

## SHORT REPORT

# Occupational fatalities among coal mine workers in Zonguldak, Turkey, 1994–2003

Hudaverdi Kucuker

<b>Background</b>	Fatal underground coal mine injuries are a worldwide problem. Zonguldak holds 95% of all Turkey's coal reserves.
<b>Aim</b>	To investigate fatalities in the underground coal-mining industry in the Zonguldak province.
<b>Methods</b>	Retrospective study of fatal underground coal-mining accidents from 1994 to 2003 through evaluation of industry records.
<b>Results</b>	There were 164 deaths available for analysis. The median age was 36 years (range: 14–56 years). Eighty-one fatalities (49%) were due to subsidence, 33 (20%) were due to underground railway accidents and 18 (11%) were due to gas poisoning. Asphyxia was the most common cause of death (99, 60%). The majority of fatalities (144, 87%) occurred instantaneously at the scene of the incident. The remainder (20, 13%) occurred on the way to the hospital or in the emergency room or the intensive care unit.
<b>Conclusion</b>	The underground coal-mining industry in Turkey requires strategies to improve safety and reduce the number of fatalities occurring. These strategies should focus on improved underground safety through engineering measures.
<b>Key words</b>	Accidents; coal mine workers; injury; occupational fatalities; traumatic deaths.

## Introduction

The underground coal-mining sector has one of the highest occupational fatality rates throughout the world [1,2]. In Turkey, the rate of injury due to underground coal-mining accidents are the highest amongst all employment sectors with a standardized employment injury rate of 11.2% compared to 4.9% in the metal industry and 3.2% in the construction sector according to the Social Insurance Institution [3] registrations. Deaths due to underground coal-mining accidents have been recorded officially since 1941, and a total of 3094 deaths were reported between 1941 and 2003 [4]. Approximately 20 000 miners work in a city of 120 000 residents. Fifteen thousand miners work for the National Hard Coal Enterprise (TTK) and 2000 work in private enterprises legally and ~3000 miners work illegally. In Turkey, regulations for coal mines are determined by the Work Safety Department of TTK which is in charge of enforcement and distribution of information concerning safety laws.

Forensic Medicine Department, Afyon Kocatepe University School of Medicine, Afyonkarahisar, Turkey.

Correspondence to: Hudaverdi Kucuker, Afyon Kocatepe Universitesi, Uygulama ve Arastirma Hastanesi Adli Tıp AD 03040, Afyonkarahisar, Turkey. Tel: +90 272 2167901 127; fax: +90 272 2172029; e-mail: drhkucuker@aku.edu.tr

All accidents, including occupational ones, are reported to the legal authorities for investigation and to the Council of Forensic Medicine in order to determine the cause and manner of death. According to Turkish Law, burial can only take place with written permission from a public prosecutor after forensic examination and autopsy [5]. The aim of this paper was to investigate fatalities in the coal-mining industry in the Zonguldak province.

## Materials and methods

The study was carried out retrospectively by investigating the records of underground coal-mining fatalities between 1994 and 2003 in the district of Zonguldak in Turkey. The cases were evaluated with respect to age, mechanism of injury, body region of wound, cause of death, and availability of autopsy report. Ethical approval of the study was not sought because the study was carried out by examination of the autopsy reports retrospectively. Fatal incidence rate was calculated using the following formula: (number of occupational fatalities)  $\times$  1000/ (number of employees). Statistical analysis was carried out using SPSS (Statistical Package for Social Sciences), version 11.5.

## Results

There were 164 coal-mining fatalities identified between the years of 1994 and 2003 in the Zonguldak area. The median age was 36 years (range: 14–56 years). Most of the fatalities occurred in the age cohorts of 18–29 years (54, 34%) and  $\geq 40$  years (69, 42%). Seventy-four per cent (40/54) of deaths in the 18- to 29-year age group were of those employed by private and illegal coal mines and seven fatalities were of illegal coal miners aged  $< 18$  years. The rate of fatalities was approximately five times greater in illegal workers with 60 deaths reported among 3000 illegal workers (2%) and 66 deaths reported among 15 000 TTK workers (0.44%).

Postmortem examination revealed that death was caused by multiple injuries in 64% (105), localized head–neck injuries in 8%, chest injury in 6% and methane intoxication in 12% of cases.

Evaluation of accidents leading to fatalities showed that 49% (81) were due to subsidence, 20% (33) were due to underground railway accidents and 11% (18) were due to methane poisoning. Forty-three per cent (35) of deaths due to subsidence occurred in illegal coal mines. Asphyxia due to collapses and methane intoxication was the most common cause of death (99, 60%). The majority of fatalities (144, 87%) occurred instantaneously at the scene of incident. The remainder (20, 13%) occurred on the way to the hospital, or in the emergency room or the intensive care unit (Table 1).

The cause of death was determined by external examination in 79% (130) of fatalities and by autopsy in the remainder.

## Discussion

Underground coal-mining has the highest occupational fatality incidence rate in Turkey. The rate of TTK is over twice that of the Australian underground coal-mining

industry and  $> 1.5$  times that of the US underground coal-mining industry during a similar period. However, the fatality rate of illegal underground coal-mining is probably  $> 10$  times the rates in these countries [6,7]. Our study has shown that half of these deaths are due to subsidence and occur at the site of the incident.

It was notable that most of the victims were in the 18- to 29-year and  $> 40$ -year age groups. As traumatic occupational deaths have similar rates in 18- to 29-year age groups in different studies, this result could be attributed to the fact that this group is an active and commonly employed age group [8,9]. In Turkey, death rates are also high in the group of  $> 40$ -year-olds. They retire in their 40s after they have worked for 20 years according to our Labour Law and suffer from decreasing income. Therefore, these workers continue to work in private and illegal coal mines under unsafe conditions. Since subsidence and underground railway accidents are most frequently encountered, multiple injuries are among the most common injury types. In Turkey, wooden roofs called ‘swine roofs’ constructed by miners are still being used in extraction areas rather than steel construction capsules used widely in developed countries. These roofs can easily collapse. The absence of modern equipment in Zonguldak underground coal mines, especially in uncontrolled private or illegal mines, may contribute to the high mortality rates.

Autopsy is necessary to diagnose the exact injury type and manner of deaths. While Turkish Law requires mandatory autopsy in occupational fatalities, it is not possible practically to carry out an autopsy in every case. Autopsy in occupational accidents not only will prevent legal problems but also will help for the determination of the causes of fatal accidents and may help to figure out their prevention [10].

In summary, the cause and type of occupational fatality in the Turkish coal-mining industry suggests that many deaths could be prevented through the use of modern mining equipment as well as through tighter enforcement and regulation in the non-public mining sector.

**Table 1.** Place of death and types of accident in fatal coal mine injuries in Zonguldak (1994–2003)

Types of accident	Place of death, no. (%)		
	Place of accident	Emergency hospital	Total
Subsidence	78 (96)	3 (4)	81 (49)
Underground railway	22 (67)	11 (33)	33 (20)
Methane intoxication	17 (94)	1 (6)	18 (11)
Methane explosion and burn	14 (88)	2 (13)	16 (10)
Electrocution	8 (80)	2 (20)	10 (6)
Fall from a height	5 (83)	1 (17)	6 (4)
Total	144 (88)	20 (13)	164 (100)

## Conflicts of interest

None declared.

## Reference

1. McGwin G Jr, Valent F, Taylor AJ *et al.* Epidemiology of fatal occupational injuries in Jefferson County, Alabama. *South Med J* 2002;**11**:1300–1311.
2. Feyer A-M, Williamson AM, Stout N *et al.* Comparison of work related fatal injuries in the United States, Australia, and New Zealand: method and overall findings. *Inj Prev* 2001;**7**:22–28.

3. Social Insurance Institution. Employment Injury and Occupational Diseases. [http://www.ssk.gov.tr/wps/sskroat/istatistik/istatistik2002/IS\\_KAZ\\_MES\\_HAST\\_16-28\\_2002.xls](http://www.ssk.gov.tr/wps/sskroat/istatistik/istatistik2002/IS_KAZ_MES_HAST_16-28_2002.xls) (23 May 2004, date last accessed).
4. Tas komuru raporu. <http://www.maden.org.tr/yeni3/yayinlar/raporlar/taskomururaporu.htm> (23 May 2004, date last accessed).
5. Turkish Penalty Law. Accepted in 1926 by the Turkish Government.
6. Mine Safety and Health Administration. *Mining Fatality Statistics for 1900 Through 2004*. <http://www.msha.gov/stats/centurystats/coalstats.htm> (18 July 2005, date last accessed).
7. Minerals Council of Australia. *Safety and health performance report of the Australian Minerals Industry 2003–2004*. [http://www.minerals.org.au/\\_\\_\\_data/assets/pdf\\_file/9731/2003\\_04\\_Safety\\_Performance\\_Repo.pdf](http://www.minerals.org.au/___data/assets/pdf_file/9731/2003_04_Safety_Performance_Repo.pdf): page 15 (24 August 2005, date last accessed).
8. Yanai O, Goldin L, Kugel C *et al*. Occupational fatalities in Israel. *J Clin Forensic Med* 1999;**6**:129–132.
9. Lee T, Anderson C, Kraus JF. Acute traumatic injuries in underground bituminous coal miners. *Am J Ind Med* 1993;**3**:407–415.
10. Colak B, Etiler N, Bicer U. Fatal occupational injuries in the construction sector in Kocaeli, Turkey, 1990–2001. *Ind Health* 2004;**42**:424–430.