

# Analysis of injuries and causes of death in fatal farm-related incidents in Lower Silesia, Poland

Marta Rorat<sup>1</sup>, Agata Thannhauser<sup>1</sup>, Tomasz Jurek<sup>1</sup>

<sup>1</sup> Department of Forensic Medicine, Wrocław Medical University, Poland

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## Abstract

**Introduction.** Workers in the agriculture sector are among the groups at the highest risk of fatal occupational injuries. The aim of study is to show the most common causes of farm-related deaths in Poland, with the circumstances, injuries sustained and mechanisms of death.

**Materials and methods.** There were 109 (90.8%) males aged 19–81 and 11 females aged 19–73. 18.3% were over 60 years of age. There were 6 children (boys) aged between 2–6. A retrospective review was undertaken of 16,140 medico-legal autopsy reports by the Department of Forensic Medicine in Wrocław between 1991–2011, which included 120 fatal farm-related incidents. The study protocol included gender, age, date and cause of death, all injuries found, circumstances and mechanism of death, place of death and blood alcohol concentration.

**Results.** The most common (33/120; 27.5%) causes of death, both in men and women, were traffic accidents, the second being hit, crushed or buried by materials and falling objects. The most common injury was multi-organ damage (27/120; 22.5%), less common were cranio-cerebral injury (17/120; 14.2%) and thoracic blunt trauma (11/120; 9.2%). In multi-organ and thoracic traumas the mechanism of death was almost always exsanguinations. 85.3% of victims died at the place found. 37.2% of victims were drunk.

**Conclusion.** In Poland, fatal injuries occurring in agriculture are mostly related to the misuse of transport and machinery. The main efforts to prevent accidents are engineering improvements, use of personal protective equipment, alcohol intake prevention and appropriate education of the workforce. Special prevention programmes should take gender and age differences into account.

## Key words

agriculture, autopsy, trauma, child, transport

## INTRODUCTION

Workers in the agriculture sector among the groups at the highest risk when it comes to fatal occupational injuries. Long working hours, exposure to difficult weather conditions and using equipment and machines with a high potential for inflicting serious harm create an exceptionally dangerous working environment. Some workers are employed on a seasonal basis, often illegally and almost always with no safety training provided, which further increases the risk of accidents [1]. Farming is one of the few industries in which workers' families (due to sharing the workload and living on the premises) are also at risk of fatal injuries [2]. The majority of fatal farming accidents are caused by vehicles and machinery [3]. Farm tractors are known to be particularly deadly despite the introduction of prevention programmes. In Poland, even though the accident rate has recently declined, agriculture is still one of the most dangerous economic sectors. In 2010, the accident rate was 12.53 per 1,000 and the rate of fatal accidents was 0.16 [4]. Furthermore, official occupational statistics do not fully reveal the scope of injuries and deaths related to farming activities [5]. The aim of this study is to show the most common causes of farm-related deaths in Poland, with the circumstances, injuries sustained and mechanisms of death.

## MATERIALS AND METHOD

A retrospective review of 16,140 medico-legal autopsy reports by the Department of Forensic Medicine in Wrocław between 1991–2011, which included 120 fatal farm-related incidents (agriculture, forestry, fishing in breeding ponds) was undertaken. The methodology used by the Forensic Department provided to collect material contains much more data than the official statistics. The victims came from Lower Silesia – one of Poland's demographic regions. The legal definition was used of fatal agricultural death established as any unwitting injury resulting in death occurring during activity related to (work on the farm) agriculture, or in connection with the performance of these activities on the farm or off-site, as part of normal farm activities related to agricultural activity. All suicides and homicides were excluded. A standard study protocol included gender, age, date of death, cause of death and all injuries found, circumstances and mechanism of death, place of death (at the place found/in hospital) and blood ethyl alcohol concentration. All accidents were classified into 10 groups depending on their circumstances: 1) traffic accidents; 2) being caught or hit by moving parts of machinery or equipment; 3) environmental factors – extreme temperatures (hypothermia, fire), electrocution; 4) intoxication (not including alcohol-related deaths); 5) being hit or bitten by farm animals; 6. drowning; 7) falling from a height; 8) being crushed or buried by materials and falling objects; 9) deaths due to natural causes (not work-related), 10) others. Fatal injuries were classified by location: cranio-cerebral, thoracic,

Address for correspondence: Marta Rorat, Department of Forensic Medicine, Wrocław Medical University, J. Mikulicza-Radeckiego 4, 50-345 Wrocław, Poland  
E-mail: rorat.marta@gmail.com

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abdominal, spinal cord, limbs and multi-organ injuries (at least 2 from those listed above).

## RESULTS

A total of 120 occupational fatalities were identified between 1991–2011. 109 (90.8%) were males aged between 19–81 and the remaining 11 were females aged 19–73. There were 6 children (boys only) aged between 2 and 6. 18.3% people were over 60 years of age. The most common (33/120; 27.5%) causes of death, both in men and women, were traffic accidents – being run over or hit by a moving vehicle (tractor, trailer, combine-harvester, water cart, drill, horse-drawn carriage). The second most common cause (15/120; 12.5%) was being hit, crushed or buried by materials and falling objects. The third (11/120; 9.2%) most common farm-related cause of death was being caught or hit by moving parts of machinery or equipment. Less common causes (10/120; 8.3%) were intoxication (CO<sub>2</sub>, plant protection products), influence of extreme temperatures, drowning and being kicked by animals (horses). The deaths in children were due to drowning in a well, falling off or being run over by a tractor, cereal grain suffocation and caught in the shaft of the tractor power relay. Analysis revealed 24 (20%) deaths due to various severe or chronic diseases (mainly heart failure and stroke), in which no was found with the work being performed.

The most common injury found during the autopsies was multi-organ damage, which was reported in 27 cases. In 17 cases, the autopsy revealed isolated lethal cranio-cerebral injuries. Thoracic blunt trauma with heart and lung injuries (11 cases) were less common; in these cases, the mechanism of death was almost always exsanguinations and, in a few cases, asphyxia due to aspiration of foreign bodies or immobilization of the thorax. Abdominal injuries were found in 4 cases, typically with a burst liver or kidney, which caused fatal bleeding. In 2 cases, isolated fatal injuries to limbs were diagnosed. In the presented study, 85.3% of the victims died at the time of the accident – at the place found. 65.8 % of the accidents occurred between May – November. 37.2% (35/94 – not including deaths due to disease and isolated alcohol intoxication) of victims were drunk at the time of the fatal accident. In 16/35 of intoxicated people, blood ethyl alcohol concentration test (GCMS) revealed significant intoxication – over 2‰.

## DISCUSSION

Agriculture is one of the most hazardous industries. However, the number of death from farm injuries appear to have declined substantially over the last decade [6]. In 1999, according to data from the Polish Central Statistical Office, the accident rate was 11.87 per 1,000 and the rate of fatal accidents was 0.08. In the following years, the accident rate ranged from 10.7–13.86, and the rate of fatal accidents 0.08–0.21, respectively. Mortality in agricultural injuries increased between 1999–2010 [4].

According to the Polish Agricultural Social Insurance Fund (ASIF), Poland has seen a systematic decline in the number of accidents since the early 1990s. This is considered to be the result of numerous initiatives aimed at preventing accidents and occupational diseases, as well as the popularization of

knowledge about the risks associated with farming activities and safety principles. The structural changes implemented after Poland's accession to the European Union (the creation of large specialized modern farms, mechanization and automation of labour, abandonment of multi-production, reduction in the number of small farms) have also contributed to improved safety in farming [7]. In the presented study it was not possible to demonstrate the actual decline in the number of fatal accidents, which may be due to the relatively small number of deaths analysed, and the fact that the data used was collected in a single voivodship (region). However, it should be pointed out that the ASIF database only includes registered and insured farmers. In this study, the subject has been approached from a broader perspective, covering all people associated with farming, including seasonal workers. However, a significant change was revealed in the distribution of causes of death since 2003 – an evident decline in the number of transport-related accidents, followed by an increase in the number of deaths caused by materials and falling objects [7].

It is a well-known fact that the highest risk of fatal injuries, especially in males, is associated with machinery and tractors, which is confirmed by this study [8, 9, 10, 1, 12, 13, 14, 15]. The large number of people being run over can be attributed to the specific design of agricultural vehicles with big, uncovered wheels, and open cabs. Rollover accidents mainly occur while driving across rough terrain, as farm tractors typically have an inclined centre of gravity and a relatively narrow wheelbase. Farmers in particular are exposed to severe injuries when thrown out of the vehicle. The introduction of rollover protection structures (ROPS) with closed cabs for tractors has been one of the most important developments in recent decades [8, 9, 10, 11, 14]. The use of ROPS and seat belts have prevented death or serious injury in approximately 99% of tractor rollovers [10]. Other improvements concerned better personal protective equipment, guards for power take off shafts (PTO), guard rails to prevent falls, closed transfer systems for agricultural chemicals, and better animal control facilities [3]. The main cause of farm-related accidents in Poland is incorrect employee behaviour. The least common cause of injuries is an inappropriate condition of the material object/agent (e.g. machinery and equipment, tools, utility buildings). Most injuries occur as a result of falls, followed by being caught or hit by moving parts of machinery of equipment, or being hit, crushed or bitten by animals.

Despite increased awareness of the risks, the deteriorating economic situation of farms has had a negative impact on the working conditions in agriculture. The main human factors influencing the accident rate are ignorance or disregard of the risks, haste and stress, engaging the elderly and children in inappropriate types of work, an untidy workplace, cleaning, regulating and checking the operation of machines in motion, performing repairs without formal qualifications and equipment, lack of use of personal protection equipment, or working after drinking alcohol, which has been confirmed in this study. Other causes of accidents are: poor technical condition of vehicles (without ROPS), machines, tools and farm buildings. Self-made machines and equipment are also exceptionally dangerous [7, 13, 14, 16].

According to the literature, the most common farm-related fatalities mainly concern cranio-cerebral trauma. The most common occupational brain injuries are motor vehicle–



related, followed by those resulting from falls or contact with objects and equipment [17, 18]. In the presented study, blunt trauma with multi-organ damage followed by bleeding was a dominant cause. Brain injuries also accounted for a significant number of deaths. It is interesting is that in the presented material 2 accidents were found to have occurred inside grain storing equipment that were caused by a disregard for safety regulations and alcohol abuse. In both cases, the cause of death was asphyxia by aspiration of loose matter into the respiratory tract lumen [19]. In most of the cases investigated, due to the circumstances, mechanisms and extent of trauma sustained, there was no possibility of saving the victims' lives. Their injuries were inevitably fatal. Therefore, it must be concluded that more attention should be paid to the use of personal protective equipment, including helmets, in the most dangerous sectors.

Entire families involved in farm work, including the elderly and children, are constantly exposed to the hazards of farm equipment. Farms, as well as being places of work, are also places where people live and children play [6, 15, 20]. High-risk age groups include the 2–5 age group (confirmed by this study) as a result of very young children being surrounded by occupational hazards, and the 12–15 age group, which is due to child labour being used on family-run farms [6, 21]. Mothers under 25 years of age at the time of the child's birth and having more than 2 children were mentioned as independent factors associated with increased child injury mortality [21]. Many researchers focus on the danger resulting from the presence of children during field activities [6, 15, 20]. Pickett et al. [20] showed the leading mechanism of injury was becoming entangled in machinery, which was related to children helping their parents with field work or leaving them unsupervised. The second most common circumstances and mechanism of injury in the study was being run over by tractors and other agricultural equipment (forward and backward). One of the reasons for such accidents is the children being so small that they may not be visible to farm vehicle operators, especially in fields. Prevention systems, such as reversing sensors, rear view back-up cameras and a beep reversing signal are not very popular in Poland. Other less common accidents were a high risk of drowning and falls from a height.

Farming is one of the very few industries with no mandatory retirement age. Old age is the next risk factor of fatal injuries during farming [9, 15, 12, 22]. Voaklander et al. [23] proved that rates of injury were higher among the older (over 60) age groups. Detailed analysis revealed that older farmers were usually killed whilst performing everyday farming tasks, that most of them were owner-operators, and that many were working alone at the time of sustaining the injury. Older farmers might also be at higher risk of serious fatal injuries as a result of medical conditions, or simply because of natural processes related to aging – loss of hearing and vision, lack of coordination and adequate reaction time. This is also the reason why older people are less likely to survive traumatic injuries [22].

Gender is also an important factor in fatal farm injuries [5, 9, 23]. Dimich-Ward et al. [5] have indicated that older women are exceptionally exposed to the risk of accidents (over 60 years of age) and that most accidents were associated with tractors. In addition, more women were injured by farm animals. In the presented study, gender differences mainly concerned the number of fatalities – only 9.2%, 5/11 were over

age of 60. The most common cause of death in women was also related to vehicles; all 3 fatal animal-related accidents occurred between men and horses.

It is an important fact that almost 40% of all accidents analysed in this study took place due to ethyl alcohol intake. In 17% the alcohol concentration was so high that the victims should not have been working at all, let alone driving. A number of studies also indicate that one of the main risk factors of injuries in the workplace is alcohol intoxication, which is why special mechanisms to control work-related drinking practices should be implemented [24, 25].

The main causes of work-related accidents are inappropriate work organization and incorrect employee behaviour in line with a disregard for safety regulations [4]. The effectiveness of security procedures depends on the precise analysis of adverse events. The first step is to obtain detailed information about the accidents and their causes from different sources (as well as forensic medicine protocols, as in the presented study). The next step is an assessment of the scale of the problem and identifying the risk factors [17]. A safety system can only be implemented with thorough research.

## CONCLUSIONS

In Poland, fatal injuries in agriculture are mostly related to the misuse of transport and machinery. The most common cause of death is multi-organ injury. The main efforts to prevent accidents are engineering improvements, use of personal protective equipment and appropriate education of the workforce, especially migrant workers. Although alcohol abuse is common in Poland, alcohol intake prevention must be introduced. Special prevention programmes should take gender and age differences into account.

**Limitations:** The study is limited by the information available concerning the victims (part-time, full-time or migrant worker, the victim's condition during the accident) and the full circumstances surrounding the accident (e.g. using safety equipment). The presented material does not cover all fatal agricultural accidents that occurred in Lower Silesia. Some cases (number unknown) were not investigated by the Forensic Department Unit in Wrocław.

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