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Deaths Due to Log Crash: An Autopsy Study: A Retrospective Research

Tomruk Çarpmasına Bağlı Ölümler: Bir Otopsi Çalışması: Retrospektif Çalışma

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ABSTRACT Objective: The forestry sector is considered one of the most hazardous industries in terms of occupational accidents. Particularly in Artvin province, due to the region's challenging geographical conditions and intense forestry activities, logging injuries emerge as a significant risk factor. This study aims to retrospectively examine deaths resulting from logging injuries and to identify the characteristics of such accidents. **Material and Methods:** This study was conducted through a retrospective analysis of cases of death caused by logging injuries, where autopsies were performed by the Artvin Forensic Medicine Branch Directorate. The study comprehensively evaluated the demographic characteristics of the cases, the types of injuries, causes of death, and the circumstances under which the incidents occurred. **Results:** All of the 11 cases examined in the study were male, with an average age of 58.4 years. It was found that all of the deaths occurred in rural areas and that 90% resulted from blunt trauma due to logging impact. The most frequent injury sites were the head and neck (n=6), with the most common causes of death identified as brain tissue damage and intracranial hemorrhage. Additionally, it was determined that 54% of the cases occurred during the autumn season. **Conclusion:** The findings of this study highlight that logging injuries represent a significant occupational health issue, necessitating urgent preventive measures. Enhancing occupational safety training, promoting the use of protective equipment, and integrating technological innovations into work processes could be effective in reducing the incidence of such injuries and fatalities.

Keywords: Log; crash; injury; autopsy

ÖZET Amaç: Ormancılık sektörü, iş kazaları açısından en tehlikeli iş kollarından biri olarak kabul edilmektedir. Özellikle Artvin ilinde, bölgenin zorlu coğrafi koşulları ve yoğun ormancılık faaliyetleri nedeniyle tomruk yaralanmaları ciddi bir risk faktörü olarak öne çıkmaktadır. Bu çalışma, tomruk yaralanmaları sonucu meydana gelen ölümleri retrospektif olarak incelemeyi ve bu tür kazaların özelliklerini belirlemeyi amaçlamaktadır. **Gereç ve Yöntemler:** Bu çalışma, Adli Tıp Kurumu Artvin Adli Tıp Şube Müdürlüğü tarafından otopsisi yapılan ve tomruk yaralanması nedeniyle ölen olguların retrospektif olarak incelenmesiyle gerçekleştirilmiştir. Çalışma kapsamında, olguların demografik özellikleri, yaralanmaların türü, ölüm nedenleri ve olayların gerçekleşme biçimleri detaylı olarak değerlendirilmiştir. **Bulgular:** Çalışma kapsamında incelenen 11 vakanın tamamı erkek olup, yaş ortalaması 58,4 olarak bulunmuştur. Ölümlerin tamamının kırsal alanda meydana geldiği ve %90'ının tomruk çarpmasına bağlı künt travma sonucu gerçekleştiği tespit edilmiştir. En sık yaralanma bölgeleri baş ve boyun (n=6) olup, en yaygın ölüm nedenleri beyin doku harabiyeti ve beyin kanaması olarak belirlenmiştir. Olguların %54'ünün sonbahar mevsiminde meydana geldiği saptanmıştır. **Sonuç:** Çalışmanın bulguları, tomruk yaralanmalarının önemli bir iş sağlığı sorunu olduğunu ve bu tür kazaların önlenmesi için acil önlemler alınması gerektiğini göstermektedir. İş güvenliği eğitimlerinin artırılması, koruyucu ekipman kullanımının teşvik edilmesi ve teknolojik yeniliklerin iş süreçlerine entegre edilmesi, bu tür yaralanmaların ve ölümlerin azaltılmasında etkili olabilir.

Anahtar Kelimeler: Tomruk; kaza; yaralanma; otopsi

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The increase in production and competition in the industry brings along risks for worker health.[1] Foremost among these risks are occupational accidents occurring worldwide.[2] It is estimated that 318,000 people die from work-related accidents globally each year.[3] The majority of fatal occupational accidents occur in developing countries.[4,5]

The forestry sector is considered one of the most dangerous industries in terms of occupational accidents.[6] Unlike other sectors, many forestry workers are exposed to dense vegetation, challenging terrain, and extreme weather conditions while working outdoors. Human error under these hazardous conditions significantly increases the risk of accidents.

Logs are large pieces of timber obtained by cutting down trees and are typically used in the forest products industry. They can be utilized in construction, furniture making, paper production, and energy generation (as wood fuel). Logs from tree trunks can reach enormous sizes, up to 2 meters in diameter. Logging injuries account for 15% of all accidents and 1/4 of fatal forestry injuries.[7] In the U.S., the annual mortality rate from logging injuries is reported to be 23 times the average for all occupational accidents.[8] Although logging injuries are relatively infrequent, their fatality rate is higher than that of other occupational accidents. One study evaluated statistics published by the Social Security Institution and found that while the rate of non-fatal work accidents in all sectors in Türkiye was 2.5 times higher than that of forestry injuries, the fatality rate from logging injuries was 1.5 times higher than that of all work accidents.[7]

Logs can cause injuries and death by falling on people due to slipping or instability from heights. Injuries can also occur from contact with sharp tools during cutting or transportation. This study aims to retrospectively examine cases of death caused by logging injuries and autopsied by the Artvin Forensic Medicine Branch Directorate, assessing the causes of death and the characteristics of these injuries.

MATERIAL AND METHODS

Within the scope of the study, the cases autopsied by the Artvin Forensic Medicine Branch Directorate between 2019-2024 were retrospectively examined, and the cases that deaths due to log crash were included in the study. Autopsies conducted by the Artvin Forensic Medicine Branch Directorate were used to determine the causes of death, the nature of the injuries, the circumstances of the incidents, contributing factors, and possible preventive measures. The research aims to describe the characteristics of these injuries and propose preventive measures based on data obtained from examining injuries in Artvin and the surrounding areas. Data analysis was performed using the IBM SPSS version 26 software (IBM SPSS Statistics for Windows, IBM Corp., Armonk, New York, USA), and meaningful results were obtained through various statistical tests.

This study was discussed at the meeting of the Ministry of Justice, Forensic Medicine Institute Education and Scientific Research Commission dated August 06, 2024 and approved with the decision number 21589509/2024/916, and the study was carried out in accordance with the principles of the Declaration of Helsinki.

With the decision of Artvin Çoruh University Scientific Research and Publication Ethics Committee dated November 20, 2024 and numbered ‘E-18457941-050.99-157004’, it was determined that ‘approval of compliance with scientific research and publication ethics is not required’ for our study.

RESULTS

Autopsy reports of 209 cases autopsied by Artvin Forensic Medicine Branch Directorate between 2019 and 2024 were reviewed retrospectively. Out of these, 11 cases were determined to have resulted in death due to log crashes and were included in the study. All 11 cases evaluated in the study were male, with an average age of 58,4 years (minimum: 37, maximum: 88). All deaths (n=11) occurred in rural areas.

Examination by the location of the incident revealed that all deaths took place in rural settings. Eight cases resulted in death at the scene before reaching the hospital or receiving medical intervention, while 3 individuals died after treatment in the hospital. Of those who died after treatment, all were treated in the intensive care unit. Deaths occurred

TABLE 1: Demographic characteristics of the cases

Cases	Age	Gender	Year the autopsy was performed	Season	Month	Where the incident occurred
1	65	Male	2019	Autumn	10	Rural
2	65	Male	2020	Autumn	10	Rural
3	55	Male	2021	Spring	3	Rural
4	60	Male	2021	Summer	8	Rural
5	46	Male	2022	Spring	4	Rural
6	57	Male	2022	Autumn	9	Rural
7	56	Male	2022	Autumn	11	Rural
8	37	Male	2022	Winter	12	Rural
9	58	Male	2023	Summer	8	Rural
10	56	Male	2023	Autumn	11	Rural
11	88	Male	2024	Autumn	10	Rural

TABLE 2: Demographic characteristics, case history and autopsy findings of the cases

Cases	Case History	Autopsy Findings
1	He fell on a piece of log he had cut in the forest.	Popliteal artery rupture, tissue destruction in the left popliteal fossa, left tibia and rib fractures.
2	He fell on a piece of log he had cut in the forest.	Black head, deformity of the abdomen, scapula, right femur and rib fractures.
3	He was hit in the head by a log while in the forest.	Contusions and subarachnoid haemorrhage in the brain, base of skull, sternum and rib fractures.
4	A log fell on him while he was working at a sawmill.	Subarachnoid haemorrhage, skull base and rib fractures, right pneumothorax, corpus callosum separation.
5	He fell on a piece of log he had cut in the forest.	Laceration and bleeding in the left lung, fracture of the left tibia and fibula.
6	He fell on a log he had cut in his own garden.	Subarachnoid haemorrhage, lacerations to both lungs, C5-C6 vertebrae and rib fractures
7	He fell on a piece of log he had cut in the forest.	Subarachnoid haemorrhage, skull base fracture
8	A log fell on him from a loaded truck at work.	Subarachnoid haemorrhage, skull base fracture, pneumothorax, rib fracture
9	A log fell on him while he was in the vehicle.	Body split in 2 at L2 level, larvae in eye and nose, organ deficiency in abdomen, brain, pericardial and lung tissue injury, subarachnoid haemorrhage, C7 vertebral fracture.
10	While loading the logs in the workplace to the vehicle, the log fell on him.	Subarachnoid haemorrhage, cerebral contusion, intraventricular haemorrhage, C1-C6-C7 spine and rib fracture
11	Tree he cut down in the forest fell on him.	Subarachnoid haemorrhage, skull base fracture, pulmonary laceration, aortic rupture, rib fractures, C5-T4 vertebral fractures

most frequently in the autumn season, accounting for 54% of the cases (Table 1).

Autopsies and post-mortem examinations were performed on all cases to determine the exact cause of death. It was found that 10 of the cases suffered blunt force trauma due to log impact; one case involved a traffic accident caused by log impact.

Injury analysis indicated that that 6 of the cases had injuries to the head and neck, 3 to the trunk, 1 to the extremities, and 1 case had injuries to both the trunk and extremities. Bone fractures associated with log injuries were observed in all cases, with all fractures being multiple bone fractures. It was determined that 6 of the cases died due to brain tissue damage and cerebral hemorrhage, while other causes of death included internal bleeding, major vessel injury, pneumothorax, and internal organ injury (Table 2, Figure 1, Figure 2).

Toxicological analysis of blood, urine, and vitreous humor samples revealed no presence of alcohol, drugs, or stimulants in any of the cases. Decomposition was observed in one case autopsied in August, while no sign of decomposition were noted in the other cases.

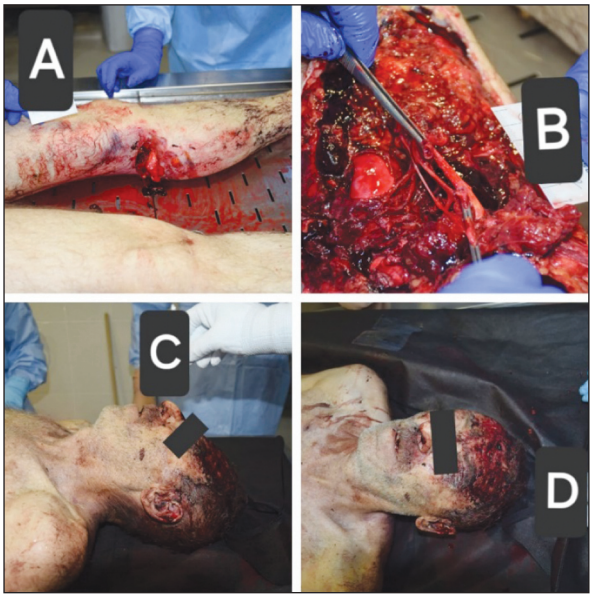

FIGURE 1: Autopsy images of Case 1 and Case 4
A) Deformed appearance in the left popliteal fossa of Case 1, **B)** Rupture of the left popliteal artery in case 1, **C and D)** Deformed appearance in the head region of Case 4

FIGURE 2: Scene of the incident of Case 9, who was hit by a log while inside a vehicle, and images showing the loss of body integrity at the L2 vertebra level

DISCUSSION

Forestry activities are inherently dangerous, with a high incidence of fatal occupational injuries among workers and those in close proximity to such activities.[2,9] Fatal injuries caused by contact with logs represent a significant hazard in forested areas and the construction industry. These injuries typically result from contact with falling heavy objects, slipping or toppling logs, and pose significant health risks. Trees exhibit considerable variability due to factors such as species, age, and size. In forestry activities, the cutting and debarking of trees, combined with factors such as the type of tree, wind, or slope of the environment, present numerous challenges in accurately predicting where, how, and at what speed a log will move. The resulting injuries vary in severity.[10] A review of the literature reveals that logging injuries represent the most frequent cause of death in forestry-related accidents.[11-14]

The majority of logging work in forestry is carried out by male workers. A review of the literature reveals a clear male-dominated nature of logging work, which is associated with a correspondingly high incidence of injuries among men.[12,13] A review of global fatality rates in occupational accidents reveals a clear dominance of the male population, a finding that aligns with the results of our study.[15,16] The higher presence of men in social and work life, coupled with their employment in more physically demanding and hazardous roles that are typically associated with relatively lower safety measures compared to other occupational groups, may explain the elevated mortality rate observed.

A study conducted in Trabzon on worker deaths reported that occupational accident-related mortality was most frequent among those aged 18 to 64.[17] A study in the United States found that 55% of deaths due to logging injuries occurred in the 35-54 age range.[10] A similar age range was reported in other studies on forestry-related deaths.[11,18] It is established that the mortality rate associated with occupational accidents in the agricultural and forestry sector is elevated among individuals in their late middle age and early old age.[19] In accordance with the findings of previous studies, our investigation revealed an average age of 58.4 years, with all cases occurring between the ages of 37 and 88. This outcome is anticipated, as middle age represents the most active period of participation in the workforce, characterized by high employment rates and the frequent oc-

currence of accidents due to the optimal utilization of physical strength.

In their analysis of forestry injuries, Lagerstrom et al. reported that the incidence of injuries was highest in the autumn season (30%) and lowest in the spring season (14%).[20] A study conducted in Türkiye examining blunt force trauma revealed that injuries most frequently occurred during the autumn season. This was attributed to the harvesting and pruning work done in the autumn, which has been found to result in an increase in injuries and fatalities during this season.[21] In our study, it was observed that 54% of the deaths occurred in the autumn season. This may be due to the prevalence of steep slopes in the Eastern Black Sea region, and the increased risk of slips and collisions with hard objects caused by wet soil conditions in the autumn season on these steep terrains.

While logging injuries can affect any part of the body, those that result in death are particularly notable for their occurrence in the head and trunk. Studies indicate that approximately half of forest workers have sustained at least one injury, with non-fatal injuries most commonly occurring in the extremities (hands, arms, legs).[22,23] While injuries can affect any part of the body, a review of fatal injuries indicates that the head and trunk are the most commonly affected areas. This has been attributed to the frequent occurrence of intracranial injuries in head and trunk injuries and the presence of accompanying bone fractures, which lead to a higher incidence of death. The lack of protective equipment among forest workers has also been suggested to contribute to this situation.[10] In a study by Wang et al. it was found that 79% of fatal injuries sustained by forest workers occurred in the head and trunk regions.[24] In a similar vein, Taçyıldız et al. described head and trunk injuries as having the highest mortality rate in forestry.[25] In our study, it was determined that blunt trauma injuries were predominantly located in the head and trunk regions, with the most common cause of death being brain tissue damage and cerebral haemorrhage. It is postulated that the elevated mortality rate associated with head and trunk injuries, in comparison to injuries sustained in other body regions, can be attributed to the severity of the injury. Furthermore, it is postulated that the more severe nature of logging injuries in comparison to non-fatal injuries documented in the literature also contributes to this phenomenon. The presence of bone fractures in all cases serves to underscore the severity of the trauma, while the disruption of bodily integrity observed in one case serves to reinforce this conclusion. The photographic evidence from the accident scenes indicates that the individuals involved were not wearing the appropriate protective equipment. The utilization of protective equipment in the context of non-fatal injuries has been demonstrated to diminish the likelihood of injury occurrence and the extent of associated harm. The lack of protective equipment is identified as a significant contributing factor to logging injuries.[26] Nevertheless, while the utilization of protective equipment is efficacious in mitigating the severity of non-fatal injuries, it may not afford the same degree of protection in the event of fatal injuries. It is therefore unclear to what extent these types of equipment can prevent fatal injuries caused by a log, which can weigh in excess of 1 tonne and gain momentum on slippery surfaces. Indeed, a study conducted in the United States examined 28 cases of logging accidents that required hospitalization and found that the majority of injuries were concentrated in the head region, with no significant difference in the severity of injuries between those who used protective equipment and those who did not ($p=0.499$).[27] This may be due to the destructive nature of log-related injuries. In this context, we believe that in addition to the use of protective equipment such as helmets, which limit head injuries, preventing the occurrence of these fatal accidents is also an effective measure in reducing fatalities.

The occurrence of log-related accidents during forestry activities can be attributed to a number of factors, including inadequate training of workers on job safety and log management, lack of attention, use of insufficient or inappropriate protective tools and equipment, poorly maintained equipment, slippery surfaces, challenging weather conditions, improper and unstable storage areas for logs, neglect of safety rules, and lack of communication among team members working in these forestry operations. These risk factors render the occurrence of accidents inevitable

and pose a significant health hazard.[2] Furthermore, elevated levels of worker fatigue and extended working hours increase the probability of lapses in attention and errors. The injuries that may result from these causes can range from relatively minor injuries such as cuts and abrasions to more severe injuries such as bone fractures, internal organ injuries, and amputations. Furthermore, such accidents not only cause physical injuries but also lead to a decrease in work efficiency and a decline in worker morale. This situation can negatively affect the overall effectiveness of forestry activities and, in the long term, lead to more serious economic losses.

CONCLUSION

Log injuries are dangerous accidents that can have serious consequences in forestry activities, with significant effects at both the individual and societal levels. In particular, the province of Artvin, where intense forestry activities and a rugged geographical terrain combine to create significant risks, is facing a serious threat from these injuries. From a forensic medical perspective, log injuries extend beyond simple injuries, with the potential to result in severe outcomes such as multiple bone fractures, internal organ injuries, amputations, and loss of bodily integrity. In the autopsy of a fatal injury, it is of great importance to meticulously document the type of injury (e.g., cut, crush, or fragmentation) and the manner in which it occurred (e.g., log fall or entrapment). Furthermore, the examination of images from the scene of the incident can facilitate a more comprehensive understanding of the mechanism of injury. It is of particular importance to evaluate the location of the injuries on the body, the affected organs, and the presence of bleeding or vascular injuries. It is also essential to consider the individual's previous health status, existing diseases, or pre-existing injuries. This information should be combined with data obtained from scene investigation images to enable a comprehensive analysis of the conditions at the time of the accident.

To prevent log injuries, it is essential that forestry workers receive comprehensive training, utilize appropriate safety equipment, and conduct regular risk assessments. Furthermore, prompt intervention and effective healthcare services should be readily available in the event of injuries. The examination of the causes and consequences of injuries within the forensic medicine framework can help prevent future accidents. Overall, log injuries require a multidisciplinary approach, and preventive measures in this area are of vital importance for individual and public health.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Burak Kaya;* ***Design:*** *Burak Kaya, Abdulkadir Sancı;* ***Control/Supervision:*** *Burak Kaya, Emre Gürkan Bulutluöz, Hüseyin Balandız;* ***Data Collection and/or Processing:*** *Burak Kaya, Abdulkadir Sancı;* ***Analysis and/or Interpretation:*** *Burak Kaya, Abdulkadir Sancı, Emre Gürkan Bulutluöz, Hüseyin Balandız;* ***Literature Review:*** *Burak Kaya, Abdulkadir Sancı, Emre Gürkan Bulutluöz; Gülşen Taşdemir Sancı;* ***Writing the Article:*** *Burak Kaya, Abdulkadir Sancı, Emre Gürkan Bulutluöz, Gülşen Taşdemir Sancı;* ***Critical Review:*** *Hüseyin Balandız, Abdulkadir Sancı, Burak Kaya;* ***References and Fundings:*** *Burak Kaya, Abdulkadir Sancı;* ***Materials:*** *Burak Kaya, Abdulkadir Sancı.*

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