Original Article

Causes and characteristics of work-related eye injuries in western Turkey

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Objectives: To analyze descriptive data and characteristics of work-related eye injuries (WREI) admitted into the emergency department (ED) and obtain information to utilize in planning measures to prevent WREI. **Materials and Methods:** This prospective study recruited patients with WREI admitted to the center in the two-year study period. Only the casualties occurred at the workplace and while working constituted the sample. The data were collected *via* face-to-face contact in the ED. **Results:** Males comprised the majority of the sample (95.3%, *n* = 778) and mean age of the patients was 28.1 ± 6.5 (range: 15-54) with the biggest percentage in between 25 and 34 years of age (46.2%, *n* = 377). Most patients were working in the metal and machinery sectors (66.4%, *n* = 542). Nearly half of the patients had less than 1 year of experience (50.4%, *n* = 411). The most common mechanism of WREI was noted to be exposures to welding light (26.9%, *n* = 219), followed by drilling/cutting injuries (21.1%, *n* = 172). "Carelessness" and "hurrying up" were the most commonly reported causes of WREIs among 'worker-related causes' (21.4% and 16.1%, respectively). Lack of protective measures ranked the highest among workplace-related causes (18.7%, *n* = 207). **Conclusions:** Programs to increase awareness on workplace safety and sound preventive strategies for both parties-employers and employees are to be pursued. Occupational safety efforts should include training on workplace eye safety and campaigns to raise knowledgeability on this disease among workers.

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Work-related eye injuries (WREI) not only constitute an important etiological entity for vision loss, but also account for a substantial part of occupational injuries. WREI hurt workers and their families, while imposing a huge burden with respect to manpower and social costs.[1] These injuries can lead to severe consequences and enormous financial losses There is no sector whose employees are immune to the risk of eye injuries.[2] When compared to the developed countries, the incidence and severity of WREI is higher in developing countries. This may be attributed to lower level of priority assigned for occupational health and workplace safety.[1] WREI are reported to be encountered mostly in younger workers. Research data suggest that around ninety percent of all WREI are preventable.[2,3]

Turkish Social Security Statistics indicate that 70,000 to 80,000 newly occurred occupational injuries are reported annually.[4] Three percent of these are WREI. Of note, these numbers represent only the officially recorded. Since these numbers only represent formally reported cases, many authors put forth that the real figures must be much higher.[5] Social Security Institution (SSK) is the biggest or main state-run institution established to manage the social security issues of the Turkish workers. Unregistered workers constitute up to 46.2% of all working population according to Turkish statistics conducted in 2007, despite sanctions pursued by the state.[4]

There are few population-based research studies which focused on WREI in Turkey. This study is conducted in a city where occupational injuries are seen very commonly. Denizli is one of the leading industrialized cities carrying a majority of the load in the western Turkey. It is one of the ten cities with highest numbers of occupational injuries in Turkey. The city is populated by approximately 900,000 people. Most manufacturers operate in single- or double-shifts in the region. Single-shift covers between 0800 hrs and 1600 hrs, although in most ateliers workers are to work an additional two- or three-hours' period after the end of the standard working hours. The University Hospital receive vast majority of WREI occurring in the city.

The objective of this study is to analyze epidemiological data, mechanisms, and characteristics of WREI admitted into the University-based emergency department (ED) and obtain data, which would pave the way to take measures in prevention of this public health issue.

Materials and Methods

Patients with WREI admitted to the center in the two-year period were enrolled in this prospective study. Institutional Review Board approval was obtained before commencement of the study. A special data recording system was developed for the study. The study sample comprised only the casualties occurred at workplace and while working de facto. The data were abstracted via face to face contact in the ED. The data sheets comprised sociodemographic and injury-related information brought together in 15-item questionnaire. Causes of occupational injuries as reported by the victims were assigned to either of two groups: "Worker-related causes" and "workplace-related causes".

Since workers are known to be pressured by the workplace to work in unsafe ways, an isolated room in the ED was used for this purpose to prevent bias and the patients were not accompanied by any person other than the medical personnel in charge of due medical care. The patients were also assured that the information obtained by the survey are to be used

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for research purposes only and no feedback is to be given to employers or related persons.

Patients who did not give consent for the study, fatal accidents, and patients younger than 15 years of age were excluded from the analysis.

Statistical analysis

All data obtained in the study were recorded in and analyzed using the Statistical Package for Social Sciences for Windows, Version 17. Numerical variables were given as mean and standard deviation (SD), while categorical variables were given as frequencies (*n*) and percentages.

Results

Demographic data

A total of 948 patients were admitted to the ED due to WREI within the study period. Of these, 97 (10.2%) declined to participate in the study, while 35 (3.7%) opted out with some reason and were excluded from the analysis. Finally, 816 eligible patients constituted the study group.

Table 1: Sociodemographic characteristics of patients with occupational injuries in the study sample

Sociodemographic variables	*n*	%
Sex		
Male	778	95.3
Female	38	4.7
Age		
15-24	132	16.2
25-34	377	46.2
35-44	193	23.6
>45	114	14.0
Occupation		
Metal-machinery	542	66.4
Construction	110	13.5
Mining	52	6.4
Wood-furniture	48	5.9
Agriculture	25	3.0
Others	39	4.8
Social security status		
Present	695	85.2
None	121	14.8
Level of education		
Illiterate	55	6.7
Elementary school	206	25.3
Secondary school-college	514	63.0
University-high school	41	5.0
Job experience (years)		
<1	411	50.4
1-5	238	29.2
>5	167	20.4
n of previous WREIs reported		
0	577	70.7
1	167	20.5
2 and more	72	8.8
Mode of disposition		
Discharge	668	81.9
Admission	148	18.1
Total	816	100.0

A vast majority of the patients were males (95.3%, *n* = 778) while mean age of the patients was 28.1 ± 6.5 (range: 15-54) with the biggest percentage in between 25 and 34 years of age (46.2%, *n* = 377). Metal and machinery sectors comprised a majority of the sample (66.4%, *n* = 542) [Table 1].

Although a majority of the patients had been registered in social security institutions, 121 cases (14.8%) were working without any insurance which is legally banned in Turkey. Average number of years worked in the sector was 3.3 ± 2.9 years (range: 1-24). The lion's share was of the group of patients with less than 1 year of experience (50.4%, *n* = 411). Most patients had been suffering from an ocular injury as the first time in their lives (70.7%, *n* = 577) [Table 1].

As of the timing of the injuries, 77.5% (*n* = 632) were reported to have occurred between 0900 hrs and 1700 hrs with a peak between 1300 hrs and 1400 hrs [Fig. 1]. Mean time interval passed after the event till admission to the ED was 1.3 ± 0.9 hours. Emergency care and management was sufficient for 81.9% (*n* = 668) of the cases who were discharged from the ED, while 18.1% (*n* = 148) were admitted to the hospital. Mean length of stay in hospital was 4.5 ± 1.9 days for the admitted patients. Permanent vision loss resulting from WREI were documented in 7.8% (*n* = 64) in the study sample.

Mechanisms and types of WREI

Exposures to welding light was the most common mechanism of WREI (26.9%, *n* = 219) followed by drilling/cutting injuries (21.1%, *n* = 172) and contact with chemicals or other substances (15.2%, *n* = 124) [Table 2].

The major diagnoses for WREI identified in this research are listed in Table 2. "Foreign body/bodies embedded in the eye" was the most common diagnosis in this context (30.7%). All of these patients were employed in the metal and machinery sectors and all had WREI caused by particles, or splinters in the eye. Other commonly reported eye injury diagnoses, in order of decreasing frequency, were "Burns/radiation" was reported in 26.8%, and "eyeball penetration/laceration" in 15.3% of patients with WREI. More than half of the patients (51.6%,

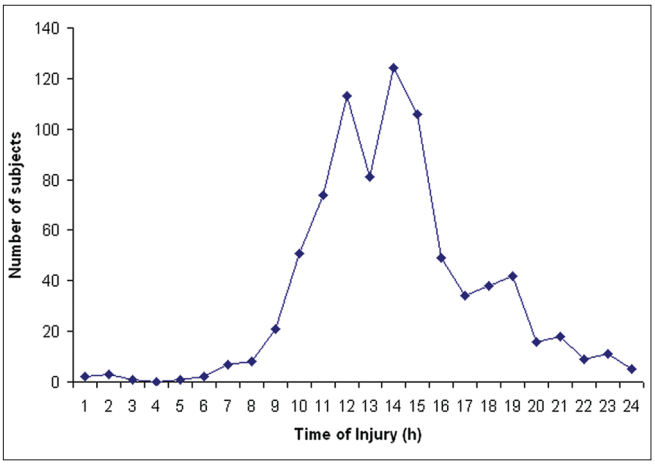

Figure 1: The time of injury for WREI among the 816 study subjects

n = 421) had injury to the right eye, while (6.0%, *n* = 49) had bilateral injuries.

Drilling/cutting injuries (82.8%, *n* = 53) ranked the highest as the mechanism of injury among patients suffering from permanent vision loss (7.8%, *n* = 64). Almost all patients in this group suffered from eyeball penetration with corneal and/or scleral involvement. Permanent vision loss was secondary to central corneal scar formation, irregular astigmatism due to wound healing and retinal complications in scleral penetration cases. On the other hand, contact with chemicals was reported in four patients (6.2%) with permanent vision loss. Of note, none of the patients with permanent vision loss used protective goggles during the accident.

Causes of injuries

Patients were asked what their injuries may have resulted from. Five hundred thirty seven (65.8%) patients reported only one cause, while 267 (32.7%) patients reported two causes, while 279 (34.2%) patients reported more than one causes. The responses were assigned into three groups, i.e., worker-related causes, workplace-related causes, and both. Nearly half of the patients (46.4%, *n* = 379) reported that their injury was resulted from merely worker-related causes, while 19.4% (*n* = 158) cited workplace-related causes as the culprit.

"Carelessness" and "hurrying up" were the most commonly reported causes of WREIs from the patients' point of view among 'worker-related causes' (21.4% and 16.1%, respectively). On the other hand, lack of protective measures (goggles etc.) ranked the highest among workplace-related causes (18.7%, *n* = 207) [Table 3]. Of note, 172 patients pointed out that protective equipment (such as goggles and gloves etc.) were available in the workplace, although they were not being used at the time of injury (21.1%).

Discussion

The present study demonstrated that workers with little job experience and young males between 25 and 34 years of age are under higher risk of exposure to WREI in our country and metal and machinery sector was the field with the highest level of risk.

In terms of labor health and workplace safety, WREI has important consequences not only with its preventable effects on young employees who are on their first years of working life, but also with its permanent hazards on worker's health and substantial loss of workforce.

There are data in medical literature similar to this study indicating young workers have higher propensity to be exposed to WREIs, while some others pointed out a higher risk in elderly workers.[2,6-10] In the present study, WREI rate for males was significantly greater than that for females, and males between 25 and 34 years of age had the highest eye injury rate. These findings suggest that extensive occupational eye safety programs could be arranged and these should focus on the specific tasks or kinds of work with high risk of WREI, regardless of sex and age.

This study also indicated that risk of exposure to WREI is inversely proportional to the job experience and young workers with little experience had a higher risk of exposure.

Table 2: Mechanisms and types of WREI among the 816 study subjects

Injury mechanisms	*n*	%
Exposure to welding light	219	26.9
Drilling/cutting	172	21.1
Hammering	79	9.7
Contact with chemicals or other substances	124	15.2
Struck by unspecified object	95	11.6
Cleaning or maintenance of equipments	59	7.2
Other	68	8.3
Diagnosis		
Burn: Chemicals (caustics etc.,)	92	11.3
Burn: Radiation	219	26.8
Eyeball penetration/laceration	125	15.3
Corneal abrasion/foreign body	251	30.7
Blunt trauma, contusion	61	7.5
Injury to the ocular adnexa and eyelids	47	5.8
Other diagnosis	21	2.6

WREI: Work-related eye injuries

Table 3: Causes of occupational injuries as reported by the victims

Causes of Injuries	*n**	%
Worker-related causes (*n*=664)		
Carelessness	237	21.4
Hurrying	178	16.1
Not using/lack of protective measures	116	10.5
Not duly trained	65	5.9
Inexperience	37	3.3
Other	31	2.8
Workplace-related causes (*n*=443)		
Lack of protective measures (goggles etc)	207	18.7
Improper physical conditions in the workplace (floor, noise, heat, chaos/untidiness)	170	15.3
Other	66	6.0
Total	1107	100

*Some patients reported more than one cause for their injuries

A similar study in Taiwan put forth that temporary workers had a higher risk of occupational injuries compared to permanent workers while Ngo *et al*., reported that WREI was seen more commonly in immigrant workers, illegal employees, and those with language problems in Singapore.[11,12] Likewise Chen *et al*., demonstrated that injury risks are higher in workers without any special training on workplace safety, who do not use protective equipment and those with a job experience longer than five years.[1] The authors also advocated that the double peaks of injury time-the first, just before the lunch, between 1100 hrs and 1200 hrs, and the second, between 1300 hrs and 1700 hrs, the time before leaving work, suggest that this latter peak may be attributed to 'rushing' phenomenon. However, the present study indicated a high risk of WREI detected just after lunch, between 1300 hrs and 1400 hrs. This study also showed metal and machinery sectors were the fields with the highest risk for WREI and the majority of workers exposed to WREI had been employed in these sectors.

Chen *et al*., reported the high-risk sector as manufacturing in Taiwan, and industrial and mechanical sectors in Tunisia.[1,13] Forrest *et al*., wrote that occupations of precision production, transportation, or farming, and industries of mining or construction also increased the risk of WREI.[9] In general, high-risk sectors for WREI differ with the level of industrial development and sectoral distribution. These variations also affect the characteristics of injuries in this context. Xiang *et al*., pointed out that chips, particles, and chemicals were the main sources of WREI. Foreign bodies or chemicals entering the eye caused more than two-thirds of these injuries.[1,3] Meanwhile, Zghal-Mokni *et al*., reported that 70.5% of cases WREI were caused by projectile objects. Most common lesion was corneal superficial foreign body (58%),[13] while another study showed the most common cause of ocular injury in the construction industry was lamellar lacerations such as superficial corneal foreign body (71.3%), and this was associated with grinding, cutting metal, welding, hammering, and drilling.[12] In the present study, the most common cause of WREI was shown to be exposure to welding light followed by drilling/cutting injuries and contact with chemicals or other substances. These findings are consistent with the report by Chen *et al*.,[1] Soong *et al*., cited the use of high-powered electrical tools were associated with high risk of WREI.[14] Overall, most research findings support each other. Nonetheless, the vast majority of WREI result in minor wounds without important sequelae. Accordingly, most patients are treated in ED and outpatient ophthalmology clinics. Previous studies in which photokeratitis, superficial foreign bodies, conjunctival or corneal lacerations, corneal abrasion, blunt injury, or chemical burn were the major types of WREI reported.[13,15] Findings of the present study were similar to the literature data- foreign bodies, burns, radiation and eyeball penetration/laceration accounted for the majority of WREI. On the contrary, in a study by Kanoff *et al*., penetrating injuries and intraocular foreign bodies ranked the highest among occupational open globe injuries.[8] Chang *et al*., studied on hospitalized eye injuries and demonstrated that open-globe injuries and contusion injuries were the most common in the wards.[10] The differences between the findings may be attributed to enrollment of occupational severe ocular injuries in these latter two studies.

An important finding with consequences on public health is that in spite of training on workplace safety and preventable nature of WREI, the issue seems to be underestimated or neglected by the employees and employers. Indeed, previous research showed that in a substantial percentage of workplaces protective measures are not undertaken as necessary.[1,11,12,16] Likewise, Zghal-Mokni *et al*., stressed on the need to gain new insights on the issue, as the lack of protection on the workplaces can be found as high as 95%.[13] Similarly, in this study, carelessness and hurrying up accounted for most of worker-related causes of WREI, while lack of protective measures ranked high among workplace-related causes. Interestingly more than one-fifth (21.1%) of the workers reported they did not use protective equipment at the time of injury despite their availability in the workplace. Studies indicate the risk of injury exposure can be diminished more than 60%[1] and that protective measures are of particular importance in WREI, therefore suggesting the need of developing statewide strategies on the issue.[14-19] Additionally, some environmental factors which may have distracting effects and preclude workers' concentration on the work should also be identified and eliminated in order to alleviate the toll resulting form these injuries.

WREI are largely preventable with the use of well-fitted, durable, protective eyewear with good visibility, and strict compliance on its use. This would greatly reduce the unnecessary loss of workdays. Finally, training programs on workplace safety measures and effective preventive strategies for both employers and employees need to be considered. Occupational safety efforts should include workplace eye safety education and training campaigns to increase awareness of this public health problem among workers.

Limitations

It can be speculated that employees cannot be totally objective when they are inquired about their work-related injuries in general, regardless of the strictness of measures to prevent bias. There is always a tendency to protect their working environment, including their employers, even though they are forced to work in unsafe ways. Consequently, the workplace-related causes can be expected to be higher than the figures found in the study. Another limitation of the study is lack of statistical data regarding the number of workers in ateliers, and specific issues in the workplace which may have paved the way to injuries.

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