

Death Cases Related to Tractor Overturns

Traktör Devrilmeleri Sonucu Ölümler

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ABSTRACT Objective: Farm tractors are not only used as farm machineries but also as communication and transportation machineries in Turkey where agricultural production plays an important role. Tractor overturns end up with casualties especially if the structurally off-balanced tractor has no rollover protection structures (ROPS) or seatbelts. Serious manpower and economical losses also result from these kinds of accidents. **Material and Methods:** In this paper, all forensic death examination reports, autopsy reports and witness statement reports obtained in city center of Kastamonu between January 2004 and July 2009 were examined and evaluated statistically. **Results:** We observed 601 death cases during this period and found that 42 (6.98 %) of them were related to tractor overturns, 92.86 % of the cases were males and 7.14% of them were females. The range of age was between 17-80 years. 19.04 % of the victims were passengers while the remaining were drivers. Most of the events (52.80 %) have occurred on the roads. In a high percentage (54.76 %) of the cases, cause of deaths was determined as chest trauma while abdomen, neck and head traumas were also observed in some cases. **Conclusion:** Although tractors are the most frequently used machineries in agricultural production of Turkey, casualties of tractor overturns do not attract much attention. These casualties are not negligible and necessary agricultural engineering strategies should be implemented immediately to prevent these unexpected accidents.

Key Words: Agriculture; cause of death; accidents, occupational

ÖZET Amaç: Tarımsal üretimin önemli bir rolünün olduğu Türkiye’de traktörler, tarım makinele-ri olarak kullanılmalarının yanında iletişim ve taşıma araçları olarak da kullanılmaktadır. Traktör devrilmeleri özellikle yapısal olarak dengesiz traktörlerde devrilme önleyici yapılar (ROPS) veya emniyet kemeri bulunmadığı durumlarda ciddi sonuçlara yol açabilmektedirler. Bu tür kazalar aynı zamanda ciddi ölçüde işgücü ve ekonomik kayıplara yol açarlar. **Gereç ve Yöntemler:** Bu çalışmada Ocak 2004-Temmuz 2009 tarihleri arasında Kastamonu il merkezinde adli ölüm raporları, otopsi raporları ve tanık ifade tutanakları incelenerek istatistiksel yöntemlerle değerlendirildi. **Bul-gular:** Bu dönemdeki 601 ölüm olgusundan 42’si traktör devrilmesine bağlıydı, bunların %92.86’sı erkek, %7.14’ü kadındı. Yaş dağılım aralığı 17-80 yıl idi. Ölenlerin %19.04’ü yolcu, kalanı sürü-cüydü. Çoğu kaza karayolu üzerinde gerçekleşmişti (%52.80). Olguların çoğunluğunda (%54.76) ölüm nedeni göğüs travması iken karın, boyun ve kafa travması daha seyrek olarak gözlenmişti. **So-nuç:** Traktörler Türkiye’de en yaygın kullanılan tarım aletleri olmalarına karşılık traktör devril-melerinden doğan kayıplara yeterince ilgi gösterilmemektedir. Bu gruptaki kayıplar ihmal edilebilir düzeyde değildir ve bu kazaları önlemek için gerekli tarım mühendisliği stratejileri acilen uygula-maya konulmalıdır.

Anahtar Kelimeler: Tarım; ölüm nedeni; kazalar, iş

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In this century, the agricultural industry and related occupations had the highest worker rates of all private industries in Turkey. Total numbers of households are 6 189 351 and households engaged in agricul-

tural activity are 4 106 983. Although there are some studies about farmer fatalities concerning pre-event, event, and post-event phases of the fatal incident or dying of agricultural workers on the scene as a result of being crushed, there are only few studies in literature regarding tractor overturns.¹⁻⁵

Kastamonu is located in the Western Black Sea Region. The neighboring cities of Kastamonu are Sinop in East, Corum in Southeast, Cankırı in South, Karabuk in West and Bartın in Northwest. Its boundaries reach Black Sea in North and mountainous district in the south. This city with profound historical roots has very hilly grounds. It is located in an area of 13.108 square kilometers. 74.6 % of the total area of Kastamonu is mountainous and forested, while 21.6 % is plateau and 3.8 % is plain. Regarding the vehicle allocation, 22 631 of vehicles in Kastamonu are automobiles while 19 803 of 56 880 total vehicles are farm tractors. Kastamonu is the second highest city with 1091 settlements. Number of households engaged in agricultural activity in Kastamonu is 60 522.

Structurally off balanced farm tractor overturns cause death especially if the driving console is not properly protected. Tractor overturn is one of the major risks in agriculture. In an overturn, if the driver is not adequately protected, the accident can cause serious injuries or even death.⁶ The health insurances of farmers cover the lost only if the accident occurs while performing agricultural activity.⁷ Because of this, tractor overturns being as an industrial accident, are another important matter for farmers.

The main objective of this paper is to emphasize the frequency and the reasons of deaths from farm tractor overturns which are used by most of the farmers in Turkey. It is also intended to emphasize the preventative instruments to be initiated to avoid fatalities caused by tractor overturns. We hypothesized that most of the victims in the fatal cases of tractor overturns who were not equipped with a rollover protective structure (ROPS) had been crushed and died at the scene and could not be transported to the hospital alive to receive medical treatment. Serious manpower and eco-

nomical losses also result from these kinds of accidents.

MATERIAL AND METHODS

In our study, 601 forensic inspections and autopsy reports and obtained reports from incident scene investigation recorded between January 2004 and June 2009 by Kastamonu Chief Public Prosecutor's Office were investigated retrospectively. 42 cases, which were caused by overturns of farm tractors are discussed regarding the relevant information about gender, age, incident scene, medical response, distribution according to seasons, the time of event (day or night), mechanical factors of tractors, pre-existing health conditions and causes of deaths. The statistical package program SPSS (Statistical Package for Social Science) was used to analyze the data. Descriptive statistics and chi-square test were used. Level of significance was taken as 0.05.

RESULTS AND DISCUSSION

In Turkey the number of farm tractors involved in accidents is more than the number of the other farm machineries. Tractor accidents generally occur as falling down from tractor, ramping of tractor, heeling of tractor and crash with other vehicles. Regarding pre-event factors of tractor accident, the most frequently seen type is overturns. All of the incidents we examined in our study only overturn cases.⁸

Tractor accidents are examined by conditions surrounding the fatal incident, pre-event, event, and post-event activities. Conditions surrounding the fatal incident include environmental factors, human factors, mechanical factors, equipment type, location, farm production type, weather, work experience, pre-existing health condition, and decedent's employment classification. Pre-event activities include initiating action. Activities during event include injury event and outcome. Post-event activities include medical response, cause of death, and intervention.

The association obtained from cross tabulation of death reason and distribution of deaths according to years and cross tabulation of seasons and age,

cross tabulation of seasons and crime scene year and crime scene were not statistically significant ($p>0.05$).

We saw 7 deaths from overturn among 97 deaths in 2004, 6 deaths from overturn among 103 deaths in 2005, 8 deaths from overturn among 96 deaths in 2006, 10 deaths among 129 deaths in 2007. 7 deaths among 145 deaths in 2008, 4 deaths among 31 deaths in the first half of 2009. Totally 42 of 601 (6.98 %) deaths have been recorded as tractor overturns by Kastamonu Chief Public Prosecutor's Office (Table 1). Regarding the gender, all but three of the losses were male (92.86 %).

In our study, with regard to gender, thirteen of incidents (92.86 %) included males and only three of them (7.14%) included females. In a research conducted in Sivas, another city of Turkey, 80.3 % were male, 19.7 % were female.⁹ As there was only one driver on tractors in the majority of the accidents during an overturn, higher male percentage was detected in our study. The mean age of the victims was 17.27 ± 46.80 years, ranging from 17 to 80 years. The youngest case in our study was a seventeen years old man while the oldest one was an eighty years old man. Eight (19.04 %) of our cases were between 20-29 years and nine (21.42%) of them were between 50-59 years (Table 2). In Sivas-research persons between ages of 20-29 (21.3 %) made up the most effected group,⁹ which is different from our study. The age range of the people in tractor accidents was similar to other agricultural accidents. This may indicate the lack of proper work safety education and lack of care about precautions of the people in agricultural activity in our country.¹⁰

TABLE 1: Distribution of deaths according to years.

Years	Total Number of Death	Deaths of Overturns	%
2004	97	7	7.21
2005	103	6	5.82
2006	96	8	8.33
2007	129	10	7.75
2008	145	7	4.82
2009 (6 month)	31	4	12.90
Total	601	42	6.98

TABLE 2: Distribution of deaths according to age.

Age (year)	Death numbers	Age specific death percentages %
Below 10	0	0
10-19	2	4,76
20-29	8	19.04
30-39	5	11,90
40-49	8	19.04
50-59	9	21.42
60-69	7	16,66
Above 70	3	7,14
Total	42	100,0

Eight of the cases (19.04%) were passengers and 34 of them (80.96%) were drivers. Total tractor accidents were 96 in Kastamonu and ratio of overturns to tractor accidents was 43.75%. Both passengers and driver died in two cases. Male and female have died together in one of the cases. Autopsy was performed in three of the cases. In Sivas research 49.2 % of the cases were passengers and 34.4 % of them were drivers. 39.3 % of the incidents occurred as tractor overturns, while 21.3 % of casualties caused by falling down from tractor.⁹ The reason of high percentage of driver deaths and overturn in our study was the bumpy structure of the agricultural area of Kastamonu and the occurrence of the incidents on the way (Table 3).

Most of the events (52.80 %) occurred on roads while eleven of the accidents (26.19%) occurred during farming in farms or gardens. One of the cases occurred in the forest and in front of the house. The places of the other events were not known. But according to cross tabulation analysis between crime scene and year no statistically significant differences were seen ($p> 0.05$), (Table 3). In most of the cases in our study, police and gendarme were firstly called and arrived to the scene. In a few cases emergency medical services arrived to the scene first. Most of the victims in the tractor overturns in Kastamonu had been crushed and died at the scene before the arrival of the police to the scene and could not be transported to the hospital alive to receive medical treatment. Fifty-seven percent of the victims (24 cases) were declared as "dead at the scene". Sixteen percent of them (7

TABLE 3: Frequencies of factors contributing to tractor overturn fatalities according to year and crime scene.

Year	n (%)	Crime scene			Total
		Deaths on the road	Deaths on the farm or garden	Death in the forest	
2004	Count	4	2	0	6
	% within crimescene	18.2	18.2	.0	17.1
2005	Count	2	3	0	5
	% within crimescene	9.1	27.3	.0	14.3
2006	Count	4	1	0	5
	% within crimescene	18.2	9.1	.0	14.3
2007	Count	7	2	1	10
	% within crimescene	31.8	18.2	50.0	28.6
2008	Count	2	2	1	5
	% within crimescene	9.1	18.2	50.0	14.3
2009	Count	3	1	0	4
	% within crimescene	13.6	9.1	.0	11.4
Total	Count	22	11	2	35
	% within crimescene	100.0	100.0	100.0	100.0

There were 7 missing cases about crime scene so total number of cases were 35 on Table 3.

cases) died before medical intervention. Cardiopulmonary resuscitation (CPR) was applied to twenty-six percent of the cases (11 cases) and 6 of them died after CPR and 5 of them died later at the hospital. Tractor overturns were found to be associated mostly with the “dead at the scene” injury outcome.¹¹⁻¹³ Thirty eight of the accidents (90.47%) occurred in the daytime and 3 (7.14%) of the accidents occurred at night. One of them was unknown (Table 3). Distributions of the cases according to seasons were as follows: 20 cases in spring, 8 cases

in summer, 12 cases in autumn, and 2 cases in winter. We saw that the majority of the cases (32 cases) were declared dead in spring and autumn but cross tabulation analysis between seasons and age revealed no statistically significant differences and also no statistically significant differences were seen between distribution among seasons and crime scene ($p > 0.05$), (Tables 4 and 5).

The causes of death were determined according to external inspection and medical records of the cases that received medical treatment at the

TABLE 4: Distribution of deaths according to seasons and crime scene.

Season	n (%)	Crimescene				Total
		Deaths on the road	Deaths on the farm or garden	Deaths in the forest	unknown	
Spring	Count	11	7	0	2	20
	% within crime scene	50.0	63.6	.0	28.5	51.4
Summer	Count	6	0	0	2	8
	% within crime scene	27.3	.0	.0	28.5	17.1
Autumn	Count	5	3	2	2	12
	% within crime scene	22.7	27.3	100.0	28.5	28.6
Winter	Count	0	1	0	1	2
	% within crime scene	.0	9.1	.0	14.2	2.9
Total	Count	22	11	2	7	42
	% within crime scene	100.0	100.0	100.0	100.0	100.0

There were 7 missing cases about crime scene

TABLE 5: Distribution of deaths according to seasons and age.

Age (year)	n (%)	Season				Total
		Spring	summer	autumn	winter	
under 19	Count	1	1	0	0	2
	% within age	50.0	50.0	.0	.0	100.0
20-29	Count	6	1	0	1	8
	% within age	75.0	12.5	.0	12.5	100.0
30-39	Count	2	0	3	0	5
	% within age	40.0	.0	60.0	.0	100.0
40-49	Count	4	1	3	0	8
	% within age	50.0	12.5	37.5	.0	100.0
50-59	Count	5	1	1	1	8
	% within age	62.5	12.5	12.5	12.5	100.0
60-69	Count	1	2	4	0	7
	% within age	14.3	28.6	57.1	.0	100.0
above 70	Count	1	2	1	0	4
	% within age	25.0	50.0	25.0	.0	100.0
Total	Count	20	8	12	2	42
	% within age	47.6	19.0	28.6	4.8	100.0

hospitals. The causes of death in cases treated at hospitals were determined according to external inspection and medical records. In twenty-four cases (57.14%), the cause of death was declared as chest trauma, while neck, head and abdominal traumas were also observed in some cases. Chest traumas alone were observed in twelve cases (28.57 %). Head traumas were seen in nineteen cases (45.23 %), and head traumas alone were also observed in sixteen cases (28.57 %). Head and chest traumas were seen in five cases (11.90%). Isolated abdominal traumas were not detected. Only in three cases abdominal traumas were seen with chest traumas as a result of overturns in our study. There were no statistically significant differences between distribution of death causes and years ($p>0.05$), (Tables 6 and 7). In Sivas research, in 55.6 % of accidents, fractured skull and/or intracranial lesions were detected.⁹ In Kentucky research, almost one-third of the victims have died of crushing injuries and one-fifth of the victims died of head injuries.¹⁰ These results are also similar with our study. In Diyarbakır research, also head injury was detected as the most frequent cause of mortality related to traffic accident.¹¹

TABLE 6: Distribution of death reason.

	Number of Death	Percentage %
Chest traumas	12	28.57
Chest and head traumas	5	11.90
Chest and neck traumas	4	9.52
Chest and abdominal traumas	3	7.14
Head traumas	16	38.09
Head and neck traumas	1	2.38
Neck traumas	1	6.98
Total	42	100

Serious manpower and economical losses result from these kinds of accidents. It was announced that in Iowa State of United States of America the cost of fatal tractor accidents was at least 7 250 000 USD per year.¹² According to a research conducted in England, regarding the non-fatal accidents in the distribution of expenditure, thirty-three of 791 accidents were tractor overturns and average expenditure was 4 486 Dollars per accident, 6 of them involved tractors with power take-off and average expenditure was 488

TABLE 7: Distribution of death reasons according to years.

Year	n (%)	Chest	Neck	Head	Abdomen
2004	Count	1	1	1	1
	% within chest	16.7	16.7	33.3	33.3
2005	Count	1	1	0	0
	% within chest	16.7	16.7	.0	.0
2006	Count	2	2	1	1
	% within chest	33.3	33.3	33.3	33.3
2007	Count	1	1	1	1
	% within chest	16.7	16.7	33.3	33.3
2008	Count	1	1	0	0
	% within chest	16.7	16.7	.0	.0
2009	Count	0	0	0	0
	% within chest	.0	.0	.0	.0
Total	Count	24	6	6	3
	% within chest	100.0	100.0	100.0	100.0

Dollars per accident, in 67 other tractor accidents average expenditure was 1596 Dollars per accident. In the agricultural institutions in USA, the accidents involving tractors and other agricultural machineries take an important place.¹³ Especially, the accidents of tractors, lacking of the protective safety frame, are very important and must be kept foreground.¹⁴ We saw that almost all of the tractors no had any protective safety frames, seatbelts or cabinets in our country. Also we do not know exactly the economical losses resulting from these kinds of accidents in our country.

Tractors are generally safe machines. In a tractor having protective safety frame or cabinet, the driver might avoid the danger of being crushed under it. However, it could not be warranted that the driver will not swing and hit to the cabinet. Thus seatbelt is also compulsory.¹³ This enforcement must also be applied in Turkey. Nearly one third of tractor accidents occur because of off-balanced structure of tractors in literature. Balance problem generally occurs when the slope of the area is bigger than the overturn angle, in case of high speed, and inappropriate lands and losses of control of vehicle. Nearly one sixth of all tractor accidents occur when the slope is bigger than the overturn angle, while 10% occur when speed is

high, a small proportion occurs in an inappropriate land and twenty-two percent of the cases occur when the driver loses the control of the vehicle. Twenty six % of tractor accidents are due to the fallacy of driver foresight, while this percentage is nineteen in other traffic accidents.¹³ There are systems calculating the angle of the land and giving vocal warning while it is over the overturn angle. However since these systems are not used widely, the prevention of accidents totally rely on the experience of the driver. Over-encouragement of the tractor driver is another imprudence factor. A tractor overturn occurs in 1.5 seconds. It is almost impossible for a driver to prevent an accident no matter how experienced he/she is. The related regulations announced by European Union enforced that all tractors should be equipped with an appropriate ROPS. However, a protective structure raises the height of tractors, while it causes problems to work in height-restricted gardens. Due to this, farmers in Turkey either enfold or remove protective structures while taking the risk in a case of overturns.⁷

One-quarter of all the tractors had a rotary mower attached. Environmental factors such as operating the tractor at dusk, on eroded terrain or with poor visibility were infrequent. As might be expected, warm weather was reported in 23% of the reports; muddy terrain, rainy, wet and sunny weather were reported in 17% of the reports. Cattle were raised on the 36% of the farms and tobacco on 32% of the farms. Over half of all incidents occurred on a slope, hill, gully, ravine, or embankment.

Tractor accidents are examined by conditions surrounding the fatal incident, pre-event, event, and post-event activities in literature but we examined only tractor overturns including in pre-event activities. In Kentucky study, only fatal tractor injuries were examined whereas Browning et al. (1998) examined nonfatal farming injuries in older farmers.¹⁴

We learned from our study that agricultural engineering strategies, and reporting and recording of Fatality Assessment and Control Evaluation

(FACE) were not cited properly. So exactly, we could not conclude anything about pre-existing health condition, human factors, work experience, employment classification, equipment type, weather condition, and environmental factors of each accident. In literature, tractor fatalities are identified and quantified according to the narrative-based injury elements based on the FACE standardized format of a fatal injury report that incorporates Haddon's matrix. Each interviewer was asked about the pre-event, event, and post-event activities. The FACE evaluator determined how the host, the agent, the physical environment, and the social-cultural environment contributed to each phase of the tractor-related fatality.

Among New York farmers, the risk factors significantly associated with farm injuries were older age, joint trouble and hearing loss, working for long hours, being the farm owner/operator and operating a farm with larger gross sales.¹⁵ In the upper Midwest, the number of hours worked, operating an auger, growing field crops and male gender were found to increase the risk of farm machine-related injuries in a study that did not include tractors.¹⁶ In central Wisconsin, the number of hours worked, non-resident worker status, and cattle-raising increased the risk of machine-related injuries, including those related to tractors.¹⁷ In previous studies examining only tractor-specific injuries, mounting and dismounting the tractor,¹⁸ gender, age and a previous injury history,¹⁹ and lacking of a ROPS and seat belt^{20,21} were the factors most frequently associated with an increased risk for an injury. In Kentucky study, a tractor rollover and operating a tractor on a slope increased the odds of being crushed by the tractor by factors of 8.8 and 6.2, respectively. It has been estimated that nationally, half of the tractors are not equipped with a ROPS; in Kentucky, only 29% of the tractors have ROPS and half of all farming deaths are due to tractor rollovers.²² Part of the reason for the high number of rollovers may be the steep, hilly terrain in the eastern half of Kentucky.²¹ Also in our study, the steep, hilly terrain of the part of Kastamonu may increase turnovers when compared with other studies.

Additionally, buckets (front-end loaders) attached to the tractor increased the odds of being declared "dead at the scene" by a factor of 9.1. Front-end loaders are used on farms to transport food, manure, dirt, and other materials. When a heavy load is raised too high, the tractor's center of gravity and stability alters, increasing the risk of rollovers. In a study of Georgia farm tractor fatalities using death certificates, 75% of the fatalities were due to tractor rollovers.² Buckets attached to the tractor were not cited in our reports also.

The Georgia study,²³ does not report whether coroners determined the cause of death listed on the death certificate, whereas in Kentucky study,²² coroners were on the scene in 74% of the cases. In our study, police and gendarme were firstly called and arrived to the scene. In a few cases emergency medical services arrived first to the scene and forensic medicine specialist determined the cause of death.

In Kentucky study,²² beef cattle and tobacco, which are the predominant local agricultural products, were also the most common products raised on the farms where the tractor fatalities occurred. In Kentuckian farmers study,¹⁴ farms that raised beef cattle either alone or in combination with tobacco were at a significantly higher risk for farm injury. In Kastamonu forestry and wheat were the most common economical products of people. This contributes to higher risk for tractor accidents in Kastamonu. Browning et al. also found an elevated risk of injury for full-time farmers compared to part-time farmers.²² In our fatality reports, farmers' work experience was not cited.

Narrative text coding and analysis using keywords has been shown to be a sensitive and specific method for classifying injury information.²⁴⁻²⁶ Narrative text coding based on the Haddon matrix and the hazard scenario frameworks has been shown to provide a comprehensive analysis of the factors contributing to injuries in specific worker populations²⁷⁻³⁰ suggested that the use of narrative analysis of reports based on Haddon's matrix provided more comprehensive information on the human, organizational, and environmental factors con-

tributing to worker injuries.

FACE fatality investigation reports consist of an examination of the geographic location of the fatality, as well as interviews of witnesses, family, employers, coroners, and others. These added resources provide a more comprehensive analysis of the pre-event, event, and post-event phases of the fatality and targeted recommendations for the prevention of fatalities of a similar nature than coroner or police reports alone. We have to put agricultural engineering strategies into use to exactly determine the reasons of death.

Report development using victim name, type of fatality, time and location of incident, name, address, employer contact and phone number, name(s) of witness(s), and a short synopsis of the incident should be obtained. After the confirmation of a reported fatal injury as work-related, a site investigation should be initiated if the worker death occurred in the agricultural industry. Analyses of these factors lead to recommendations for prevention of future similar-nature incidents.³¹ Also health professionals especially emergency specialists have medico-legal responsibilities to reduce fatality in accidents.³²

Multiple source documents such as Occupational Safety and Health Administration (OSHA), medical examiner, toxicology, and police reports are examined, and manufacturers, distributors, engineers, organizations, associations, and governmental agencies should be consulted to develop recommendations for prevention. These recommendations are aimed at increasing knowledge,

changing work practices, and changing behaviors and attitudes of employers and employees.

We are asserting that the production of tractors in appropriate standards and the driving of tractors safely without neglecting the fact that they are motor vehicles, can prevent these unexpected accidents and consequently decrease the incidents of injuries and casualties to the least level. Fatality Assessment and Control Evaluation reports are valuable tools for the identification of additional factors contributing to tractor fatalities that can inform farm safety training, identify new areas for agricultural interventions, and support the development of new agricultural engineering strategies. We have to put into use agricultural engineering strategies to know more about agricultural tractor fatality and to prevent unexpected accidents.

CONCLUSION

This study contributes to the knowledge of tractor fatalities in Kastamonu one of the mountainous and forested cities and also the second highest city with 1091 settlements. Although tractors are the most common machineries in agricultural production of Turkey, accidents of tractor overturns do not attract much attention. Most of the victims in the tractor fatality with tractor overturns in Kastamonu have been crushed and died at the scene. These casualties are not negligible and necessary agricultural engineering strategies should be implemented immediately to prevent these unexpected accidents.

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