Analysis of injuries and deaths by trauma scores due to occupational accidents

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ABSTRACT

BACKGROUND: This study was aimed to evaluate the injury characteristics, causes, results, and hospital charges in cases of occupational accidents that were reported to judicial authorities using trauma scores.

METHODS: The study was performed after obtaining permission from the judicial authorities and approval from the local ethics committee. All occupational accident cases that were reported to the judicial authorities in Bolu Province between 2015 and 2019 were included in the study. The groups were compared with the Chi-Square test, Mann-Whitney U Test, and the Kruskal-Wallis Test. P<0.05 was considered statistically significant.

RESULTS: This study included 3599 cases. The majority of the cases (74.70%) were male, with a mean age of 34.90±10.50 years. Occupational accidents occurred most frequently between 8 and 16 h (n=1982; 55.10%), on Friday (n=595, 16.53%), in April (n=356; 9.89%), and in spring (n=971; 26.98%). Occupational accident-related death occurred in 29 cases (0.8%). The most common injury due to occupational accidents occurred in the food industry (n=1256, 34.90%). Blunt object injury (n=1112, 30.90%) was the most common type of occupational accident; and the upper extremity (n=2049, 54.93%) was the most common injury localization. The mean Abbreviated Injury Scale of the cases was 0.94±0.74, the mean Injury Severity Score (ISS) was 1.79±4.47, and the mean New-Injury Severity Score (NISS) was 2.11±5.28. The means of ISS and NISS were statistically significantly higher for males, life-threatening injuries, work accidents in the Construction and Agriculture-Forestry sectors, fall from height, traffic accidents, and caught-in-machinery. The total hospital charge was 1,351,339.10 TL and its average was 380.30±2418.90 TL. The mean of treatment costs was significantly higher in the agriculture-forestry and construction sectors.

CONCLUSION: The evaluation of all occupational accidents that are submitted to the jurisdiction on a provincial basis may provide more useful information in the prevention of work accidents. The use of trauma scores in the evaluation of occupational accidents is a useful argument for understanding the sectors and injury types that cause severe trauma. Furthermore, trauma scores may be an important predictor of hospital costs.

Keywords: Forensic medicine; injury; occupational accident; trauma scores.

INTRODUCTION

Work-related injuries and deaths are an important public health problem all over the world.[1] The International Labour Organization estimates that approximately 340 million occupational accidents occur annually worldwide, with approximately 2.3 million individuals dying from occupational accidents and diseases each year.[2] According to the data of the Social Security Institution, the rates of occupational accidents in Turkey increase every year (286,068 work accidents in 2015, 422,463 work accidents in 2019).[3] Young and older age group, shift work, long working hours, male gender, lack of formal education, frequent alcohol consumption, and low work experience were defined as important risk factors for occupational accidents.[4,5] Occupational accidents may cause serious morbidity and mortality, economic burden, lower liv-

ing standards of victims, and long-term psychological effects. [6–8] Although it is very difficult to eliminate occupational accidents, most occupational accidents may be prevented with simple precautions.[9]

For this reason, it is necessary to clearly reveal the work accident data in each province, to determine the injuries that cause severe trauma and mortality, and then to develop prevention strategies to prevent work accidents. This study was aimed to evaluate the cases of occupational accidents that occurred in the province of Bolu in 5 years and reflected the judicial authorities using trauma scores.

MATERIALS AND METHODS

Permission was obtained from the Ministry of Justice, General Directorate of Criminal Affairs dated July 2, 2020, and numbered E.19120602-45-02-0356-2020-1042/51911 for this study, to retrospectively scan the archives of the Bolu Palace of Justice. Subsequently, ethics committee approval was obtained for the study from Bolu Abant İzzet Baysal University Clinical Research Ethics Committee dated October 19, 2020, and numbered 419. Then, permission was obtained from the Bolu Governorship Provincial Health Directorate dated April 22, 2021, and numbered E-38244951-604.02 to reach the hospital bills of the occupational accident cases, and special permission was obtained from the Private Hospitals.

After the approval and permissions were obtained, the work accident files that occurred in the province of Bolu between 2015 and 2019 were examined retrospectively from the records of the chief public prosecutor's office, the criminal court of general jurisdictions, heavy penal courts, and labor court. All cases who were injured or dead as a result of occupational accidents and applied to judicial authorities were included in the study. The cases included in the study were evaluated in terms of the following parameters: "age, gender, educational status, the time of the incident, injury site, sector, type of the occupational accidents, death, monthly income (in Turkish Liras), degree of forensic injury, trauma scores (Abbreviated Injury Scale [AIS] - Injury Severity Score [ISS] - New-Injury Severity Score [NISS]), and hospital charges."

Statistical Analysis

Statistical Package for the Social Sciences (SPSS), version 21.0 (IBM SPSS Statistics for Window, Version 20.0, Armonk, NY: IBM Corp.) statistics program was used for data analysis of the study. The variables were investigated using visual (histograms plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test) to determine whether or not they are normally distributed. Descriptive statistics were presented with frequency, percentage, mean, median, and standard deviation values.

Categorical variables were compared with the Chi-square Test. Non-parametric tests were conducted to compare non-normally distributed: paired groups were evaluated with the Mann-Whitney U Test, and groups with more than two were evaluated with the Kruskal-Wallis Test. Spearman Correlation Test was used in the analysis of the measurement data with each other. $P<0.05$ was considered to show a statistically significant result.

RESULTS

In this study, 3599 cases were included: 74.70% (n=2687) of the cases were male and 25.30% (n=912) were female. The mean age of the cases was 34.9±10.5 (min: 13, max: 77) and the most common age group was 18–24 years (n=679, 18.90%) (Table 1). Almost half of the cases (n=1280; 41%) were primary school graduates (Table 1). Occupational accidents occurred most frequently between 8 and 16 hours (n=1982; 55.10%), on Friday (n=595, 16.53%), in April (n=356; 9.89%), and in spring (n=971; 26.98%) (Table 1).

The upper extremity (n=2049, 54.93%; hand area= 43.04%; and upper extremity excluding the hand: 13.89%) was the most common injury localization (Table 1). The most common injury due to occupational accidents occurred in the food industry (n=1256, 34.90%) and the metal industry (n=544, 15.1%) (Table 1). Blunt object injury (n=1112, 30.90%), sharp object injury (n=561, 15.60%), and accidental low fall (n=548, 15.20%) were the most common types of the occupational accident (Table 2). Fall from a height, blunt object injuries, and burns/explosions were statistically higher in males than females. Caught-in-machinery, poisoning, sharp object injury, and accidental low fall were statistically higher in females than males (Table 2). Occupational accident-related death occurred in 29 cases (0.8%). The rate of occupational accident-related death in males was significantly higher than in females (p<0.01) (Table 2).

The rate of traffic accidents among working in transportation was higher than in not (p<0.001). The rates of fall from height, blunt object injury, and electric shock were significantly higher among working in the construction (p<0.001). In the metal industry workers, the rates of caught-in-machinery and sharp object injury were significantly higher (p<0.001). The rate of traffic accidents in agriculture and forestry was significantly higher (p<0.01). The relationship between the type of occupational accident and the sectors is shown in Table 3, and the monthly income (in Turkish Liras) and degree of forensic injury data of the cases are shown in Table 4 in detail.

The average AIS was 0.94±0.74, the average ISS was 1.79±4.47, and the average NISS was 2.11±5.28. The average ISS and NISS in males were significantly higher than in females (p<0.001) (Table 4). The average ISS and NISS increased with the degree of forensic injury (p<0.001) (Table 4).

Table 1. Characteristics of occupational accidents

		n	%			n	%
Age (Years)	<15	2	.05		December	293	8.14
	15–17	35	.97	Season	Spring	971	26.98
	18–24	679	18.87		Summer	893	24.81
	25–29	513	14.25		Autumn	940	26.12
	30–34	555	15.42		Winter	795	22.09
	35–39	580	16.12	Injury site	Injuries	3434	95.42
	40–44	530	14.73		Head–neck	752	20.89
	45–49	402	11.17		Chest	175	4.86
	50–54	168	4.67		Abdomen	51	1.42
	55–59	86	2.39		Back	224	6.22
	60–64	34	0.94		Hand	1549	43.04
	≥65	15	0.42		Upper extremity excluding	500	13.89
Hour	0–8 hours	491	13.6		hand		
	8–16 hours	1982	55.1		Pelvis–lower extremity	766	21.28
	16–24 hours	1126	31.3		Multiple	404	11.23
Day	Monday	536	14.89	Sector	Food	1256	34.90
	Tuesday	547	15.20		Metal industry	544	15.12
	Wednesday	584	16.23		Construction	432	12.00
	Thursday	591	16.42		Others	317	8.79
	Friday	595	16.53		Transportation	236	6.56
	Saturday	400	11.11		Wood–paper–cement–glass	233	6.48
	Sunday	346	9.61		Textile–leather trade	204	5.67
Month	January	217	6.03		Hospitality–entertainment	176	4.89
	February	281	7.81		Manufacturing	151	4.20
	March	289	8.03		Agriculture–forestry	50	1.39
	April	356	9.89	Total		3599	100
	May	326	9.06	Educational status	Illiterate	9	.29
	June	275	7.64		Primary school	1280	41
	July	311	8.64		Secondary school	645	20.66
	August	306	8.50		High school	972	31.13
	September	326	9.06		Licensee	211	6.76
	October	329	9.14		Master	5	.16
	November	290	8.06	Total		3122	100

The average ISS was significantly higher in the construction, transportation, and agriculture-forestry sectors (Table 5). The average NISS was significantly higher in the construction and agriculture-forestry sectors (p<0.001) (Table 6). In addition, the average ISS and NISS of occupational accidents in form of falls from height, traffic accidents, and caught-in-machinery were significantly higher (Tables 5 and 6).

The total treatment costs of 3554 cases, whose hospital treatment costs could be reached, were 1.351.339,10 TL and the mean was 380.30±2418.90 TL. The average treatment cost in the agriculture-forestry, and construction sectors were significantly higher (p<0.001) (Table 7). In addition, the average treatment cost of occupational accidents in the form of fall from height, and caught-in-machinery were significantly higher (p<0.001) (Table 7). A positive correlation was found between AIS, ISS, and NISS scores and hospital treatment costs due to the event (r=0.433; p<0.001).

DISCUSSION

Gender

A study conducted in a trauma unit in England demonstrated that the majority of cases (91.30%) were male.[8] Similarly,

Table 2. Type of occupational accidents by gender

Type of occupational accidents	Gender				Total		p	X²
	Male		Female					
	n	%	n	%	n	%		
Blunt object injury	885	32.94	227	24.89	1112	30.90	<.001	20.645
Sharp object injury	372	13.84	189	20.72	561	15.59	<.001	24.489
Accidental low fall	346	12.88	202	22.15	548	1522	<.001	45.352
Caught–in–machinery	303	11.28	136	14.91	439	12.20	.004	8.404
Traffic accident	323	12.02	34	3.73	357	9.92	<.001	52.404
Fall from height	131	4.87	6	.66	137	3.81	<.001	33.074
Others	83	3.09	43	4.72	126	3.50	.021	5.328
Ocular foreign body	94	3.50	28	3.07	122	3.39	.537	.381
Burning–Explosion	98	3.65	20	2.19	118	3.28	.033	4.541
Intoxication	25	0.93	23	2.52	48	1.33	<.001	13.106
Electrical shock	27	1.00	4	.44	31	.86	.110	2.557
Total	2687	74.7	912	25.3	3599	100		
Death								
Yes	28	0.78	1	.03	29	99.2	.007	7.406
No	2659	73.88	911	25.31	3570	.80		

Chi–square test.

mostly (86%) males suffered from occupational accidents in South India.[5] The majority of the victims (73.10–97.50%) injured due to occupational accidents in Turkey were male.[10–15] This was related to the fact that men were more involved in work and worked more in heavy jobs.

Age

In studies conducted in Turkey, the average age of occupational accident victims ranges from 30.70 to 36.[10,12–18] In general, occupational accidents were seen in the 25–39 age group.[12–14,18] However, there are also studies reporting that more occupational accidents were seen in the 18–29 age group.[16,17] In this study, the mean age of the cases was 34.90±10.50 (min: 13, max: 77) and the most common age group was 18–24 years (n=679, 18.90%). We think that this may be related to the fact that people are more inexperienced and work in riskier jobs in this age group.

Educational Status

The probability of injury as a result of an occupational accident is closely associated with a low level of education.[19] Sayhan et al.[16] reported that the majority (82.60%) of the victims were primary school graduates. In this study, 41% of the cases (n=1280) were primary school graduates (Table 1).

Time of the Accident

Occupational accidents occurred most frequently on Friday (19.50%) and Monday (19.30%) in Spain.[20] On the other hand,

in Northern Italy, work accidents occurred most frequently on Mondays (18.77%).[1] In Turkey, there are studies reporting that occupational accidents occurred most frequently on Mondays,[13,14] as well as studies stating that they occurred most frequently on Thursday, Friday, and Saturday.[10–12] In this study, occupational accidents occurred most frequently on Friday (n=595, 16.53%). Although some studies attribute occupational accidents to the lack of attention and compliance on the 1st day of the week, the data in our study and the literature demonstrates that occupational accidents include regional differences and depend on other dynamics. Kadioglu et al.[10] reported that occupational accidents occurred most frequently in August (11.20%) and summer (31.60%). Occupational accidents were most common in August (10.70%) and autumn (29.40%) in Ankara;[13] In Gaziantep, it occurred most frequently in May (11.10%) and spring (29.30%).[12] In this study, occupational accidents occurred most frequently in April (n=356; 9.89%) and spring (n=971; 26.98%) seasons. According to our study and studies in the literature, we think that the increase in work accidents in the spring and summer seasons may be related to the mobilization in the construction sector on these dates. In general, occupational accidents occur between 8 and 16 h, which are working hours.[11–13,16,18] In this study, similar to the literature, the most common occupational accident occurred between 8 and 16 h (n=1982; 55.10%).

Injury Site

In Southern India, the abdomen and pelvis were the most

Table 3. Type of occupational accidents in the various sectors

	Food						Metal industry						Construction					
	No		Yes		p	X²	No		Yes		p	X²	No		Yes		p	X²
	n	%	n	%			n	%	n	%			n	%	n	%		
Fall from height	123	5.25	14	1.11	<.001	38.182	134	4.39	3	.55	<.001	18.545	52	1.65	85	19.67	<.001	337.637
Caught-in-machinery	300	12.81	139	11.07	.129	2.304	323	10.57	116	21.32	<.001	49.833	418	13.20	21	4.86	<.001	24.674
Traffic accident	302	12.89	55	4.38	<.001	66.278	353	11.56	4	.74	<.001	60.496	333	10.51	24	5.55	.001	10.463
Intoxication	20	0.85	28	2.23	.001	11.760	47	1.54	1	.18	.011	6.439	44	1.39	4	.92	.431	.620
Blunt object injury	711	30.35	401	31.93	.328	.957	929	30.41	183	33.64	.133	2.257	960	30.31	152	35.19	.040	4.227
Electrical shock	26	1.11	5	0.40	.028	4.849	26	.85	5	.92	.874	.025	20	.63	11	2.55	<.001	16.322
Sharp object injury	353	15.07	208	16.56	.239	1.388	415	13.58	146	26.84	<.001	61.650	520	16.42	41	9.49	<.001	13.869
Burning-Explosion	87	3.71	31	2.47	.046	3.997	107	3.50	11	2.02	.074	3.191	105	3.32	13	3.01	.737	.112
Accidental low fall	270	11.52	278	22.13	<.001	71.311	509	16.66	39	7.17	<.001	32.232	490	15.47	58	13.43	.267	1.233
Ocular foreign body	83	3.54	39	3.11	.490	.478	97	3.18	25	4.60	.092	2.845	103	3.25	19	4.40	.217	1.524
Others	68	2.90	58	4.62	.008	7.123	115	3.76	11	2.02	.042	4.149	122	3.85	4	.93	.002	9.636

	Transportation						Wood-paper-cement-glass						Textile-leather trade					
	No		Yes		p	X²	No		Yes		p	X²	No		Yes		p	X²
	n	%	n	%			n	%	n	%			n	%	n	%		
Fall from height	133	3.95	4	1.70	.079	3.076	133	3.95	4	1.72	.085	2.972	137	4.04	0	.00	.003	8.558
Caught-in-machinery	439	13.05	0	.00	<.001	35.087	392	11.64	47	20.17	<.001	14.790	366	10.78	73	35.79	<.001	112.334
Traffic accident	164	4.88	193	81.78	<.001	1459.576	355	10.55	2	.86	<.001	22.891	353	10.40	4	1.96	<.001	15.330
Intoxication	47	1.40	1	.42	.207	1.598	47	1.39	1	.43	.213	1.549	48	1.41	0	.00	.087	2.923
Blunt object injury	1093	32.50	19	8.05	<.001	61.744	1026	30.48	86	36.91	.040	4.218	1052	30.99	60	29.41	.636	.224
Electrical shock	29	.86	2	.85	.981	.001	28	.83	3	1.29	.467	.530	29	.85	2	.98	.850	.036
Sharp object injury	559	16.62	2	.85	<.001	41.705	512	15.21	49	21.03	.018	5.608	547	16.11	14	6.87	<.001	12.511
Burning-Explosion	117	3.48	1	.42	.011	6.491	113	3.36	5	2.14	.315	1.008	98	2.89	20	9.80	<.001	29.036
Accidental low fall	535	15.91	13	5.51	<.001	18.478	531	15.78	17	7.30	<.001	12.138	528	15.55	20	9.80	.026	4.926
Ocular foreign body	121	3.60	1	.42	.009	6.785	111	3.30	11	4.72	.246	1.348	116	3.42	6	2.94	.715	.133
Others	126	3.75	0	.00	.002	9.163	118	3.51	8	3.43	.954	.003	121	3.56	5	2.45	.401	.706

Table 3. Type of occupational accidents in the various sectors continue

	Hospitality–entertainment						Manufacturing						Agriculture–forestry					
	No		Yes		X²	p	No		Yes		X²	p	No		Yes		p	X²
	n	%	n	%			n	%	n	%			n	%	n	%		
Fall from height	133	3.89	4	2.27	1.189	.276	127	3.68	10	6.62	3.413	.065	133	3.75	4	8.00	.119	2.435
Caught–in–machinery	435	12.71	4	2.27	17.020	<.001	427	12.38	12	7.95	2.659	.103	434	12.23	5	10.00	.632	.229
Traffic accident	354	10.34	3	1.70	13.976	<.001	346	10.03	11	7.28	1.224	.269	346	9.75	11	22.00	.004	8.281
Intoxication	45	1.31	3	1.70	.193	.660	44	1.28	4	2.65	2.072	.150	47	1.33	1	2.00	.679	.171
Blunt object injury	1067	31.17	45	25.57	2.462	.117	1060	30.74	52	34.44	.925	.336	1098	30.94	14	28.00	.655	.199
Electrical shock	31	.91	0	0	1.608	.205	31	.90	0	.00	1.369	.242	31	.87	0	.00	.507	.441
Sharp object injury	517	15.10	44	25.00	12.459	<.001	535	15.52	26	17.22	.319	.572	560	15.78	1	2.00	.008	7.115
Burning–Explosion	102	2.98	16	9.09	19.713	<.001	113	3.28	5	3.31	.001	.982	118	3.32	0	.00	.190	1.719
Accidental low fall	505	14.75	43	24.44	12.148	<.001	523	15.17	25	16.56	.216	.642	536	15.10	12	24.00	.082	3.024
Ocular foreign body	114	3.33	8	4.55	.755	.385	118	3.42	4	2.65	.264	.607	122	3.44	0	.00	.182	1.779
Others	120	3.51	6	3.41	.005	.946	124	3.60	2	1.32	2.210	.137	124	3.49	2	4.00	.847	.037

Chi-squared test.

frequently injured body parts in traumatic work accidents (36%).[5] In Northern Italy, the predominant area of injury in fatal occupational accidents was the head (33.56%).[1] Upper extremity injury (50%) was seen at a higher rate than other body parts in Glasgow, England.[8] In all of the studies conducted in Turkey, the most common injury site (45.40–65.30%) was the upper extremity.[10–14,16,21] In this study, the injuries occurred most frequently in the upper extremity (n=2049, 54.93%), consistent with studies conducted in Turkey (Table 1).

The Victim's Sector

In Southern India, the most frequent occupational injuries occurred in quarries (27%) and constructions (20%).[5] While some studies reported that occupational accidents were most common in the construction sector (28.7–40%) in Turkey,[16,18] as well as some studies reported that they occurred in the machinery-automobile sector (22%),[15] the service sector (44%),[13] and the metal-machinery sector (23.1–30.1%).[14,21] In this study, occupational accidents occurred most frequently in the food industry (n=1256, 34.90%) and the metal industry (n=544, 15.10%). The sectorial difference detected in the studies is due to the differences in the distribution of business lines in the provinces where the studies were carried out.

Type of Occupational Injury

Falling (25%) and cutting/penetrating injury (20%) were the most common causes of occupational accidents in Glasgow, England.[8] In Turkey, victims were generally exposed to sharps and stab wounds at workplace.[11,13,14,16,18] In this study, blunt object injury (n=1112, 30.90%) and sharp object injury (n=561, 15.60%) were the most common types of the occupational accident (Table 2).

The most common injury types in the construction industry in Ethiopia were cutting (66.30%) and falling (28.50%).[4] The majority of occupational accidents in the construction industry in Saudi Arabia were caused by fall from height (82%), followed by electric shock (38%).[7] The rates of fall from height, blunt object injury, and electric shock among working in construction were significantly higher (p<0.001) (Table 3). In the United States, traffic accidents were the most common cause of death for victims over the age of 55 due to work-related injuries in the transportation industry.[22] In this study, the rate of traffic accidents was found to be higher in working in the transportation sector than in not (p<0.001) (Table 3). Small tools, machines, and lifting machines were contributed to more than half of the accidents in the metal industry in India.[23] Workers in the metal industry in China had occupational accidents due to "changing sharp blades," "using defective machines," and "using different

Table 4. Distribution of mean ISS and NISS according to gender, education status, monthly income (Turkish Liras:TL), and degree of forensic injury

		ISS		p'
		Mean±SD	Median	
Gender	Male	2.03±4.89	1.00	<.001
	Female	1.12±2.82	1.00	
Educational status	Illiterate	1.22±1.09	1.00	.636²
	Primary school	1.60±3.71	1.00	
	Secondary school	1.56±3.32	1.00	
	High school	1.23±1.59	1.00	
	Licensee	1.42±2.91	1.00	
	Master	1.20±2.17	.00	
Total monthly income (TL)	0–1000	1.96±5.28	1.00	.145²
	1001–2000	1.80±4.49	1.00	
	2001–3000	1.61±3.43	1.00	
	3001–4000	1.39±2.67	1.00	
	>4000	5.24±11.68	1.00	
Degree of forensic injuries	No lesion	.00±.00	.00	<.001²
	Cured by simple medical intervention	0.77±0.42	1.00	
	Not cured by simple medical intervention	4.22±2.52	5.00	
	Life-threatening	20.67±15.67	17.00	

		NISS		p'
		Mean±SD	Median	
Gender	Male	2.40±5.79	1.00	<.001
	Female	1.28±3.22	1.00	
Educational status	Illiterate	1.44±1.13	1.00	.641²
	Primary school	1.87±4.38	1.00	
	Secondary school	1.80±3.87	1.00	
	High school	1.41±1.98	1.00	
	Licensee	1.67±3.27	1.00	
	Master	1.40±2.61	.00	
Total monthly income (TL)	0–1000 (n=596; 16.58%)	2.28±5.96	1.00	.201²
	1001–2000 (n=1966; 54.62%)	2.16±5.47	1.00	
	2001–3000 (n=970; 26.95%)	1.84±3.93	1.00	
	3001–4000 (n=38; 1.06%)	1.55±2.69	1.00	
	>4000 (n=29; .79%)	5.79±13.23	1.00	
Degree of forensic injuries	No lesion (n=165; 4.58%)	.00±.00	.00	<.001²
	Cured by simple medical intervention (n=2815; 78.22%)	.87±.60	1.00	
	Not cured by simple medical intervention (n=516; 14.34%)	5.02±3.82	5.00	
	Life-threatening (n=103; 2.86%)	24.99±16.72	21.00	

¹Mann-Whitney U test; ² Kruskal-wallis test. ISS: Injury severity score; NISS: New–Injury severity score; SD: Standard deviation.

machines."[24] In this study, the rates of caught-in-machinery and sharp object injury were significantly higher in the metal industry workers (p<0.001). Motor vehicles accounted for one-third of machine-related injuries in agriculture in Sweden.[25] In this study, the rate of traffic accidents in agriculture-forestry was significantly higher (p<0.01) (Table 3).

Table 5. Distribution of mean ISS according to the type of occupational accidents and sectors

| | | ISS | | p |
		Mean±SD	Median	
Type of occupational accidents				
Fall from height	No	1.62±4.15	1.00	<.001
	Yes	6.33±8.41	5.00	
Caught–in–machinery	No	1.75±4.62	1.00	<.001
	Yes	2.14±3.21	1.00	
Traffic accident	No	1.56±3.21	1.00	<.001
	Yes	3.93±10.17	1.00	
Intoxication	No	1.81±4.50	1.00	.697
	Yes	.98±.73	1.00	
Blunt object injury	No	1.96±4.92	1.00	.423
	Yes	1.44±3.25	1.00	
Electrical shock	No	1.79±4.47	1.00	.497
	Yes	2.77±4.57	4.00	
Sharp object injury	No	1.93±4.85	1.00	<.001
	Yes	1.10±.53	1.00	
Burning–Explosion	No	1.82±4.55	1.00	.133
	Yes	1.07±.76	1.00	
Accidental low fall	No	1.94±4.80	1.00	<.001
	Yes	1.00±1.66	1.00	
Ocular foreign body	No	1.83±4.55	1.00	.021
	Yes	.83±.58	1.00	
Others	No	1.82±4.51	1.00	<.001
	Yes	1.06±3.35	.00	
Sectors				
Construction	No	1.68±4.35	1.00	<.001
	Yes	2.68±5.22	1.00	
Manufacturing	No	1.81±4.53	1.00	.521
	Yes	1.46±2.92	1.00	
Textile– leather trade	No	1.83±4.59	1.00	.592
	Yes	1.19±1.33	1.00	
Transportation	No	1.67±4.08	1.00	.004
	Yes	3.67±8.04	1.00	
Hospitality–entertainment	No	1.82±4.55	1.00	.378
	Yes	1.33±2.63	1.00	
Food	No	2.18±5.37	1.00	<.001
	Yes	1.08±1.68	1.00	
Wood–paper–cement–glass	No	1.81±4.58	1.00	.002
	Yes	1.67±2.54	1.00	
Metal industry	No	1.86±4.81	1.00	<.001
	Yes	1.46±1.58	1.00	
Agriculture–forestry	No	1.70±3.99	1.00	<.001
	Yes	8.50±16.46	1.00	
Others	No	1.73±4.04	1.00	.949
	Yes	2.46±7.60	1.00	

Mann-Whitney U test; ISS: Injury severity score; SD: Standard deviation.

Table 6. Distribution of mean NISS according to the type of occupational accidents and sectors

| | | NISS | | p |
		Mean±SD	Median	
Type of occupational accidents				
Fall from height	No	1.91±4.90	1.00	<.001
	Yes	7.36±9.88	5.00	
Caught–in–machinery	No	2.03±5.29	1.00	<.001
	Yes	2.74±5.22	1.00	
Traffic accident	No	1.83±4.02	1.00	.034
	Yes	4.75±11.28	1.00	
Intoxication	No	2.13±5.31	1.00	.315
	Yes	1.15±1.49	1.00	
Blunt object injury	No	2.33±5.80	1.00	.457
	Yes	1.63±3.85	1.00	
Electrical shock	No	2.09±5.26	1.00	.260
	Yes	4.71±6.66	4.00	
Sharp object injury	No	2.30±5.73	1.00	.049
	Yes	1.11±.55	1.00	
Burning–Explosion	No	2.14±5.37	1.00	<.001
	Yes	1.53±.98	1.00	
Accidental low fall	No	2.29±5.67	1.00	<.001
	Yes	1.17±1.84	1.00	
Ocular foreign body	No	2.16±5.37	1.00	.001
	Yes	.84±.65	1.00	
Others	No	2.15±533	1.00	<.001
	Yes	1.14±3.48	.00	
Sectors				
Construction	No	1.97±5.12	1.00	<0.001
	Yes	3.19±6.28	1.00	
Manufacturing	No	2.13±5.33	1.00	.579
	Yes	1.71±4.10	1.00	
Textile– leather trade	No	2.16±5.42	1.00	.859
	Yes	1.32±1.77	1.00	
Transportation	No	1.95±4.82	1.00	.391
	Yes	4.47±9.47	1.00	
Hospitality–entertainment	No	2.15±5.38	1.00	.238
	Yes	1.44±2.70	1.00	
Food	No	2.59±6.30	1.00	<.001
	Yes	1.23±2.16	1.00	
Wood–paper–cement–glass	No	2.11±5.32	1.00	.015
	Yes	2.17±4.73	1.00	
Metal industry	No	2.18±5.62	1.00	.001
	Yes	1.75±2.63	1.00	
Agriculture–forestry	No	2.00±4.76	1.00	<.001
	Yes	10.52±18.27	2.00	
Others	No	2.05±4.95	1.00	.462
	Yes	2.77±7.95	1.00	

Mann-Whitney U test; NISS: New–Injury severity score; SD: Standard deviation.

Table 7. Distribution of mean hospital charge according to the type of occupational accidents and sectors (in Turkish Liras: TL)

| | | Hospital charge (TL) | | p |
		Mean±SD	Median	
Sectors				
Construction	No	306.03±1457.48	100.21	<.001
	Yes	934.14±5776.28	125.30	
Manufacturing	No	390.52±2470.58	102.50	.582
	Yes	146.96±160.83	102.70	
Textile–leather trade	No	393.44±2488.91	103.69	<.001
	Yes	164.61±406.40	80.97	
Transportation	No	353.01±2399.04	101.14	.117
	Yes	785.81±2669.94	138.91	
Hospitality–	No	389.95±2476.76	104.00	<.001
entertainment	Yes	194.05±593.73	71.98	
Food	No	465.92±2742.74	109.80	<.001
	Yes	223.00±1657.01	93.36	
Wood–paper–	No	382.83±2487.32	100.74	<.001
cement–glass	Yes	344.12±1025.83	130.50	
Metal industry	No	386.48±2590.20	100.47	.011
	Yes	345.95±1043.17	108.47	
Agriculture–forestry	No	371.67±2422.27	101.72	<.001
	Yes	1052.83±2053.78	217.81	
Others	No	385.97±2506.14	102.50	.709
	Yes	320.74±1159.10	102.52	
Type of occupational accidents				
Fall from height	No	289.35±1132.75	99.05	<.001
	Yes	2700.16±10845.26	328.65	
Caught–in–machinery	No	364.96±2539.93	100.26	<.001
	Yes	489.90±1246.31	120.45	
Traffic accident	No	352.30±2427.13	100.67	.239
	Yes	645.65±2326.22	133.70	
Intoxication	No	384.07±2435.19	102.66	.280
	Yes	104.85±69.50	78.00	
Blunt object injury	No	435.35±2812.60	108.27	<.001
	Yes	257.60±1114.11	91.57	
Electrical shock	No	379.67±2428.08	101.90	<.001
	Yes	452.23±905.31	187.57	
Sharp object injury	No	423.44±2630.30	101.16	.828
	Yes	149.33±273.30	104.80	
Burning–Explosion	No	388.47±2458.71	103.65	.007
	Yes	138.35±203.81	75.07	
Accidental low fall	No	406.23±2606.69	100.47	.027
	Yes	237.21±789.20	115.27	
Ocular foreign body	No	391.09±2460.24	105.68	<.001
	Yes	74.47±193.25	41.93	
Others	No	389.19±2460.67	103.10	<.001
	Yes	132.56±328.56	70.91	

Mann-Whitney U test; SD: Standard deviation.

Death

In this study, death due to work accidents occurred in 0.8% (n=29) of the cases. In the same period, 0.40% (6.978/1.740.716) of all occupational accidents in Turkey resulted in death.[3] It is quite remarkable that the death rate (0.81%) in Bolu Province was twice that of Turkey in general (0.40%) in the same period. These numerical data demonstrate that the prevention activities of fatal occupational accidents in Bolu Province should be given importance. Shewiyo et al.[26] reported that the probability of being exposed to work-related death and injury was twice as high in males as in females. In this study, the rate of occupational accident-related death in males was significantly higher than in females (p<0.01) (Table 2). We think that this may be related to the fact that males generally work in higher-risk jobs than females.

AIS-ISS-NISS

Anders et al.[27] reported that the average ISS was 19.2 due to work accidents. Celik et al.[18] reported that the average ISS was 9.79±8.1 in work-related injuries. Ozkan et al.[17] found the average ISS as 4. Akkoca et al.[28] determined that the average AIS was 2.92±0.88, the average ISS was 28.51±12.39, and the average NISS was 31.57±15.77 in injuries resulting from falling from height. In this study, the average AIS of the cases was 0.94±0.74, the average ISS was 1.79±4.47, and the average NISS was 2.11±5.28. Our average ISS and NISS were lower than other studies. This situation suggests that occupational accidents in Bolu are generally caused by less severe traumas.

ISS-NISS – Gender, Sectors, Type of Occupational Accidents

Sears et al.[29] reported that the average ISS in males was higher than females in occupational accidents. In this study, the average ISS and NISS in males were significantly higher than in females (p<0.001) (Table 4). We think that this is related to the higher incidence of severe traumas such as fall from a height and traffic accidents in males than in females (Table 2).

Fedakar et al.[30] suggested that the ISS and NISS were more useful in demonstrating life-threatening injuries than the Glasgow coma scale, revised trauma score and trauma, and injury score, and might be used to detect life-threatening injuries mentioned in the Turkish Penal Code. In this study, there was a significant relationship between the degree of forensic injury and the average ISS and NISS, and the values of life-threatening injuries were significantly higher (Table 4) (p<0.001). Based on the data we have obtained, we think that ISS and NISS are a useful argument in determining the life-threatening and simple medical intervention concepts specified in the Turkish Penal Code.

ISS and NISS mainly indicate the severity of trauma and are closely related to mortality.[31] Akkoca et al.[28] indicated that

AIS, ISS, and NISS were closely associated with mortality in cases of falls from height. Pfortmueller et al.[25] demonstrated that the height of falls in injuries resulting from work accidents was positively correlated with ISS and mortality. In Northern Italy, the most frequent deaths due to work accidents were seen in construction (36.62%), mechanical industry (19.25%), and agriculture (13.15%).[1] In addition, most of the deaths (77.69%) were associated with mechanical traumas such as falls, machine-related events, and blunt trauma in the same study. Shewiyo et al.[26] argued that explosions, traffic accidents, and falls were more likely to result in fatal injury. Fatal injuries in construction were mostly caused by fall from height, vehicle accidents, and electric shock in Kocaeli.[32] Celik et al.[18] reported significantly higher ISS averages in agriculture, electricity, and industry sectors. The average ISS and NISS were significantly higher in the construction and agriculture-forestry sectors (Tables 5 and 6). As there is more severe trauma in construction and agriculture-forestry sectors, we think that additional measures and inspections should be increased for these sectors.

In a study involving occupational accident cases admitted to the emergency department, it was demonstrated that Excess Mortality Ratio adjusted ISS was higher in the group injured as a result of falling from a height compared to the other injuries group, and the hospital stay was longer in those injured as a result of falling.[33] In this study, the average ISS and NISS of occupational accidents in form of fall from height, traffic accidents, and caught-in-machinery were significantly higher (Tables 5 and 6).

Mean Hospital Charges-Sectors, Type of Occupational Accidents, AIS, ISS, and NISS

Anders et al.[27] calculated that the average direct cost per patient in severe trauma was €35,661. Macdonald et al.[8] estimated the total cost of patients hospitalized in the trauma unit with work-related injuries to be approximately 326.110 GBP. Celik et al.[18] reported that the mean cost of work-related injuries was $1729.57±8178.30. In this study, the total treatment cost of 3554 cases, whose hospital treatment costs could be reached, was 1,0351,339.10 TL and the mean cost of occupational injury was 380.30±2418.90 TL. Erdemli et al.[13] stated that the highest rates of hospital treatment costs per person due to occupational accidents were in the construction (92.10 TL), the service sector (73.30 TL), and the transportation (64.50 TL) sectors. Celik et al.[18] reported that hospital charges in occupational accidents were at the highest level in the construction, transportation, and food sectors. In this study, the average treatment costs in the agriculture-forestry, and construction sectors were significantly higher (p<0.001) (Table 7). In addition, the average treatment cost of occupational accidents in the form of falling from a height, and caught-in-machinery were significantly higher (p<0.001) (p<0.001) (Table 7). Sears et al.[29] reported

that there was a significant relationship between the severity of the ISS and the medical costs in occupational accidents and that there was a monotonous increase in medical costs with the increase in the severity of the ISS. In this study, a positive correlation was found between AIS, ISS, and NISS and hospital treatment costs due to the event (r=0.433; p<0.001).

This study has strengths as well as weaknesses. First of all, the retrospective design of the study is an important limitation. The hospital treatment costs of 45 of the cases included in this study could not be reached. Hospital treatment costs were calculated from the hospital bills of the remaining 3554 cases, and no further estimation could be made about especially indirect costs and out-of-hospital treatment costs. Although our case number included a high cluster of 3599, it only included work accidents before judicial authorities. It may not be said that the study includes all occupational accidents in Bolu Province, considering that there may be too many occupational accidents that have not been written up. However, we believe that this study may provide important data to the literature in terms of revealing the causes of occupational accident injuries and severe trauma in Bolu Province.

Conclusion

Most of the work accident studies in the literature included a single-center such as a hospital emergency department. However, these studies may not fully demonstrate the occupational accident population in the study area. We think that the evaluation of all occupational accidents that are submitted to the jurisdiction on a provincial basis may provide more useful information in the prevention of work accidents. In this study, we determined that more severe trauma occurred in males, workers in the Construction and Agriculture-Forestry sectors, occupational accidents in the form of fall from height, traffic accident, and caught-in-a machines. The use of trauma scores in the evaluation of occupational accidents is a useful argument for understanding the sectors and injury types that cause severe trauma. We also think that trauma scores may be an important predictor of hospital costs.

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ORİJİNAL ÇALIŞMA - *ÖZ*

İş kazasına bağlı yaralanma ve ölümlerin travma skorları ile analizi

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AMAÇ: Çalışmamızda travma skorları kullanılarak adli makamlara yansıyan iş kazası olgularında yaralanma özellikleri, nedenleri, sonuçları ve hastane maliyetinin travma skorları kullanılarak değerlendirilmesi amaçlanmıştır.

GEREÇ VE YÖNTEM: Çalışma adli makamlardan izin ve yerel etik kurulundan onay alındıktan sonra yapıldı. 2015–2019 yılları arasında Bolu ilinde adli makamlara yansıyan tüm iş kazası olguları çalışmaya dahil edildi. Gruplar Ki-Kare testi, Mann-Whitney U Testi ve the Kruskal-Wallis Testi ile karşılaştırılmıştır. P değeri <0.05 istatistiksel olarak anlamlı kabul edildi.

BULGULAR: Çalışmaya toplam 3599 olgu dahil edildi. Olguların büyük çoğunluğu (%74.70) erkek olup yaş ortalaması 34.90±10.50'dir. İş kazası en sık 8–16 saatleri (n=1982; %55.10) arasında, cuma günü (n=595, %16.53), Nisan (n=356; %9.89) ayında ve ilkbahar (n=971; %26.98) mevsiminde meydana gelmiştir. İş kazasına bağlı ölüm 29 olguda (%0.80) gerçekleşmiştir. En sık yaralanma gıda sektöründe (n=1256, %34.90) meydana gelmişti. En sık iş kazası tipi künt cisim yaralanması (%30.90) olup, mağdurlar en sık üst ekstremiteden (%54.93) yaralanmıştır. Olguların AIS ortalaması 0.94±.74, ISS ortalaması 1.79±4.47 ve NISS ortalaması 2.11±5.28'dir. Erkeklerde, yaşamı tehdit eden yaralanmalarda, inşaat ve tarım-ormancılık sektörlerinde, yüksekten düşme, trafik kazası ve makineye sıkışma şeklindeki iş kazalarına ISS ve NISS ortalaması istatistiki olarak anlamlı derecede daha yüksektir. Toplam tedavi masrafı 1.351.339,10 TL olup, ortalamasının ise 380.30±2418.90 TL'dir. İnşaat ve tarım-orman sektöründe tedavi masrafları anlamlı derecede daha yüksektir.

TARTIŞMA: Adli makamlara yansıyan tüm iş kazalarının her il bazında ayrı olarak değerlendirilmesi, iş kazaları için alınacak önlemlerin belirlenmesinde yararlı olabilir. Travma skorlarının kullanımı, ağır travmalara neden olan sektörlerin ve yaralanma mekanizmalarının tespiti ve tedavi masraflarının belirlenmesinde önemli bir argüman niteliği taşımaktadır.

Anahtar sözcükler: Adli tıp; iş kazası; travma skorları; yaralanma.