebella tumor 3% and the rest was electrocution and other causes.<sup>11</sup> While in the study by Wauters et al in Belgium, among 400 patients with brain death and organ donor, the brain death causes were in order as follow: cardiovascular diseases (190 cases), trauma (185 cases), hypoxia (18 cases ), metabolic diseases (4 cases), tumors (2 cases), and infection (1 case).<sup>12</sup>

Timely detection and identification of brain death patients and investigation of its creating causes in each area can be useful sources of information for the better management of the organ donation cases for the needy patients. Since the epidemiology

of brain death is different in every region and Chaharmahal and Bakhtiari province based on the Health Ministry's statistics has the first place of organ donation in the country in relation to the population,<sup>13</sup> so the aim of this study was to determine the prevalence of brain death in this province in one decade period.

## METHODS

This study was a retrospective study which was designed in the form of a thesis of legal medicine program and was conducted on all cases of brain death in Chaharmahal and Bakhtiari province from 2003 to 2013. After approval of the proposal by the Vice-Chancellor in Research Affairs of Shahid Beheshti University of Medical Sciences under Code 46, and necessary coordination with the Vice-Chancellor in Treatment Affairs of Shahrekord University of Medical Sciences for sampling, all patients with a final diagnosis of brain death who had been hospitalized in Ayatollah Kashani Hospital of Shahrekord in Chaharmahal and Bakhtiari province during the study period (2003-2013), were included in the study.

Necessary data was collected using retrospective method and completion of questionnaire. Briefly, the records of brain death patients during ten-year period of study were separated and encoded and the required information has been extracted. The checklist of cases including age, sex, cause of brain damage, status of patients in terms of (driver, passenger, pedestrian), the accident season, time of death and hospitalization period in all roads in and out of town were extracted from the records of patients.

Finally, the obtained data was analysed by SPSS software using descriptive statistical methods like mean, percentage, prevalence and the descriptive tests like

chi-square and Kruskal-Wallis. The significance level in the study was considered  $P < 0.05$ .

The checklist form which was being used in this study was designed based on data from similar studies and opinions of experts in this area. To ensure the face validity of the tools used in this research, the questionnaire was completed by ten persons of the personnel of the section of brain dead patients, and the family members of patients with brain death, which had been similar to the population under study in terms of conditions. Also, they were asked to specify if there was difficulty in understanding or ambiguity in the items of the checklist, and they were not understandable to them, or there were editing problems, or difficult sentences. Then in order to verify its content, the questionnaire was reviewed by ten persons of the faculty members of Legal Medicine in a qualitative quantitative method, and therefore its content validity ratio was calculated. Thus, the mean relevance score was calculated 0.99, the mean simplicity score 0.98, and the mean clarity score 0.97, and in general, the score of the content validity of the questionnaire was calculated 0.98, that is an acceptable score in terms of the validity of the content.

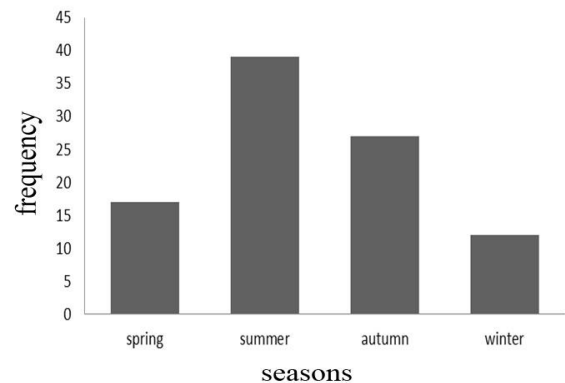
## RESULTS

The obtained results of this study showed that 95 patients over a ten-year study period in Chaharmahal and Bakhtiari province were brain death. Mean age of the individuals was  $15.45 \pm 3.03$  years with the age range from 5 to 78 years and the median of 32 and mode of 40. 35.8% (33 patients) of the patients were female and the rest were male 63.8% (62 patients). The most common cause of brain death was accidents with 44.2%

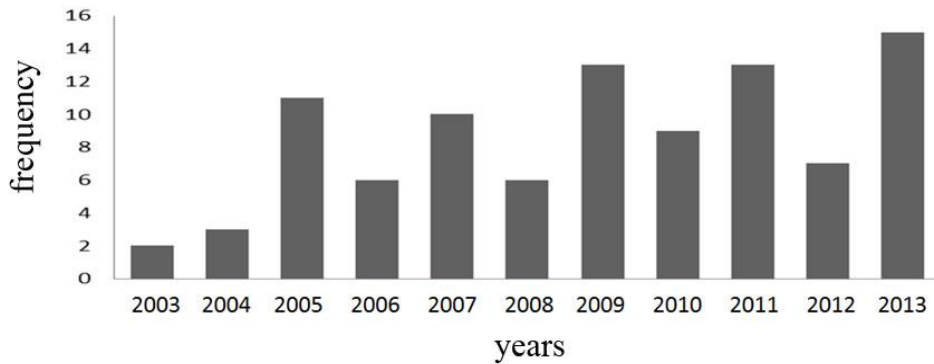
(42 cases). No significant difference was observed between the frequency of the brain death in different seasons of the year,  $P = 42\%$ , while summer with 41.1% (39 cases) of brain death had the highest statistics among the different seasons of year. The average length of hospitalization was  $4.45 \pm 3.86$  days with the range of 2 to 26 days. (Table 1, Figure 1). The results also showed that the highest statistics of brain death during the ten-year period of this study was related to year 2003 with 15 cases of brain death (Figure 2).

**Table 1:** Causes of brain death, in Chaharmahal and Bakhtiari province, between 2003 and 2013

Cause of occurrence	Frequency	Percentage
Traffic accidents	42	44.2
Fall	11	11.6
Vascular events	25	26.3
Tumor	4	4.2
Chronic diseases	10	10.5
Hanging	2	2.1
Shooting	1	1.1
Total	95	100



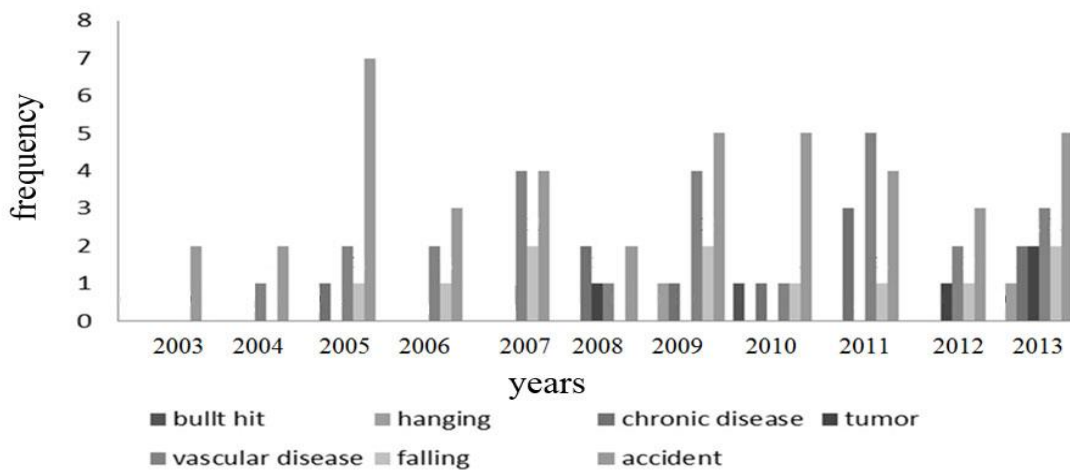
**Figure 1:** The frequency of brain death in different seasons during the years 2003 to 2013 in Chaharmahal and Bakhtiari province of Iran



**Figure 2:** Statistics of brain death with separation of the studied years in Chaharmahal and Bakhtiari province of Iran

The lowest average age of the brain death patients was related to year 2003 with an average of  $21.00 \pm 5.65$  and the highest average age of patients was related to year 2009 with an average age of  $38 \pm 15.45$  years. The distribution of obtained data in this study was not in the normal range ( $P < 0.05$ ), therefore the non-parametric tests were used for data analysis. Kruskal-Wallis statistical test showed no significant difference between age and death year of patients

( $P = 0.97$ ). Chi-square statistical test showed that there was no significant statistical difference between the age of the dead people and cause of brain death in any of the studied years ( $P > 0.05$ ). Based on the study results, in all studied years, the most frequent of brain death was due to accidents, while the chi-square test results showed that the causes of brain death in the studied years had no significant difference with each other ( $P > 0.05$ ) (Figure 3).



**Figure 3:** The frequency of brain death cases with separation of their creation cause in years 2003-2013 in Chaharmahal and Bakhtiari province of Iran

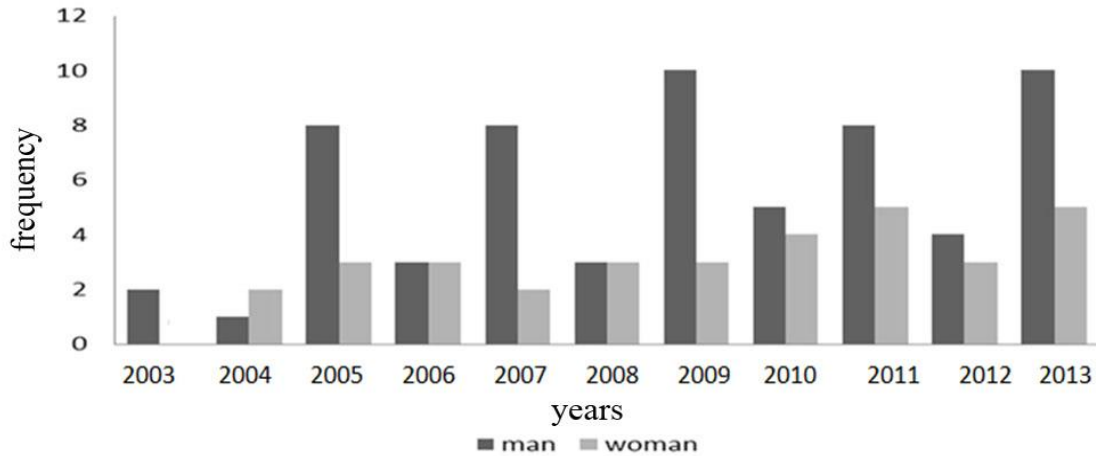
The chi-square test showed that there was a significant difference between the

cause of brain death and sex of the dead people ( $P = 0.02$ ). Thus, the cases of brain

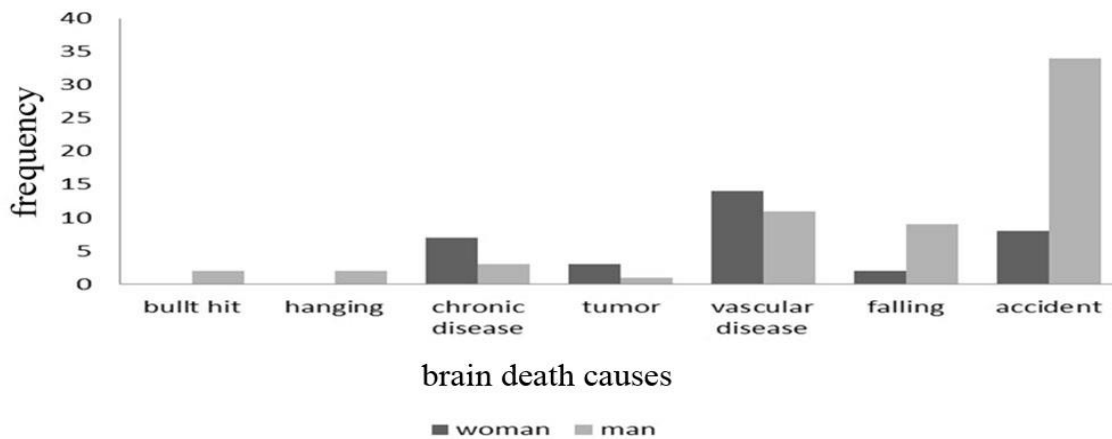
death in men due to accident, hanging, falling and shooting was more than those of women (Figure 4). Chi-square test showed no significant difference ( $P= 0.38$ ) for the cause of brain death in both sexes and in the years of the study. The obtained results in this study showed that there was no significant relationship between accident

and other causes of brain death and seasons. (Spring ( $P= 0.39$ ), summer ( $P= 0.58$ ), autumn ( $P= 0.61$ ) and winter ( $P= 0.23$ ).

Chi-square statistical test showed that none of the studied years had significant difference between both sexes in the frequency of brain death ( $P= 0.67$ ) (Figure 4 and 5).



**Figure 4:** The frequency of brain death in the studied years due to the gender in Chaharmahal and Bakhtiari province of Iran



**Figure 5:** Frequency of brain death causes based on gender in years 2003-2013 in Chaharmahal and Bakhtiari province of Iran

The lowest mean age of patients with brain death was related to the year 2003 with an average of  $21.00 \pm 5.65$ , and the highest mean age of the patients was

related to the year 2009 with an average age of  $38 \pm 15.45$  years.

In this study, data distribution was not in the normal range ( $P < 0.05$ ), thus

non-parametric tests were used for data analysis. The Kruskal-Wallis statistical test

showed no significant difference between the patients' age and their year of death (Table 2).

**Table 2:** An investigation on brain death by age, in Chaharmahal and Bakhtiari province in Iran, between 2003 and 2013

Year	Mean	Standard deviation	Minimum	Maximum
2003	21	5.65	17	25
2004	36	11.53	23	45
2005	30.73	13.89	5	46
2006	34.33	24.07	10	78
2007	31.10	16.42	5	52
2008	38	15.47	17	54
2009	29.31	15.88	5	60
2010	29.78	13.72	10	45
2011	31.08	17.15	6	60
2012	28.86	17.02	9	55
2013	30.67	15.02	7	52

Significance level= 0.97

According to the results of the study, in all years of the study, the highest frequency of brain death was due to traffic accidents. However, the chi-square test results showed that there were no significant differences amongst the causes of brain death, in different years of study, (P= 0.95) (Table 3). The current study showed that the mean age

of patients with brain death was 31.03+15.45 years, and 76.8% of them were older than 18 years and the rest were younger than 18 years. Chi-square statistical test showed that there was no significant difference between the age of the deceased patients and the cause of brain death, in any year of the study (Table 4).

**Table 3:** An investigation on the frequency distribution of causes of brain death, in Chaharmahal and Bakhtiari province in Iran, between 2003 and 2013

Year	Cause	Traffic accident	Fall	Vascular diseases	Tumor	Chronic diseases	Hanging	Shooting	Total
2003		2	0	0	0	0	0	0	2
2004		2	0	1	0	0	0	0	3
2005		7	1	2	0	1	0	0	11
2006		3	1	2	0	0	0	0	6
2007		4	2	4	0	0	0	0	10
2008		2	0	1	1	2	0	0	6
2009		5	2	4	0	1	1	0	13
2010		5	1	1	0	1	0	1	9
2011		4	1	5	0	3	0	0	13
2012		3	1	2	1	0	0	0	7
2013		5	2	3	2	2	1	0	15
Total		42	11	25	4	10	2	1	95

**Table 4:** An investigation on the frequency distribution of causes of brain death by years and the patients' age, in Chaharmahal and Bakhtiari province in Iran, between 2003 and 2013

Year	Age range	Traffic accident	The other causes	Significance level
2003	16-25	2	0	*
2004	16-25	1	0	0.38
2005	36-45	1	1	0.10
	5-15	2	0	
	16-25	2	0	
	26-35	2	0	
	36-45	1	3	
2006	46-55	0	1	0.26
	5-15	0	1	
	16-25	1	1	
	36-45	2	0	
	66-85	0	1	
2007	5-15	1	1	0.12
	16-25	2	0	
	36-45	0	4	
	46-55	1	1	
2008	16-25	1	1	0.68
	36-45	0	1	
	46-55	1	2	
2009	5-15	0	1	0.78
	16-25	3	3	
	26-35	1	1	
	36-45	0	1	
	46-55	1	1	
	56-65	0	1	
2010	5-15	1	1	0.40
	16-25	2	0	
	26-35	0	1	
	36-45	2	2	
2011	5-15	2	0	0.39
	16-25	0	2	
	26-35	0	2	
	36-45	2	2	
	46-55	0	1	
	56-65	0	1	
2012	5-15	2	0	0.13
	16-25	0	1	
	26-35	0	2	
	36-45	1	0	
	46-55	0	1	
2013	5-15	0	3	0.51
	16-25	2	1	
	26-35	0	3	
	36-45	2	1	
	46-55	1	2	

\*Since the number of patients were less than 5 persons, the software was not able to determine the significance level.

## DISCUSSION

The brain death phenomenon and the possibility of using it in organ transplantation have long been discussed in scientific and social circles. In brain death, the blood supply to the brain is stopped, oxygen supply is not carried out and the brain loses all its functions and experiences irreversible damage. However, other organs such as heart, liver and kidneys still have function that organ transplantation is the only return way to a normal life in many patients.<sup>4</sup>

The present study showed that among 95 patients with recorded brain death in hospitals of Chaharmahal and Bakhtiari province, average age of patients was  $31.03 \pm 15.45$  that 76.8% of them were more than 18 years old and the rest of them were younger that the results are consistent with the findings of Hosseinloo et al. in Azerbaijan. Their results showed that about 77% of people were over 18 years and 23% under 18 years.<sup>11</sup> In addition, also in the study of Khodami Vishteh et al., from 373 confirmed brain death patients, 29 patients (8%) were under the age of 15 years and 344 patients (92%) were older than 15 years. The mean age of the patients was  $44 \pm 22$  years.<sup>7</sup> This difference in average and age group percentage of patients may be due to significant difference in the number of the studied sample size in the study with the study of Khodami Vishteh.

In addition, 63.8 of patients in the study were male, and the rest (35.8%) were female. In the study of the Khodami Vishteh, 63% of patients were male (234) and 139 patients (37%) were female<sup>8</sup> which is consistent with the present study.

The findings of this study showed that the most common cause of brain death in hospitals of Chaharmahal and Bakhtiari province was trauma caused by accidents (44.2%) followed by cerebrovascular incidents (26.3%) and falling from height (11.6%).

The pattern was similar in people over 18 years, but in people younger than 18 years the first cause of brain death was accidents, the second was diseases such as treatment-resistant epilepsy and seizures and then cerebrovascular incidents. The results of this study was in harmony with the results of Khodami Vishteh study in year 2033 in affiliated hospitals of Shahid Beheshti University that reported that the most common causes of brain death were trauma caused by accidents with 35% and coronary events with 14%.<sup>7</sup> In the study of Hosseinloo et al. in Azerbaijan province, the most common causes of brain death were accidents with 61%, cardiovascular and bullet hit events with 13% and falling from height with 5%.<sup>11</sup> In the study of Wauter et al., that was carried out in Belgium, among 400 brain death patients of organ donor, causes of brain death were respectively cardiovascular diseases (190 cases), trauma (185 cases), hypoxia (18 cases), metabolic diseases (4 case), tumor (2 cases), and infections (1 case).<sup>12</sup> Also, the results of the study of Savzi et al. conducted in Taskani showed that in patients with brain death, the etiology factor of 53.8% of cases were due to cerebrovascular incidents of brain, 20.1% trauma, 15.5% anoxia and 1.2% neurologic neoplasms and 8.4% other diseases. Thus, in their study, the most common cause of brain death was cerebrovascular events.<sup>14</sup> The results of these two studies are different from the present study, the difference is likely related to the differences in roads safety and the quality of vehicles and the culture of using safety devices and present traffic regulations in the studied countries.

However, in the study of Pereyra et al., in Argentina<sup>7</sup> and Neejbor et al., in the Netherlands,<sup>15</sup> the most common cause of brain death was traumatic injuries to the brain that is similar to the results of the present study. In Uruguay also in a two-year

period, 30.5% of brain death causes were traumatic, 44.2% stroke and 1% brain tumors.<sup>16</sup> In Saudi Arabia in the years 1986 to 2008, traffic accidents were responsible for 43.9% of brain death cases.<sup>17</sup> In Brazil, 17.61% of brain death causes was skull trauma (62.6% due to accidents), 30.8% CVA and 1.4% brain tumors.<sup>18</sup> However, in Brazil during years 1988 to 2004, the rate of brain death due to skull trauma increased to 34.8%, while the CVA as the brain death cause increased to 49.4% and brain tumors to 2.4%.<sup>19</sup> This trend continued in this country, so that in 2005, only CVA formed 55.5% and brain trauma 29% of brain death cases.<sup>20</sup> In Belgium, the most common cause of brain death in years 1991-92 was brain trauma with 69% and then cerebral vascular disease by 24 percent. The cases in years 2006-7 were respectively 38% and 46%.<sup>21</sup> Since, the health status improvement of patients in the last decade have increased longevity of patients, it can be expected that the aging complications of population such as brain strokes also show increasing trend. In addition, due to the high statistics of traffic accidents in Iran and the fact that probably many deaths caused by traffic accidents in Iran is a sign of brain death, the high incidence of brain trauma as the main cause could be expectable. On the other hand, it is expected that cerebrovascular events occur in patients with high blood pressure and chronic diseases such as kidney diseases and also the higher prevalence of these diseases in the older ages, the results of the study is justifiable.

The findings of the study showed that the highest rate of brain death was in summer (41.1%) that brain death due to trauma caused by accidents were 20 cases and then winter and spring had the highest traffic accidents led to brain death. The findings of the study were similar to the results of other studies. In the study of Cherkzi et al., conducted on the trauma cases caused by accidents in the



Golestan province, the highest statistics of accidents were related to summer with (38.5%) followed by spring and winter.<sup>22</sup>

High prevalence of accidents that led to the brain death in this season is justifiable according to the Nomads migration and increasing of travels to the province in this season and inappropriate roads of the province.

The mean duration of patients hospitalization was  $5.45 \pm 3.86$  days which is similar to the study results of Khodadadi et al., who reported that all the subjects were hospitalized less than 2 weeks.<sup>23</sup> Short duration of hospitalization can be due to the serious physical situation of patients and their critical disease.

Also, the results of the study showed that 50% of brain death patients due to an accident were driver of the vehicle. In the study of Khodadadi et al., 66.3% of the victims due to the trauma caused by driving were drivers of the vehicle,<sup>23</sup> while in the study of Cherkezi and colleagues, most of the victims were pedestrians.<sup>22</sup> Due to the face-to-face occurrence of most accidents and dangerous and accident-prone roads of the province, occurrence of accidents is predictable in the areas around the capital of the province. On the other hand, the short duration of training for drivers and the lack of re-training durations for drivers will be one of the factors affecting in accidents. In addition, pedestrians also do not have sufficient knowledge about traffic rules.

The results of the above study showed that the mean age of patients with brain death due to accident was  $27.38 \pm 14.10$  years. The results of the study are consistent with the findings of other studies in other parts of the country.<sup>13,24,25</sup> The results of Ghorbani and colleagues' study showed that 31.6% of the victims were in the age group of 29-30 years.<sup>26</sup> In the study, men had the highest statistics of brain death due to the accident (ratio of 17 to 4). In the studies of

Charkazi<sup>22</sup> and Ghorbani<sup>26</sup> the ratio of men to women was 7 to 5 and 8 to 5, respectively.

The reason for the difference in the results of mentioned studies may be due to the differences in society and geographic area of study and on the other hand, in this study we studied people who were brain death due to the accident. The ratio in the conducted studies of developed countries is 3.6 to 1.6.<sup>27,28</sup> The difference of these ratios could be due to the different condition of our society and developed countries. In those countries, men and women are equally involved in the transportation, while the use of bicycles and motorcycles is not common among women in our country due to cultural restrictions and also driving of women is only common in a certain segment of society.

## CONCLUSION

The results showed that the most common causes of brain death in adults and children in the studied population are trauma caused by accidents. High statistics of brain death followed by accidents and limited use of safety devices in the studied samples poses the necessity of the authors' try to build culture of using safety devices during the driving.

In this study, unlike many other studies performed during shorter period, the studied period was long and about 10 years. We attempted in the study to find out more about the causes and factors related to the brain death. Incomplete records were some limitations of the study that led to non-investigation of the cases like the accident mechanism.

Therefore, it is recommended that the future studies are prospective and assess items like consent or refusal of organ donation with the incidence of brain death.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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