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Causal Factors in Thresher Accidents in Turkey

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Abstract

Farm machinery offers many benefits for the farmers; however, they present important occupational safety concerns when they are not designed and used safely. Previous studies in Turkey concentrated on accidents of farm tractors and general farm machinery. No study was available on thresher accidents which cause significant number of casualties and injuries in Turkey. Hence, the aim of this study was to investigate the thresher accidents to determine main causal factors towards reducing the accidents, fatalities, injuries and monetary losses. Data on thresher accidents were collected based on accident news. A total of 103 thresher accidents were identified between 2002 and 2017 of which 90 were on-field and 13 were on-road incidents. It was observed that fatality rate was very high at about 39.6%. Accidents were higher in some regions such as Central Anatolia region (28.2%) and Black Sea region (25.2%). Majority of the accidents were in summer months (77.7%). Most of the on-field accidents occurred as entanglement of body parts (63.3%) to thresher's moving parts followed by entanglement of clothes (16.6%) and fall into thresher (13.3%). The percentage of children with an age of less than 10 was considerable (13.0%). Safer material intake and safer power transmission designs are needed. Farmers need training on how to safely operate a thresher and how their clothing should be for safer work. Also, precautions are needed to distant children from work area of the threshers.

Key words: Agriculture, Machinery, Thresher, Safety, Accidents, Turkey

Türkiye'de Yaşanan Patoz Kazalarında Nedensel Faktörler

Özet

Tarım makineleri çiftçiler için birçok yarar sunmaktadır ancak güvenli bir şekilde tasarlanmadıkları ve kullanılmadıkları zaman önemli iş güvenliği riskleri ortaya çıkmaktadır. Türkiye'de yapılmış olan mevcut çalışmalar, tarım traktörleri ve genel tarım makineleri kazalarına yoğunlaşmıştır. Türkiye'de önemli sayıda ölüm ve yaralanmaya neden olan patoz (sapdöver harman makinası) kazaları hakkında bir çalışmaya rastlanmamıştır. Bu çalışmanın amacı; patoz kazalarında; kaza sayısı, ölüm, yaralanma ve maddi kayıpları azaltmaya yönelik nedensel faktörleri incelemektir. Patoz kazaları ile ilgili veriler kaza haberlerine dayanılarak elde edilmiştir. 2002 ile 2017 yılları arasında 90'ı arazide ve 13'ü yolda olmak üzere toplam 103 patoz kazası tespit edilmiştir. Kazalarda ölüm oranının %39,6 gibi yüksek seviyede olduğu görülmüştür. Kaza sayısı İç Anadolu Bölgesi (%28,2) ve Karadeniz Bölgesi (%25,2)'nde daha yüksektir. Kazaların büyük çoğunluğu (%77) yaz aylarında gerçekleşmiştir. Arazi kazalarının büyük çoğunluğu patozun hareketli parçalarına vücudun bir kısmını kaptırma (%63,3) şeklinde gerçekleşmiş ve bunu giysilerin kaptırılması (%16,6), patozun içerisine düşme (%13,3) takip etmiştir. Kazaya karışan 10 yaşından küçük çocukların oranı önemli seviyededir (%13). Daha güvenli ürün besleme girişi ve hareket aktarım sistemi tasarımı gereklidir. Çiftçiler daha güvenli patoz kullanımı ve daha güvenli çalışma için nasıl giyinmeleri konusunda eğitilmelidir. Ayrıca çocukların patoz çalışma alanından uzak tutulmaları için önlemler alınmalıdır.

Anahtar kelimeler: Tarım, Makine, Patoz, Güvenlik, Kaza, Türkiye

Introduction

Advances in science and technology affect the agricultural sector as well. Historically, many new technologies and applications have been observed in agriculture. One of them is the agricultural mechanization which is considered as one of the 20 greatest engineering achievements in the 20th century (NAE, 2018). Agricultural mechanization offers many benefits including timely application of the agricultural tasks, higher productivity, increased yield, higher quality products, new related subsidiary industries, etc. It has also some negative impacts such as increased fossil fuel consumption, air pollution from exhaust gases, higher rural unemployment rates and most importantly occupational safety concerns due to unsafe design and usage.

Agriculture is one of the risky sectors in terms of work safety along with construction and transportation (Paoli, 1992). A European survey revealed that 51%, 46% and 37.5% of the agricultural, construction and transport workers respectively feel themselves at risk while working (Paoli, 1992). ILO (2000) reports that the fatal accident rate in farming is double the average for all other industries in several countries. Risk factors affecting the farm workers include machinery, hazardous chemicals (pesticides, fertilizers, etc.), toxic, allergenic and carcinogenic substances, transmissible animal diseases, confined spaces (silos, tanks, etc.), noise, vibration, ergonomic hazards (unnatural body positions, repetitive work, etc.), extreme temperatures and contact with wild and poisonous animals (ILO, 2000). Among these, farm machinery including tractors and harvesters results in highest frequency and fatality rates of injury (ILO, 2000).

Agriculture is a crucial sector in Turkey having a population of about 76 million people (GTHB, 2013) and 820 billion USD Gross Domestic Product (18th largest economy in the world) (Aytop et al., 2014). With a total of about 24 million ha agricultural land (GTHB, 2013), Turkey ranked first in the world in the production of apricots, cherries, hazelnuts, figs and quinces and second in sheep milk, strawberries, leeks, sour cherries, honey and chestnuts based on 2011 figures (Aytop et al., 2014). Also, with an agricultural production of about 41 billion USD, the rural population constitutes about 29.0% of the total in 2013 (Aytop et al., 2014). One of the important problems in Turkish agriculture is that the average size of farm lands (5.9 ha) is small as compared to developed countries (17.4 ha and 18.0 ha in the EU and US, respectively) (Berk, 2013). Small farm size is a crucial constraint preventing the farmers to obtain modern machinery technologies to be used on the farm. Turkish Government put legal arrangements into effect to consolidate small lands and create bigger farm sizes.

A thresher is a crucial farm machinery especially in developing countries. It is mainly used to thresh agricultural products such as cereals (mainly wheat), beans, chick peas, lentils, hazelnuts, etc. In sloped lands and small fields where farmers cannot use combine harvesters and in the case there is not a mechanized harvester for the crop (like hazelnut), they harvest the crop by hand and let it dry and then use a thresher to separate the grain from straw and chaff. There are about 176 523 threshers in Turkey as of 2015 (Table 1). There are mainly two types of threshers powered by tractor PTO shaft or tractor pulley system (Figure 1). It is also common to see threshers powered by electric motors. Farmers feed the material from material feeding unit and the thresher separates the material into two parts as grain and chaff (Figure 1). In some models particularly for hazelnuts, vacuum feeding systems are also employed. The chaffs are used as animal feed. This machine is operated as stationary and has many moving parts such as PTO shaft, pulleys and belts. Accidents are common as entanglement of body parts or clothing to the moving machinery parts and resulting in injury or fatality. Another crucial risk factor is the involvement of children to the machinery parts.

Table 1. Numbers of some important farm machinery in Turkey (TurkStat, 2016)
Çizelge 1. Türkiye'deki bazı önemli tarım makinelerinin sayıları

Machinery ***Makine***	**2000**	**2005**	**2010**	**2015**
Farm tractors *Tarım traktörü*	941 835	1 022 365	1 096 683	1 260 358
Farm tractor trailers *Römork (tarım arabası)*	920 222	995 523	1 061 656	1 126 166
Combine harvesters *Biçerdöver*	12 578	11 811	13 799	15 998
Cotton harvesters *Pamuk hasat makinesi*	17	128	595	1 080
Threshers (hazelnut) *Patoz (fındık)*	5 587	5 851	5 309	5 687
Threshers (other) *Patoz (diğer)*	228 945	197 017	187 978	170 836
Threshers (total) *Patoz (toplam)*	234 532	202 868	193 287	176 523

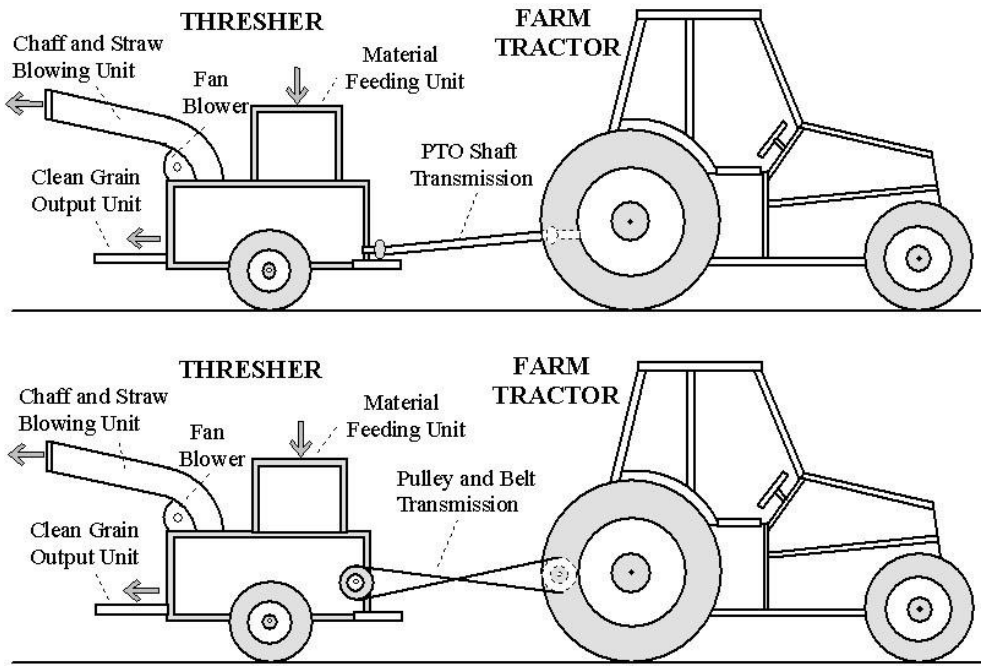

Figure 1. Threshers powered by tractor PTO shaft (top) and pulley system (bottom)
Şekil 1. Patozlarda kuyruk milinden şaft ile (üstte) ve kasnak ile (altta) güç iletimi

There have been a number of studies on agricultural machinery accidents in developed and developing countries including Turkey. However, most of the studies involved in the farm tractors and less concentrated on other machinery. Main data sources used by the researchers were:

- official accident reports recorded by law enforcement staff (mainly for traffic accidents on roads)
- social security and/or insurance records
- survey studies with the farmers who had accidents before (mainly face-to-face interviews)
- hospital records of killed or injured farmers after an accident
- forensic (autopsy) records of killed farmers after an accident
- media accident news reports (printed media or internet media).

There have been some studies on threshers mainly in East Asia. Verma et al. (1978) reported that about 73% of the thresher incidents in India's Punjab state were due to human factors while 13% machine factors and 14% crop and other factors. Nag and Nag (2004) mentioned that thresher accidents (14.6%) was second after tractor accidents (27.7%) on average of four regions of India and reported that due to high accident rates, Indian government legislated the Dangerous Machines Act (1983) for mainly safer feeding unit and PTO shaft shield but many threshers used in rural areas did not meet the safety requirements. Singh et al. (2005) studied 52 patients with wheat thresher injuries in India reporting the injuries of upper limbs most of which needed amputations and reporting the causes as poor lighting, unskilled workers, drug/alcohol abuse, fatigue, poor design and lack of orientation and cited the safety measures of improved design, education, legislation, compensation and surveillance. Manes et al. (2006) reported that thresher accidents were maximum (35.2%) compared to other farm machinery in India despite all efforts and observed that only 63.4% of the manufacturers used certified feeding chutes. Ahmad et al. (2013) reported that threshers are extensively used in Pakistan but they have low efficiency and they did redesign work and stated that manual crop feeding into thresher is the main cause of human accidents.

In Turkey, no study was found on thresher incidents; but, there have been a number of studies on farm tractor and machinery accidents. Golbasi (2004) studied 880 tractor and 1167 farm machinery accidents in 1990-2001 in Turkey and reported that among the machinery accidents, thresher incidents were third (12.8%) after trailers (24.3%) and ploughs (16.5%) while causing factors in all farm machinery accidents were of the human (74%), machinery (16%) and environment (10%) origin and the most significant accident types were entanglement of a body part (37%) and rollover (31%). Bulbul (2006) studied farm tractor and machinery accidents in Ankara province and reported that thresher accidents (16%) were third after farm trailers (29%) and ploughs (27%) and most important accident cause was human factor (carelessness) (62%). Görücü Keskin et al. (2012) studied tractor operator safety awareness in Hatay province and found that most major cause of the incidents was personal mistakes (60.4%) while only 13.5% of the operators had training on work safety even if 95.1% mentioned that accidents could be declined by training. Oz and Cakmak (2014) studied 217 farm machinery accidents excluding tractors based on media news reports in Turkey and reported that most accidents were related to threshers (35.5%; 77 of 217) and silage machinery (26.7%; 58 of 217) and most frequent accident type was entanglement of arm or hand (47.9%; 104 of 217) and foot or leg (25.3%; 55 of 217) as most important cause was carelessness (33%) followed by maintenance on running machinery (25%). Yildirim and Altuntas (2015) conducted a survey study in Tokat province on 285 farm tractor and machinery accidents and found that the machinery which had most frequent accidents was soil tillage (54%) and harvesting machinery (22%) while the most important accident cause was operator carelessness (60%). Keskin et al. (2016) reported that between 2004 and 2013 in Turkey, yearly 1903 tractor accidents (79 fatal, 1201 injury) occurred on roads on average and about 40 drivers were killed and 504 drivers injured in these accidents. Saglam et al. (2017) carried out a survey study on 48 farm tractors and 40 machinery accidents (total 88) in Kayseri province citing that most frequent machinery accidents were sowing equipment (32.5%; 13/40), ploughs (20.0%; 8/40) and threshers (12.5%; 5/40). Arslan and Keskin (2017) studied 644 trailer attached two-wheel tractor (Patpat) accidents on roads in Turkey and reported that about two-thirds of the accidents were mainly in the form of crash/collision.

Literature review revealed that most of the previous studies in Turkey concentrated on accidents of farm tractors and all farm

machinery together. No study was available on only thresher accidents which cause significant number of casualties and injuries in Turkey. Thus, the aim of this work was to study the thresher accidents to find out main causal factors towards reducing the accidents, fatalities, injuries and monetary losses.

Material and Method

It is difficult to find official accident data on thresher accidents in Turkey. Hence, accident data on these accidents were collected based on accident news stories obtained from internet search. Different related search terms such as thresher (patoz, patöz), accident (kaza), killed (öldü), injured (yaralandi), hospital (hastane) were used on Google search engine. Accident news stories were identified and saved separately as word processing files (MS Word 2010). Then, the data were summarized in a spreadsheet program (MS Excel 2010). Accident data included accident time (year, month, day, time), accident place (region, province, city, road, field), accident type, accident cause, injured body part, health status of the victim (dead, injured) age and gender of the victim, etc. Data were tabulated and graphed in the spreadsheet program.

Results and Discussion

Number of Accidents and Victims

A total of 103 thresher accidents were identified between 2002 and 2017 in whole country Turkey (Figure 2). 70 people were injured and 46 people were killed making the total number of victims 116. Fatality rate was found to be very high at about 39.7% (46/116) while the number of victims per accident was found to be 1.13 (116/103). Regarding the accident place, 13 out of 103 accidents occurred on roads (12.6%) while remaining 90 accidents were on field (87.4%) while working. All of the on field accidents involved only one person while some of the on-road traffic accidents involved multiple victims. On-road accidents occurred while transporting the thresher from one place to another while pulled behind a tractor or carried on a truck. As regard to the crop type threshed in the machinery, the data were available in 60 of the incidents. The crops were cereals (40.0%) followed by animal feed material (straw, clover, grass, etc.) (20.0%), hazelnut (15.0%), pulses (lentil, bean, chickpea) (13.3%), corn (6.7%) and herbal and aromatic crops (5.0%).

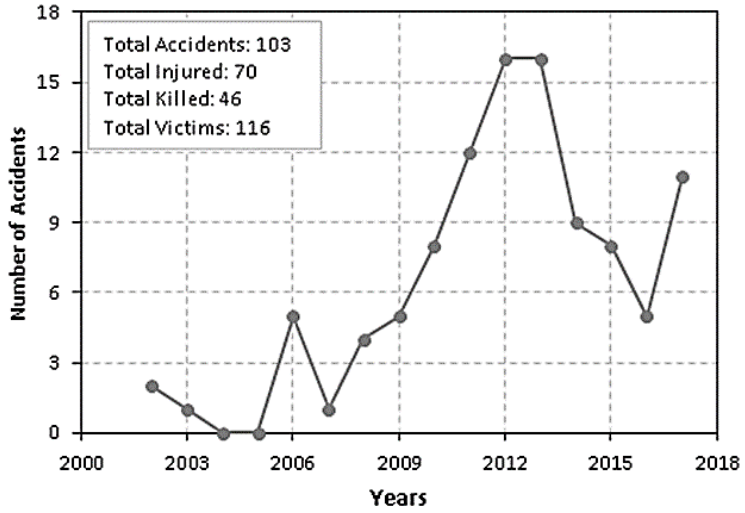

Figure 2. Number of thresher accidents and victims according to years in Turkey
Şekil 2. Türkiye'de yıllara göre patoz kazaları ve kazazede sayılar

Place of the Accidents

Turkey has seven geographical regions and 81 provinces. Concerning the regions, most of the accidents occurred in Central Anatolia region (28.2%; 29/103) followed by Black Sea region (25.2%; 26/103) and East Anatolian region (14.6%; 15/103). As of the provinces, Konya province (7.8%; 7/90) had more on-field accidents followed by Samsun, Sivas and Kayseri provinces each of them having same amount of accidents (5.6%; 5/90). As of on-road accidents, Ordu province had more accidents (23.1%; 3/13) than the other provinces.

Timings of Accidents

Regarding the accident timings, most of them took place in summer months (77.7%) mostly in July (35.0%; 36/103), August (23.3%; 24/103) and September (19.4%; 20/103) (Figure 3). This time period corresponds with the harvest time of cereal grains. As of the accidents days, it was observed that the accidents occurred slightly more on week days (13.3% to 17.3%) compared with the weekends (10.2% to 14.3%). Most of the accident news stories did not have accident timing data; thus, only the ones that had this data were considered. Based on this, on-field accidents occurred mostly in the evenings (36.4%; 8/22) and mornings (22.7%; 5/22) while the on-roads traffic accidents took place more at night (50.0%; 2/4).

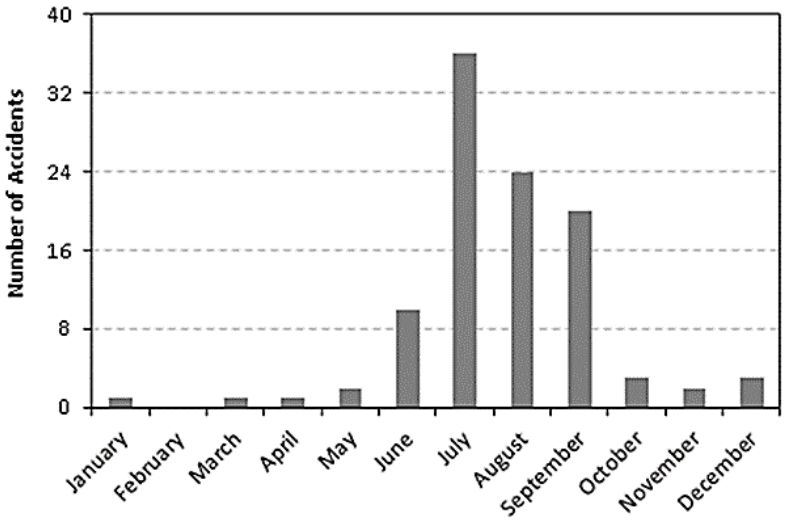

Figure 3. Number of thresher accidents according to months in Turkey
Şekil 3. Türkiye'de aylara göre patoz kazası sayıları

Types and Causes of Accidents

Most of the on-field accidents occurred as entanglement of body parts (63.3%) to thresher's moving parts followed by entanglement of clothing (15.6%) and fall into thresher (13.3%) (Table 2). Among all accident types, most fatal one was fall into thresher accidents in which all of the victims lost their lives (Table 2). Percentages of the harmed body parts in on-field thresher accidents are presented on Figure 4. Most common entangled body parts in on-field accidents were arms (36.8%) and hands (35.1%). Three main on-field accident causes were carelessness (60.5%), loss of balance on the machine (28.9%) and machinery related (10.5%). Therefore; safer material intake and power transmission design is needed. Farmers need training on how their clothing should be for safer work. This means that 89.5% of the causes were human origin as 10.5% were machine related. Regarding the on-road traffic accidents, most common accident types were crash / collision (46.2%), machine rollover on the victim (30.8%) and running off road (15.4%) (Table 2).

Table 2. Accident types in thresher accidents in Turkey
Çizelge 2. Türkiye'deki meydana gelen patoz kazası türleri

Accident Place *Kaza yeri*	**Accident Type** *Kaza türü*	**Fatal** *Ölümlü*	**Injury** *Yaralanmalı*	**Number** *Sayı*	**Ratio** *Oran*
On-field accidents *Arazi kazaları*	Entanglement of body parts *Vücudun bir bölümünü kaptırma*	9	48	57	63.3%
	Entanglement of clothing *Kıyafeti kaptırma*	10	4	14	15.6%
	Fall into thresher *Patozun içine düşme*	12	0	12	13.3%
	Impact of separated machine part *Makine parçası fırlaması*	4	0	4	4.4%
	Machine rollover on the victim *Makinenin üzerine devrilmesi*	1	1	2	2.2%
	Fall from machinery *Makine üzerinden düşme*	1	0	1	1.1%
		37	**53**	**90**	**100**%
On-road accidents *Yol kazaları*	Crash / collision *Çarpma / çarpışma*	3	3	6	46.2%
	Machine rollover on the victim *Makinenin üzerine devrilmesi*	3	1	4	30.8%
	Run off road *Yoldan çıkma*	1	1	2	15.4%
	Seperation from tractor *Traktörden ayrılma*	1	0	1	7.7%
		8	**5**	**13**	**100**%

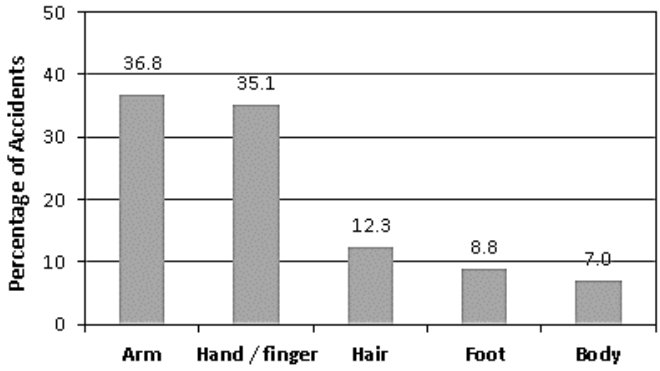

Figure 4. Percentages of the harmed body parts in on-field thresher accidents
Şekil 4. Patoz arazi kazalarında yara alan vücut bölümlerinin oransal dağılımı

Age and Gender of the Victims

In on-field thresher accidents, gender data of the 82 victims out of 90 were available. Among these, 74.4% of the victims were male while 25.6% of them were female. In on-road traffic accidents, gender data of the 10 victims out of 27 were available and all of the victims were male. Regarding the age groups of the victims in on-field accidents, most of the victims were in 31-40 (19.5%) and 41-50 (19.5%) age groups (Table 3). Only one victim was over 71 years old. One of the important safety concerns in agricultural works is the involvement of children and youth in the accidents. In this study, the percentage of children with an age of less than 10 was considerable with the ratio of 13.0%. Young and usually inexperienced

workers are also likely to have accidents. The ratio of young workers with an age of between 11 and 20 was also substantial with the ratio of 16.9%. On the other hand, a crucial factor in saving a victim's life is how the victim is brought to hospital. Data were available in 47 of the accidents and in about half of the incidents (51.1%), the victims were brought to hospital by their relatives, neighbors or friends while the emergency health crew helped the victims in 48.9% of the cases.

Table 3. Age distribution of the victims in thresher accidents in Turkey
Çizelge 3. Türkiye'deki patoz kazalarına karışanların yaş dağılımı

Age *Yaş*	**Male** *Erkek*	**Female** *Kadın*	**Unspecified** *Belirsiz*	**Total** *Toplam*	**Ratio** *Oran*
<10	8	2	0	10	13.0%
11-20	8	4	1	13	16.9%
21-30	6	3	0	9	11.7%
31-40	11	3	1	15	19.5%
41-50	12	2	1	15	19.5%
51-60	6	4	0	10	13.0%
61-70	2	2	0	4	5.2%
>71	1	0	0	1	1.3%
Total *Toplam*	**54**	**20**	**3**	**77**	**100%**

Conclusions

The aim of this study was to investigate the thresher accidents to determine main causal factors towards reducing the accidents, fatalities, injuries and monetary losses in Turkey. Main findings and conclusions of the study were as follow:

- Fatality rate was found to be very high at about 39.6%.
- Accidents were higher in some regions including Central Anatolia region (28.2%) and Black Sea region (25.2%).
- Majority of the accidents were in summer months.
- Most of the on-field accidents occurred as entanglement of body parts (63.3%) to moving parts followed by entanglement of clothes (16.6%) and fall-into-thresher (13.3%).
- The percentage of children with an age of less than 10 was considerable (13.0%).

Study results suggest that safer material intake and power transmission design is needed for threshers. Thresher manufacturers should be inspected for safer production of the machinery. In case of thresher intake clogging, farmers should not use their hands or feet to remove the clogging. PTO shaft cover must always be used to eliminate entanglements. Also, safety measures are needed in thresher operations especially in summer months and in the regions where the accidents are more dominant. Farmers need training on how to safely operate the threshers and how their clothing should be for safer work. Moreover, precautions are needed to distant the children from work area of the threshers. During the transportation of the machine on the road especially at night, the back side of the machine must have appropriate lighting and vehicle signs.

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