ANALYSIS OF INJURIES AND CAUSE OF DEATH IN FATAL ACCIDENTS WITH FARM TRACTORS

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ABSTRACT

Farm tractor accidents are a frequent cause of death for people in agricultural field of work. The aim of this study was to evaluate the characteristics of the fatal farm tractor accidents, as well as the most significant types of injuries and causes of death. Research is based on epidemiological criteria of subjects, traffic participation, cause of death, distribution of injury, outliving period and toxicological details. The study included 22 (4.2%) farm tractor related fatalities out of all 525 subjects who died from sustained injuries or complications of the injuries sustained in road traffic accidents. The highest number of deaths was reported in men in 95.5%. The highest percentage died of bleeding out (41%), while in 18% of cases, complications that occurred during the outliving period were the cause of death. Analyzing injuries through organ systems, it is observed that the highest number of farm tractor drivers had a chest injury (90%), and the most common chest injury was a rib fracture (82%). When determining the outliving period, the highest number of fatal farm tractor drivers died at the scene of accidents (68.2%). Of all of the subjects, 32% were under the influence of alcohol, while 23% had blood alcohol concentration level greater than 0.5 ‰. The high mortality of farm tractor drivers can be reduced by introducing a mandatory rollover protective structures system and the use of a seat belt in farm tractors with cabs, which would reduce the possibility of the driver falling out of the farm tractor seat and additional injuries due to rollover.

Keywords: *Farm tractor, accidents, autopsy, cause of death.*

INTRODUCTION

World Health Organization estimated that in 2030 road traffic accidents (RTA) might be the fifth leading cause of death in the world (1). More than 3000 people die in RTA every day, which adds up to about 1.25 million people a year (1). Farm tractor drivers are the type of participants in the RTA who are less represented in the overall sample, but are not negligible. Farm tractor accidents are a frequent cause of death for people in agricultural field of work (2, 3). The most used agricultural equipment on farm are farm tractors, and they are used for work purposes in agriculture, forestry (4) and as transportation vehicle in rural parts of Serbia. Among machines that are being used in agriculture, farm tractors are one of the most lethal. Farm tractors are among most lethal of agricultural machines that are being used performing agricultural activities. More farmers are injured in farm tractors related accidents per year compared to injuries related to any other piece of farm equipment. About half of all deaths associated with injuries in the agricultural industry involve farm tractors (5). In numerous studies farm tractors were reported as the most common causative agents of fatal accidents (6-8). Also, about 50% to 60% of all fatal farm tractor accidents deaths are due to rollovers (9, 10). Accidents usually occur on farmland, tracks, or roads when the vehicle suddenly overturns and the driver or passenger gets thrown to the ground and crushed. Different vector forces may cause the farm tractor to overturn backwards, forward or to one side, crushing the victim's chest, head or limbs. Medico legal autopsies are demanded in all cases of violent deaths, i.e. in all traffic accidents, including those involving farm tractors.

The aim of this study was to evaluate the characteristics of the fatal farm tractor accidents in Kragujevac and the surrounding area, as well as the most significant types of injuries and causes of death.

MATERIALS AND METHODS

This study used epidemiological, cross-sectional autopsy examining of farm tractor related fatalities between 2001 and 2016 in Kragujevac, Serbia. A retrospective review of 1,366 medico legal autopsy reports by Clinical Centre of Kragujevac, Department of Forensic Medicine and Toxicology included 525 road traffic accidents. This study included a total of 22 farm tractor related fatalities. The data on the sustained injuries were obtained by analyzing the autopsy records, available medical documentation as well as the retrospectively acquired hetero-anamnestic information. The study did not include children younger than 14 years of age.

Research is based on epidemiological criteria (age, gender, year, month and day distribution) of subjects, cause of death, distribution of injury, outliving period and toxicological details. Causes of death were classified into the following groups: bleeding out, breathing disorder, head injuries, breathing disorder and bleeding out and complications of injury like pneumonia or sepsis. The presence of injuries by systems was also analyzed: head, chest and abdomen. According to the time distribution of death after injury the subjects were divided into two categories: ones who died at the scene of the accident and others who outlived the accident for a certain period of time. Femoral blood and urine samples were collected at the autopsy from subjects who died at the scene of the accident or who outlived injuries up until 24 hours after the accident and analyzed by „headspace" gas chromatography (Shimadzu GC-2010 plus).

Statistical analysis for variances was performed using statistical Package for Social Sciences-SPSS for Windows, Version 20 (SPSS Inc Chicago, IL). All numerical variables were tested with the Kolmogorov-Smirnov and Shapiro-Wilks tests for normal distribution and appropriate descriptive statistics were employed (mean values with standard deviation). In variables that showed a nonparametric distribution, the Pearson's chi-square test (with Yates correction) was applied. The p value of 0.05 has been considered to be significant.

This study was conducted with the approval of the Ethical Committee of the Clinical Centre of Kragujevac (18/10/2016, No 01/13221).

RESULTS

Number of cases and gender distribution

At the Department of Forensic Medicine and Toxicology, Clinical Centre of Kragujevac, a total of 1,366 medico legal autopsies were performed between 2001 and 2016. The study included 22 (4.2%) farm tractor related fatalities out of all 525 road traffic accidents subjects who died from sustained injuries or complications of the injuries. The highest number of deaths was reported in men in 95.5% of cases (21 of 22), while women were represented in 4.5% of the cases (1 of 22).

Year, month and day distribution

The year 2010 had the highest number of farm tractor accidents (7, i.e. 31.8%), which are provided in Figure 1. July, August and September had the highest number of fatal accidents (4 i.e. 18.2%), while February and December are months when there weren't any farm tractor accidents (Figure 2). Depending on the days of the week, the highest number of farm tractor accidents happened on Tuesdays (7, i.e. 31.8%), while there were no accidents on Saturdays which is presented in Figure 3.

Age distribution

The study included 22 subjects, whose average age was 61.2±13.6 years (ranging from 25 to 83 years). The distribution of subjects by age ranges are presented in Table 1. Almost half of all deceased farm tractor drivers were over 65 years of age, which is statistically significant (χ^2=8.182; df=3; p=0.042).

Figure 1. Farm tractor accident distribution by year.

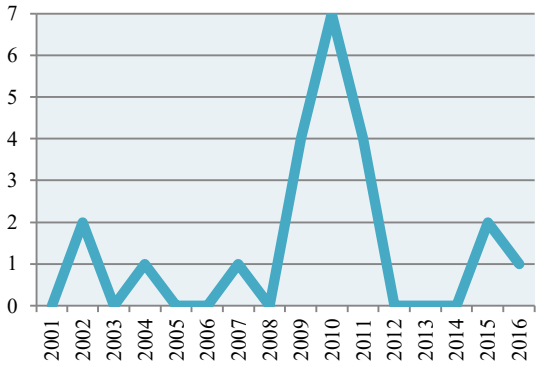


Figure 2. Farm tractor accident distribution by month.

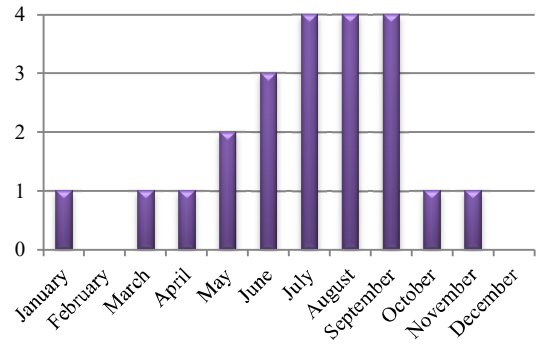
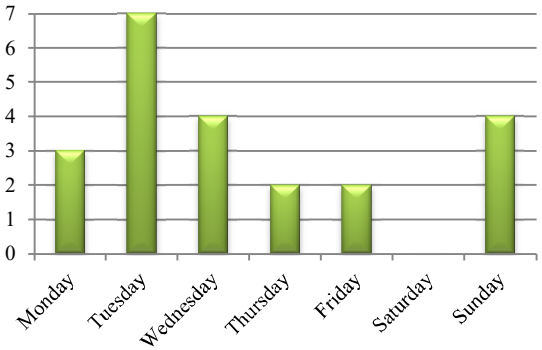


Figure 3. Farm tractor accident distribution by week.



Cause of death and *distribution of injury*

Out of all farm tractor drivers, the highest percentage died of bleeding out (9 out of 22, i.e. 41%), which is statistically significant (χ^2=26,068; df=10; p=0,004). Other causes of death such as head injuries, breathing disorder, breathing disorder and bleeding out are represented by a smaller percentage (Table 2). In 18% (4 out of 22) of cases, complications that occurred during the outliving period were the cause of death (two cases of pneumonia and sepsis). Analyzing injuries through organ systems, it is observed that the highest number of farm tractor drivers had chest injuries (20 out of 22, i.e. 90%), while abdomen injuries (10 out of 22, i.e. 45%) and head injuries (5 out of 22, i.e. 23%) were much less common. The most common chest injury was a rib fracture (18 out of 22, i.e. 82%), with fractures of ribs on both sides present in as many as 16 cases, which is statistically significant (χ^2=8.909; df=1; p=0.003). Lung injuries, i.e. lung contusions and lacerations, were also present in a large proportion (13 out of 22, i.e. 59%). Hemothorax was present in almost half of all the farm tractor drivers (10 out of 22, i.e. 45%).

Outliving period

When determining the outliving period, we concluded that only 4 (18.2%) of all 22 subjects had an outliving period of over 6 hours (Table 3). The highest number of farm tractor drivers died at the scene of accidents (15, i.e. 68.2%), which is statistically significant (χ^2=32.545; df=4; p=0.000). In the group of drivers who died within a certain period of time after the accident (7, i.e. 31.8%) the following injuries were noted: bilateral rib fractures (5, i.e. 23%), lung contusions (2, i.e. 10%), liver (3, i.e. 14%), spleen (3, i.e. 14%) and intestines injury (3, i.e. 14%).

Toxicological report

Blood alcohol concentration was measured in all subjects who died at the scene of accidents, and subjects who outlived the injuries for more than 24 hours were excluded from this study. Of the 22 subjects, 7 (32%) were under the influence of alcohol, 5 (23%) had BAC greater than 0.5 ‰, while 9 (41%) were negative, and in 6 (27%) it was not measured because they outlived the injuries longer than 24 hours. Blood alcohol concentration values in deceased farm tractor drivers ranged from 0.22 ‰ to 1.9 ‰, with mean value being 0.96±0.61‰.

Table 1. The distribution of subjects by age ranges.

Age ranges	Number	%
15-35	1	4.5
36-50	4	18.2
51-65	7	31.8
> 65	10	45.5
Total	**22**	**100**

Table 2. The distribution of cause of death.

Cause of death	Farm tractor drivers	
	Number	%
Bleeding out	9	41
Breathing disorder	3	14
Bleeding out and breathing disorder	3	14
Fatal head injury	3	14
Complication of injuries	4	17
Total	**22**	**100**

Table 3. The distribution of subjects by outliving period and injuries.

Outliving period	Farm tractor drivers	
	Number	%
Died at the scene	15	68.3
Outliving 6 hours	3	13.7
Outliving 24 hours	/	/
Outliving 72 hours	/	/
Outliving 7 days	2	9
Outliving 14 days	1	4.5
Outliving 30 days	1	4.5
Total	**22**	**100**

DISCUSSION

The agriculture industry is the sector of the economy in which occupational injuries are quite common, most frequent being farm tractor- related. According to data provided by Statistical Office of the Republic of Serbia, machines used in agriculture are outdated and old, especially farm tractors (86% of farm tractors and 82% of combine harvesters are over 20 years old. Also, there is an increase in the proportion of older people living in rural areas and a decline in the proportion of younger people.

This study presents fatalities with farm tractors over a sixteen year period in the territory of the city of Kragujevac with the surrounding area. In our study, of the total number of RTAs, approximately 4% were accidents involving farm tractors. Similarly, about 5% of deaths with farm tractors have been reported in other studies (6,7). Over 95% of farm tractor drivers were male, which is similar to the results of other studies in Turkey (6) about 86%, Croatia (4) and Poland (9) about 91%. The small share of women is explained by the fact that women are less represented in agricultural work requiring the operating of farm tractors and similar machines.

According to the data from our study, the most common farm tractor related accidents have occurred during the summer months when the most intensive agricultural and forestry work was taking place. Similar results have been reported in other studies, which point out that the occurrence of such accidents is highest in the summer months and early fall (4,6,7,9,12). In the winter months, the activity in agriculture decreased, so the minimum number of injuries and deaths was expected in these months. Although in a similar study it was shown that Monday and Friday are the days when farm tractor accidents are the most common (12), in our study most farm tractor accidents happened on Tuesdays, so some regularity cannot be established.

According to our study, farm tractor drivers are among the oldest participants in road accidents, with an average age of over 61, with the highest number being over 65 years old. In our country, the elderly population is most often engaged in agriculture (11), which explains the high proportion of older fatal farm tractor drivers. In a similar autopsy study in Croatia (4), it is emphasized that the most of RTA participants involving farm tractors who succumbed to their injuries were older than 65 years, which also corresponds to the results of our study.

According to the results of our study most frequently injured part of the body was chest (in 90%), while the injuries of other body parts were represented in much smaller numbers. The high incidence of chest injuries in farm tractor drivers can be explained by the farm tractor's technical characteristics and mechanism of injury. According to our heteroanamnestic data, these kinds of accidents mostly involve farm tractors without cabs, which leads to drivers falling out of the driver seat or farm tractor, some farm tractor implements or trailers overturning over the driver, inevitably resulting in chest injuries. In a similar study conducted in Turkey (6), head injuries and thoracoabdominal injuries are equally represented, but the majority of studies point out that in farm tractor drivers with fatal outcomes head injuries are the most common (7,13-16). When interpreting these results, it should be borne in mind that almost all agricultural machines in our country, including farm tractors, are over twenty years old and that they do not have rollover protective structure system, which is present in almost all farm tractors used in developed countries. Also, in our country, farm tractor drivers are usually elderly people, in whom all injuries, including bone fractures (and most commonly rib fractures) are produced with much less force, compared to other age groups. Rib fractures are among the most common lung injuries in traffic participants and are often associated with lung tissue injuries (20). The most common cause of death for farm tractor drivers in our study was bleeding out, which occurred after aortic rupture. In situations of farm tractor overturning and pinning the driver to the ground and causing pressure in the chest area, injuries such as serial rib fractures and aortic rupture are inevitable. The occurrence of aortic rupture is explained by several mechanisms: due to a sudden increase in blood pressure, water-hammer effect, stretching of the aortic wall, or pressure on the aorta due to compression of the chest between the sternum and the spinal column (21). In our study, the mechanism of aortic rupture was thoracoabdominal compression during rollover, due to the pressure of farm tractor parts or implements on the body of the farm tractor driver. This mechanism explains the occurrence of rib fractures and lung tissue damage in the form of contusions and lacerations.

Most of the farm tractor drivers in our study died on the spot and within the first few hours after the accident (82%), while only a small number survived injuries for some period of time (18%). Thus, a large percentage of participants who had died on the scene can be explained by the presence of thoracic injuries such as: bleeding from damaged intercostal arteries and the aorta, the breathing disorder due to fractures of the ribs and/or compression of the thorax. An additional factor that accelerates the onset of death and aggravates all of the aforementioned injuries is the age of the participants (19,22), as evidenced in our study. It should also be noted that farm tractor drivers are often isolated on fields or in

forests, sometimes in inaccessible places, which makes it impossible to provide first aid in a timely manner and transport them to the appropriate health care facility. In other studies, similar results were reported for those who died on the spot and in the first 24 hours; in the study in Portugal (18) about 65%, in Turkey (6) about 79%, in Croatia (4) about 81%, and in Poland (10) about 85%. In participants who outlived the injuries for a certain period of time, complications such as pneumonia and sepsis were the immediate cause of fatal outcome.

About one third of the farm tractor drivers in our study were under the influence of alcohol. In a study conducted in Portugal (18), one in four fatally injured farm tractor drivers was under the influence of alcohol. Many studies confirm that alcohol is a leading risk factor for work-related injuries (23,24) as slightly intoxicated people and people under the influence of alcohol tend to become more daring, bolder and inclined towards making poor decisions. The higher frequency of drunk farm tractor drivers in our country can be culturally explained, given that drinking alcoholic beverages in our region has been traditionally accepted and culturally approved.

CONCLUSION

Farm tractor drivers are among the least represented fatalities in road traffic accidents in the Kragujevac area with its surroundings. They belong to the group of oldest participants with an average age of about 61 years and are mostly male. They most often die in road accidents from May to September, during the season of the most intensive agricultural work. In farm tractor drivers the most common chest injuries are the following: rib fractures and lung injuries, and the most common causes of death are bleeding and breathing disorders as a result of farm tractor overturning. They were more likely to die on the spot, than to outlive the injury. About a third of the farm tractor drivers were under the influence of alcohol.

High mortality of farm tractor drivers can be reduced by introducing a mandatory Rollover protective structures system, by using seat belts in farm tractors with cabs, which would reduce the possibility of the driver dropping out of the farm tractor seat and subsequent injury due to rollover, as well as continuous education of the population.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethical Committee of the Clinical Centre of Kragujevac (18/10/2016, No 01/13221).

FUNDING

None.

CONFLICT OF INTEREST

None.

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