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Factors related mortality in occupational injuries: five-year experience

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Aim: The aim of this study is to evaluate factors related mortality in occupational injuries admitted to emergency department.
Methods: Patients admitted to emergency department because of occupational injuries between January 2015 and December 2019 were retrospectively analyzed. The first admission to the emergency department following each occupational injuries was recorded.
Results: 3240 patients included the study. We observed that occupational injuries decreased with age and were more common in males (91.4%), in agriculture (27.6%) and construction (24.9%) industries, and in summer (29.9%) and autumn (28%). In addition, occupational injuries generally occurred due to falling (31.8%) and caused superficial injuries (39.8%). A majority of patients (83.6%) were discharged from the emergency department. 351 and 156 patients were hospitalized in the surgical clinics and intensive care unit respectively. A total of 25 and 18 patients died in emergency department and intensive care unit, respectively (total 43 deaths, 1.32%). Moreover, increasing age (p: 0.000), construction industry (p: 0.008), immigration (p: 0.037) and working in night shifts (p: 0.009) are independent risk factors related to mortality after occupational injuries.
Conclusion: The labor conditions of immigrants as well as of those working at night shifts and in the construction industry should be supervised. Their job security should be increased and working without social security should not be allowed.

Keywords: construction industry, emergency department, immigration, mortality, night shift, occupational injuries
Short Title in English: Factors related mortality in occupational injuries

Introduction

Occupational injuries are one of the main causes of injuries and deaths worldwide. They decrease people's healthy and productive years. It has been estimated that 374 million nonfatal occupational injuries occur in the world every year, and 2.34 million people die because of occupational injuries (1). Occupational injuries and related deaths are more common in the developing countries where production is more in the construction industry. The number of occupational deaths in the US is 3.6/100,000 workers, whereas it reaches 9.3/100,000 workers in Latin American countries (2). Based on the data published by the Turkish Statistical Institute, the number of occupational injuries that occurred in Turkey in 2018 was 431,276, and 1,542 people died because of occupational injuries (3).

Social costs of occupational injuries also cause a serious burden to all countries. Economic costs account for ~3.9% of the gross domestic product (1). In 2015, workers' compensation costs alone were approximately $95 billion in the US, and the total cost is estimated to be hundreds of billions of dollars (4,5).

It is important to examine the mechanism of injury in workers, the types of injuries, the medical services required after injuries, and the causes of occupational deaths, in order to ensure occupational safety. Because occupational injuries are preventable injuries and most of them are still not reporting.

The aim of the present study was to determine the distribution of mortality rates based on gender, age, and other factors, to evaluate the economic and social results and to shed light on the measures to be taken against possible occupational injuries.

Materials and methods

This retrospective study was carried out in the emergency department (ED) of a regional academic hospital, that provides tertiary healthcare services. The study was conducted in

compliance with the Declaration of Helsinki and approval by regional ethical committee with decision no.2020/01-08.

Study design, setting, and patient selection

The medical records of patients who were admitted to ED because of occupational injuries between January 1, 2015 and December 31, 2019 were retrospectively analyzed. The first admission to the ED following each occupational injuries was recorded. Patients with missing medical data and repeated admissions were excluded from the study.

Data collection and analyses

In addition to the patients' age and gender, the following information was recorded: nationality (Turkish/immigrant); social security status; related industry; day of the injury (weekday/weekend); hour of the injury (day time/night shift) and season along with mechanism of injury (falls, blunt object injury, lifting heavy weight, penetrating sharp object injury, burns, traffic accidents, and intoxications); type of injury (superficial injuries, strain-sprain, bone injury, burn injury, solid organ injury, deep cut and multiple injuries); injured body sites (thorax, spine, lower extremity, upper extremity, head and neck, abdomen, and multiple sites); presence of fracture; emergency termination; treatment costs due to injury; and the duration of the disability.

Data were analyzed using SPSS version 22.0. Visual (histogram and probability graphs) and analytical methods (Kolmogorov–Smirnov/Shapiro–Wilk's tests) were used to determine if the variables showed normal distribution. Descriptive analyzes are expressed as mean ± standart deviation (SD) for variables showing normal distribution and as median and interquartile range (IQR) for those lacking normal distribution. In comparisons between groups, chi-square test was used for categorical variables, student's t-test for continuous variables, and Mann–Whitney U test for non-normally distributed continuous variables and sequential

variables. Multivariate logistic regression analysis was performed to determine the relationship between mortality and possible confounding factors. Age, gender, nationality, social security status, time of the day, season, industry information, injury mechanism, injury type and injury site included in the model for multivariate logistic regression analysis. A p value of < 0.05 was considered statistically significant.

Results

A total of 3,608 patients were found to be eligible for this study, and 368 of those patients were excluded because of missing data and repeated admissions; thus, 3240 patients were finally included. Most of the patients were male (n: 2960, 91.4%) and the mean age was 32.69 ± 10.61 (range 14-80). The patients' demographic data are summarized in Table 1.

The occupational injuries were most common in the agriculture industry (27.6%), followed by the construction industry (24.9%). The most common mechanism of injury was falls (31.8%), followed by penetrating sharp object (23.1%). The most common injured body areas were upper and lower extremities (23.4%–37.7%). Fractures were diagnosed in 795 (24.5%) patients. Injury characteristics of the patients are presented in Table 2.

A majority of the patients (n: 2,708, 83.6%) were discharged from the ED. A total of 351 (10.83%) and 156 (4.81%) patients were hospitalized in the surgical clinics and intensive care unit (ICU), respectively. A total of 25 and 18 patients died during the treatment in ED and ICU, respectively (total 43 deaths, 1.32%).

There was a statistically significant difference in terms of age, gender, working hours, season, industry, presence of fracture, nationality, social security status, length of hospital stay, and treatment costs between the patients who died and survived ($p < 0.05$) (Table 3).

In non-fatal injuries, 125 (3.9%) patients had permanent incapacity and 3072 (94.8%) patients had temporarily incapacity. 2322 patients were able to return to work after 1 day.

Among the other 750 patients, the hospitalized patients lost median 36 (IQR: 17) workdays and discharged patients lost mean 14.88 ± 2.81 workdays.

There was a statistically significant difference in terms of age, gender, season, industry, presence of fracture, length of hospital stay, and treatment costs between the patients with permanent and temporary incapacity ($p < 0.05$) (Table 4).

Logistic regression analysis revealed that increasing age, construction industry, immigration, and night shifts were risk factors for mortality. There was no statistically significant correlation between gender, social security status, season, mechanism of injury, type of injury, injured body site, and mortality (Table 5).

Discussion

The number of fatal occupational injuries worldwide has tended to decrease in the last decade (1). It has been shown that morbidity and mortality due to occupational injuries have decreased significantly thanks to improved measures. Although employment has doubled following the establishment of institutions, such as the Occupational Safety and Health Administration and National Institute for Occupational Safety and Health in 1970 in the US, occupational injuries and deaths have gradually decreased (6). The study by Turkkan and Pala showed that occupational injuries decreased from 1988 to 2003; however, they relapsed with a sudden rise in 2011, and the number of occupational injuries in Turkey increased again (7). After the enforcement of legal regulation on occupational health and safety (law no. 6331), the number of fatal occupational injuries decreased. The mortality rate of 8.91/100,000 workers in 2010 decreased to 6.98 in 2018 (3,8). However, this does not mean that occupational health and safety has improved in Turkey. The study by Nishikitani and Yano have reported that the mortality rate in Turkey is higher than that in 26 OECD countries (9).

The present study has shown that although the number of occupational injuries and deaths gradually decreased in the last 5 years, the rate of death/occupational injuries has been gradually increasing (Figure 1). We observed that occupational injuries decreased with age and were more common in males, in agriculture and construction industries, and in summer and autumn. In addition, they generally occurred due to falling and caused superficial injuries in extremities, and a majority of patients were discharged from the emergency department. Moreover, there was a statistically significant correlation between age, construction industry, immigration, working in night shifts, and mortality.

Although the number of female patients (8.6%) was higher than that in studies conducted in Turkey, it was lower in many other studies (6,10,11). This can be explained by the fact that women work in jobs with a relatively lower risk of work related injuries. Another reason for this is that women in Turkey commonly work in cleaning services and agriculture industry and informally. In Turkey, the obligation of women to take out insurance while working in daily jobs was enacted in 2015 and its scope is very limited. We think that these injuries are generally not recorded, since such injuries are superficial and do not need hospital admission.

The majority of occupational injuries cause superficial injuries and most patients are discharged after treatment without the need for further examination or treatment (10,12). In the present study, 2,708 (83.6%) patients were discharged from ED after their treatments were completed, which is consistent with the literature.

Previous studies have reported various mortality rates. In the study by Ozkan et al., the mortality rate due to occupational injuries was 7.8% (12). In the study by Turkkan and Pala, the mortality rate was 22/100,000 workers and the fatality rate was 13.4/1,000 injuries. However, they also observed that the official data used did not comprise a significant portion of active employees (7). The mortality rates due to occupational injuries are affected by differences in

the industrial sectors in the study region. Agriculture, construction, and manufacturing industries are common in our region, but there are no working areas in the mining sector. In this study, 25 and 18 patients died during the treatment in emergency department and ICU, respectively. The number of deaths per 1,000 occupational injuries was 13.27. Based on the data from the Turkish Social Security Institution (2018), the number of deaths per 1,000 occupational injuries was 3.57 (3). The rate of death/occupational injuries in this study was higher than that in the official data. We believe that this is due to the lack of hospital admissions after nonfatal and superficial injuries that did not require hospitalization.

In this study, the mean age was 32.69 ± 10.61 years, and 1,350 patients were in the age range of 18–29 years. It has been previously shown that occupational experience improves as the age progresses and therefore injuries decrease (2). The number of studies on occupational injuries involving patients <18 years is very limited (7). However, agriculture is an important source of income in our region, and people <18 years work to support their families. Hence, we included this age group in our study. There were 92 (2.8%) patients <18 years, and most of them were working in the agriculture sector (35.9%) and with no social security (51.1%). The number of occupational injuries decreased with increasing age, whereas the mortality rate increased significantly with increasing age. The study by Gonzales-Delgado et al. reported that the mortality rate increases with age (13). On the other hand, the study by Salminen has shown that younger workers have a higher risk of occupational injuries but lower risk of death due to occupational injuries. The reason for this is that the young people are more resistant to impact and recover faster than the elderly (14). In this study, increased age was considered as a significant risk factor for mortality.

Most fatal injuries in the construction industry occur because of falling down from height and crashing into a moving vehicle, whereas most nonfatal injuries are caused by falling down (from same level) or crashing into moving objects (15,16). The study by Arndt et al.

reported that 2.52 times more occupational disabilities occur in construction injuries compared to the general labor force (17). In addition, Aksorn et al. emphasized that the risk of fatal injuries in the construction industry is five times higher than that in other industries (18). In this study, majority of the occupational injuries in the construction industry were due to falls (38%). Because of occupational injuries in the construction industry, 60 patients permanently lost their working ability while 26 patients died. The risk of fatal occupational injuries in the construction industry was 4.1 times higher than that in other sectors, which is consistent with the literature.

Many previous studies have reported that working at night shift causes various cognitive disorders; therefore, resulting in more occupational injuries compared to working at daytime (19,20). In this study, occupational injuries were more common between 08:00 and 16:00 (62.1%). Although daytime occupational injuries are numerically high, nighttime occupational injuries are proportionally higher, considering the number of daytime and nighttime workers. We have observed that working at night shift increases the risk of death due to occupational injuries 3.43 times.

Migrants work without receiving adequate occupational health and safety training and without health or social security protection, in physically harder jobs with longer working hours and lower wages, and therefore face more occupational injuries (21-25) (1). In this study, the number of immigrants was 77 (2.4%). Most immigrants worked in the agriculture and construction industries (n: 59, 76.6%, $p < 0.001$). We think that, immigrants do not admitted to the ED after superficial injuries because of the fear of losing their current job and in fact, the number of occupational injuries among immigrants is much higher. Immigrants constituted 11.6% (n: 5) of all deaths, and immigration was considered as a significant risk factor on deaths due to occupational injuries.

Study Limitations

The main limitation of this study is that patients who were not admitted to the hospital and whose data were missing could not be included in the study. In addition, this was a single-center retrospective study. There is a need for multicenter, prospective studies in which employers also provide data, in order to better understand occupational injuries and improve measures.

Conclusion

In conclusion, the labor conditions of immigrants as well as of those working at night shifts and in the construction industry should be supervised. Their job security should be increased and working without social security should not be allowed. In addition, the number of occupational injuries and deaths has been decreasing over the years, whereas the death/occupational injuries rate has been increasing. Many of the occupational deaths and injuries can be prevented if the measures are improved.

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Tables

Table 1. Sociodemographic data of study population

Age (years), mean ± SD	32.69±10.61
Age (years), n ,(%)	
<18	92 (2.8)
18-29	1350 (41.7)
30-39	980 (30.2)
40-49	572 (17.7)
50-64	233 (7.2)
≥65	13 (0.4)
Gender, n, (%)	
Male	2960 (91.4)
Female	280 (8.6)
Nationality, n, (%)	
Turkey	3163 (97.6)
Others	77 (2.4)
Presence of Social security, n, (%)	
TSSI or Private Insurance	2909 (89.8)
None	331 (10.2)
Days of the week, n, (%)	
Weekday	2652 (81.9)
Weekend	588 (18.1)
Time of the day, n, (%)	
Day time (08:00-16:00)	1997 (61.6)
Night shift (16:00-08:00)	1243 (38.4)
Season, n, (%)	
Spring	906 (28)
Summer	968 (29.9)
Autumn	741 (22.9)
Winter	625 (19.3)
Sector, n, (%)	
Agriculture and forestry	894 (27.6)
Construction	808 (24.9)
Manufacturing and textile	650 (20.1)
Wholesale and retail trade	445 (13.7)
Transportation and storage	443 (13.7)

TSSI=Turkish Social Security Institution

Table 2. Injury characteristics of study population

Mechanism of Injuries, n, (%)	
Falls	1031 (31.8)
Blunt object injury	562 (17.3)
Lifting heavy weight	460 (14.2)
Penetrating sharp object injury	882 (27.2)
Burns	105 (3.2)
Traffic accidents	157 (4.8)
Intoxications	43 (1.3)
Injury Type, n, (%)	
Superficial injuries	1291 (39.8)
Strain-sprain injuries	703 (21.7)
Bone injury	562 (17.3)
Burn injury	92 (2.8)
Organ injury	293 (9)
Deep cuts	186 (5.7)
Multiple injuries	113 (3.5)
Injury Site, n, (%)	
Thorax	160 (4.9)
Spine	102 (3.1)
Lower extremity	759 (23.4)
Upper extremity	1220 (37.7)
Head and neck	497 (15.3)
Abdomen	108 (3.3)
Multiple	394 (12.2)
Presence of fracture, n, (%)	795 (24.5)
Prognosis, n, (%)	
Discharged from ED	2708 (83.6)
Admitted to hospital	351 (10.8)
Neurosurgery	24 (0.7)
Plastic and Reconstructive Surgery	112 (3.5)
Thoracic Surgery	20 (0.6)
Orthopaedic surgery	170 (5.2)
General Surgery	14 (0.4)
Ophthalmology	7 (0.2)
Cardiovascular Surgery	4 (0.1)
Admitted to ICU	138 (4.3)
Exitus	43 (1.3)
Exitus in ED	25 (0.7)
Exitus in ICU	18 (0.6)
Length of stay in hospital (days), median, (IQR)	4 (6)
Treatment costs (TL), median, (IQR)	1729 (2757)

ED=Emergency Department, ICU=Intensive Care Unit, TL=Turkish Lira

Table 3. Comparison of survival and death patients

	Survival (n:3197)	Death (n:43)	*p value*
Age (years), mean ± SD	32.57±10.55	41.47±12.01	<0.001
Length of stay in hospital (days), median, (IQR)	4 (5)	11.5 (20)	<0.001
Treatment costs (TL), median, (IQR)	1684 (2320)	9178 (32307)	<0.001
Gender, n, (%)			<0.05
Male	2917 (98.5)	43 (1.5)	
Female	280 (100)	0 (0)	
Nationality, n, (%)			<0.01
Turkey	3125 (98.8)	38 (1.2)	
Others	72 (93.5)	5 (6.5)	
Presence of Social security, n, (%)			<0.05
TSSI or Private Insurance	2876 (98.9)	33 (1.1)	
None	321 (97)	10 (3)	
Days of the week, n, (%)			0.203
Weekday	2620 (98.8)	32 (1.2)	
Weekend	577 (98.1)	11 (1.9)	
Time of the day, n, (%)			<0.05
Day time (08:00-16:00)	1978 (99)	19 (1)	
Night shift (16:00-08:00)	1219 (98.1)	24 (1.9)	
Season, n, (%)			<0.001
Spring	900 (99.3)	6 (0.7)	
Summer	947 (97.8)	21 (2.2)	
Autumn	725 (97.8)	16 (2.2)	
Winter	625 (100)	0 (0)	
Sector, n, (%)			<0.001
Agriculture and forestry	887 (99.2)	7 (0.8)	
Construction	782 (96.8)	26 (3.2)	
Manufacturing and textile	643 (98.9)	7 (1.1)	
Wholesale and retail trade	443 (99.6)	2 (0.4)	
Transportation and storage	442 (99.8)	1 (0.2)	

TL=Turkish Lira, TSSI=Turkish Social Security Institution

Table 4. Comparison of temporarily incapacity and permanent incapacity patients

	Temporarily Incapacity (n:3072)	Permanent Incapacity (n:168)	*p value*
Age (years), mean±SD	32.37±10.39	38.57±12.81	<0.001
Length of stay in hospital (days), median, IQR	4 (5)	5 (9)	<0.001
Treatment costs (TL), median, IQR	195 (129)	2088 (8231)	<0.001
Gender, n, (%)			<0.01
Male	2795 (94.4)	165 (5.6)	
Female	277 (98.9)	3 (1.1)	
Nationality, n, (%)			0.06
Turkey	3003 (94.9)	160 (5.1)	
Others	69 (89.6)	8 (10.4)	
Presence of Social security, n, (%)			0.827
TSSI or Private Insurance	2759 (94.8)	150, 5.2	
None	313 (94.6)	18, 5.2	
Days of the week, n, (%)			0.470
Weekday	2518 (94.9)	134 (5.1)	
Weekend	554 (94.2)	34 (5.8)	
Time of the day, n, (%)			0.286
Day time (08:00-16:00)	1900 (95.1)	97 (4.9)	
Night shift (16:00-08:00)	1172 (94.3)	71 (5.7)	
Season, n, (%)			<0.01
Spring	871 (96.1)	35 (3.9)	
Summer	897 (92.7)	71 (7.3)	
Autumn	700 (94.5)	41 (5.5)	
Winter	604 (96.6)	21 (3.4)	
Sector, n, (%)			<0.01
Agriculture and forestry	850 (95.1)	44 (4.9)	
Construction	748 (92.6)	60 (7.4)	
Manufacturing and textile	613 (94.3)	37 (5.7)	
Wholesale and retail trade	427 (96)	18 (4)	
Transportation and storage	434 (98)	9 (2)	

TL=Turkish Lira, TSSI=Turkish Social Security Institution

Table 5. Multivariate logistic regression analysis for mortality predictors

Risk Factor	Odds Ratio (%95 Confidence Interval)	*p value*
Age	1.06 (1.04-1.09)	**0.000**
Male gender		0.995
Immigration	4.82 (1.1-21.11)	**0.037**
Lack of social security		0.968
Night shift	3.43 (1.36-8.61)	**0.009**
Season		0.507
Construction industry	4.1 (1.73-9.7)	**0.008**
Injury mechanism		0.471
Injury type		0.966
Injury site		0.984

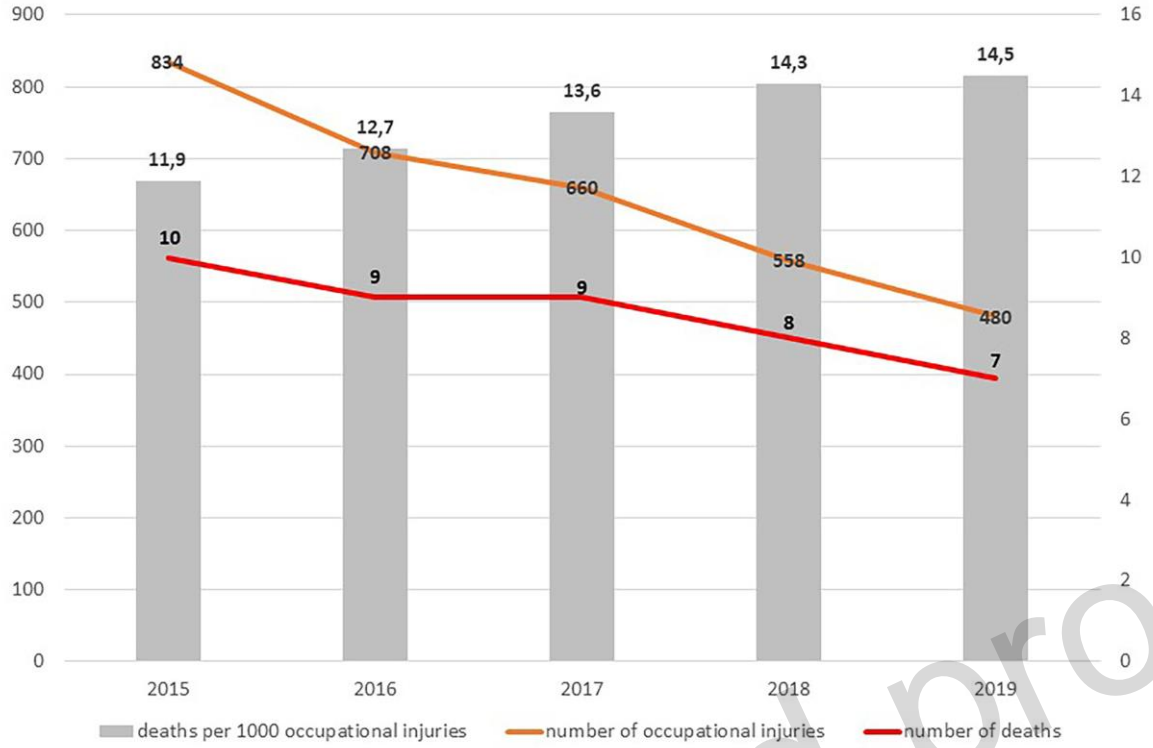

Figure 1. Changes in the number of occupational injuries, deaths and the rate of deaths per 1000 occupational injuries within five years