

Work- and non-work-related eye injuries in a highly industrialized area in northern Italy: comparison between two three-year periods (1994-1996 and 2005-2007)

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KEY WORDS

Eye injury; epidemiology; work-related eye trauma

PAROLE CHIAVE

Trauma oculari; epidemiologia; trauma correlate al lavoro

SUMMARY

Background: Ocular trauma is a major cause of monocular blindness and visual impairment in industrialized countries. **Objectives:** The aim of this paper was to study epidemiology, causes, and clinical features of work-related and non-work-related eye injuries in a highly industrialized area of northern Italy. **Methods:** All patients hospitalized for eye injuries were enrolled. Two 3-year periods were studied (1994-1996 and 2005-2007). The variables analyzed included sex, age, social class of the patients, nature of the injuring agent (e.g. metal, plastic, etc.), place where the accident occurred (e.g. home, work, etc.), and time of the year (e.g. summer, winter, etc.). **Results:** We enrolled 1,001 men and 129 women. There were no significant differences between the two 3-year periods as regards distribution of sex, age, and location. Road-related injuries significantly decreased ($p < 0.004$). Comparison of injuring agents showed a decrease in metallic agents ($p < 0.001$) and an increase in lime agents ($p < 0.001$). Analysis of the type of trauma showed a decrease in blunt traumas ($p < 0.001$) and an increase in chemical injuries ($p < 0.001$) and actinic keratitis ($p = 0.002$). In the second 3-year period, we found a significant increase in injuries in non-Italian subjects ($p < 0.001$). **Conclusions:** Work-related injuries were the major cause of eye trauma. Road accident-related eye injuries dropped significantly in the second 3-year period. The adoption of higher safety standards, as well as information and educational campaigns, can significantly reduce work-related and non-work-related eye injuries.

RIASSUNTO

«Traumi oculari occupazionali e non occupazionali registrati in un'area altamente industrializzata del nord d'Italia: confronto tra due trienni (1994-1996 e 2005-2007)». **Background:** I traumi oculari sono una delle principali cause di cecità monocolare e disabilità visiva nei paesi industrializzati. **Obiettivi:** Lo scopo di questo lavoro è quello di valutare epidemiologia, cause e caratteristiche cliniche dei traumi oculari sia in ambito lavorativo

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*che non lavorativo, in una zona altamente industrializzata del nord Italia. **Materiali e Metodi:** Sono stati arruolati tutti i pazienti ricoverati in ospedale per traumi oculari nel corso di due trienni (1994–1996 e 2005–2007). È stato eseguito un confronto per sesso, età, classe sociale dei pazienti, natura dell'agente di ferimento (ad esempio metallo, plastica, ecc), luogo in cui è avvenuto l'incidente (ad esempio casa, lavoro, ecc), e il periodo dell'anno (ad esempio estate, inverno, ecc.). **Risultati:** Sono stati arruolati 1.001 uomini e 129 donne. Non ci sono state differenze significative tra i due trienni per la distribuzione di sesso, età e luogo di infortunio. Gli incidenti stradali sono significativamente diminuiti nel secondo triennio ($p < 0,004$). Il confronto tra agenti lesivi ha mostrato una diminuzione degli agenti metallici ($p < 0,001$) e un aumento delle causticazioni da calce ($p < 0,001$). L'analisi del tipo di trauma ha mostrato una diminuzione dei traumi contudenti ($p < 0,001$) ed un aumento delle lesioni chimiche ($p < 0,001$) e delle cheratiti attiniche ($p = 0,002$). Nel secondo triennio, abbiamo riscontrato un significativo aumento delle lesioni per i soggetti non italiani ($p < 0,001$). **Conclusioni:** Gli infortuni sul lavoro si sono dimostrati la maggiore causa di un trauma oculare. Le lesioni oculari in corso di incidenti stradali sono diminuite notevolmente nel secondo triennio. L'adozione di standard di sicurezza più elevati, così come campagne di informazione e di istruzione, possono ridurre in modo significativo i traumi oculari per cause sia professionali che non professionali.*

INTRODUCTION

Ocular trauma is a major cause of preventable monocular blindness and visual impairment in industrialized countries where work-related eye injuries continue to be a major problem (1, 6, 9, 15). The socioeconomic impact is substantial, as the population affected is generally young and of working age. Eye injuries can significantly reduce the quality of life and ability to work (16). Worldwide, an estimated 1.6 million people are blind as a result of eye injuries, and more than 19 million have monocular blindness or low vision due to eye trauma (8). The Beaver Dam Eye Study, analyzing the causes of acquired visual disabilities, reported a 19.8% prevalence of eye injuries, with an annual average incidence of 3.1 every 100,000 inhabitants (18). Men were more affected in all series, with a male to female ratio of 4:1 (3, 7, 10). Currently, the economic costs of partial or total blindness in Italy, 35% of which is caused by eye injuries, exceed 460 million Euros per year. According to data gathered by the Italian National Insurance Institute for Work Accidents, the eye is the third most injury-affected anatomical site after the hand and foot (4).

A 2008 prospective study on work-related eye traumas carried out by the Malaya University Medical Centre in Kuala Lumpur, Malaysia, showed that in 93.3% of cases, the victim of an injury was not provided with any protective device.

In 4.2% of the cases, the victim did not use a protective device. In 2.5% of the cases, the victim was wearing an appropriate protective device (14). From this study, we deduce that proper use of personal protective equipment can prevent more than 95% of work-related eye injuries.

Our study retrospectively analyzed the epidemiology of patients with ocular trauma referred to the Department of Ophthalmology at the University of Brescia. The province of Brescia (Lombardy, Italy) is one of the most industrialized in Europe, with a high concentration of metal industries. Brescia General Hospital is one of the largest in Europe. More than 6,000 ocular traumas occur annually, and approximately 200 of these patients are hospitalized. The aim of this study was to analyze the frequency and features of patients admitted to hospital for ocular traumas in this particular area and to collect data on risk factors and possible prevention strategies. We carried out a statistical comparison of two three-year observation periods in 2 consecutive decades (1994–1996 and 2005–2007) to verify the changes in ocular traumatology in relation to socioeconomic, cultural, and legislative changes.

MATERIALS AND METHODS

All patients enrolled in this study were admitted to the Division of Ophthalmology for eye trauma

during the 2 observed 3-year periods (1994-1996 and 2005-2007). All ophthalmologists responsible for managing emergency ophthalmologic incidents were instructed on how to manage patients and their enrolment. We collected information on the circumstances and dynamics of the accident, type and material of the traumatic agent, and the patient's clinical data. We used the Birmingham Eye Trauma Terminology classification for recording the type of trauma (13). The subjects were also classified into 5 working groups: Group 1, service industry workers (managers, employees, and teachers); Group 2, skilled workers (workers with special qualifications, foremen and artisans); Group 3, unskilled workers; Group 4, unemployed and retirees; and Group 5, preschool children and students from junior high school to university.

We compared gender distribution, average age, place where injury occurred, type of trauma, traumatic agent material, and nationality of the patient for the two 3-year periods. Statistical analyses were performed using the Statistical Package for Social Sciences version SPSS 16.0 for Windows (SPSS Inc.©, Chicago, IL, USA). Frequency and percentages were used to report categorical variables while mean, median, and standard deviations were used in reporting quantitative variables. The statistical test used to compare the data obtained was the χ^2 test, which was applied to the index of Yates' correction for tables with only 1 degree of freedom (2 x 2 contingency tables). The p value was considered statistically significant when it was less than 0.05.

The procedures used in this study conformed with the recommendations of the Declaration of Helsinki and were performed after receiving institutional review board approval (IRB of the Clinica Oculistica, University of Brescia). Informed consent was obtained from all patients after a detailed description of the procedure to be used and aims of the study.

RESULTS

During the 2 periods of our study, 1,130 eye injury patients were admitted to the Ophthalmology Division of Brescia University Hospital, of whom

1,001 were males (88.5%) and 129 were females (11.5%) (table 1). During the first period (1994-1996), 586 patients were hospitalized for 654 injured eyes. Gender distribution showed a male:female ratio of 9.4:1, with 530 males (90.4%) and 56 females (9.6%). During the second period (2005-2007), 544 patients were hospitalized for 587 injured eyes. Gender distribution showed a male:female ratio of 6.5:1, with 471 males (86.6%) and 73 females (13.4%). In the first triennium, the mean age of patients was 37.2 years, with 36.7 years for males (range, 3-93 years) and 41.7 years for females (range, 3-88 years). In the second triennium, the mean age was 37.4 years, with 36.8 for males (range, 8 months-94 years) and 40.9 years for females (range, 4-93 years). Comparison of the distribution of sex showed no significant differences, although there was a decrease in the ratio from 9.4:1 to 6.5:1. Similarly, no significant differences were found in the mean age between the first and the second 3-year periods.

In the first 3-year period, the leading causes of eye trauma in males were work-related injuries (218 cases, 41.1%), followed by domestic accidents (125 cases, 23.6%), sports-related injuries (42 cases, 7.9%), road accidents (41 cases, 7.7%), and eye injuries due to acts of aggression or fights (31 cases, 5.8%). The leading causes of eye trauma in females were domestic accidents (28 cases, 50.0%), followed by ocular trauma due to acts of aggression or domestic violence (6 cases, 10.7%), sport-related eye injuries (6 cases, 10.7%), work-related eye injuries (5 cases, 8.9%), and road accidents (5 cases, 8.9%).

In the second 3-year period, the leading causes of eye trauma in males were work-related injuries (190 cases, 40.3%), followed by domestic accidents (101 cases, 21.4%), road accidents (80 cases, 16.9%), sports-related injuries (77 cases, 16.3%), and eye injuries due to acts of aggression or fights (24 cases, 5.1%). The leading causes of eye trauma in females were domestic accidents (41 cases, 56.2%), followed by recreational activities (6 cases, 8.2%), road accidents (5 cases, 8.9%), and trauma due to acts of aggression or domestic violence (5 cases, 8.9%). No significant differences between the main causes of eye injuries were found in the two periods (figure 1).

Table 1 - The table describes the main data of the epidemiological study on ocular trauma in the two 3-year periods studied. The data in heavy type indicate statistically significant values. The significance level is shown below the table with a superscript letter indicating the compared data

Data	1994-1996			2005-2007		
Male	530 (90.4%)			471 (86.6%)		
Female	56 (9.6%)			73 (13.4%)		
Mean age	37.2 [m: 36.7–f: 41.7]			37.4 [m: 36.8–f: 40.9]		
M:f ratio	9.4:1			6.5:1		
Circumstance of injury	Male	Female	Tot.	Male	Female	Tot.
• work	218 (41.1%)	5 (8.9%)	213 (36.3%)	190 (40.3%)	5 (6.8%)	195 (35.8%)
• home	125 (23.6%)	28 (50.0%)	153 (26.1%)	101 (21.4%)	41 (56.2%)	142 (26.1%)
• sport	42 (7.9%)	5 (8.9%)	47 (8.0%)	48 (10.2%)	2 (2.7%)	50 (9.2%)
• road	41 (7.8%)	5 (8.9%)	46 (7.8%)*	15 (3.2%)	5 (6.8%)	20 (3.7%)*
• violence	31 (5.8%)	6 (10.7%)	37 (6.3%)	24 (5.1%)	5 (6.8%)	29 (5.3%)
	n (%)			n (%)		
Type of trauma						
• contusion	244 (41.6%)^b . WR 54; NWR 190			162 (29.8%)^b . WR 36; NWR 126		
• lamellar laceration	101 (18.8%). WR 48; NWR 53			135 (24.8%). WR 42; NWR 93		
• penetrating w.	69 (11.8%). WR 27; NWR 42			61 (11.2%). WR 23; NWR 38		
• IOFB	52 (8.9%). WR 33; NWR 19			28 (5.1%). WR 17; NWR 11		
• traumatic cataract	41 (7.0%). WR 22; NWR 19			51 (9.4%). WR 27; NWR 24		
• lens dislocation	20 (3.4%). WR 3; NWR 17			17 (3.1%). WR 4; NWR 13		
• retinal tear	10 (1.7%). WR 4; NWR 6			30 (5.5%). WR 11; NWR 19		
• retinal det.	9 (1.5%). WR 3; NWR 6			17 (3.1%). WR 1; NWR 16		
• hyphema	181 (30.9%)^c . WR 45; NWR 136			110 (20.2%)^c . WR 39; NWR 71		
• chemical burn	33 (5.6%)^d . WR 18; NWR 15			79 (14.5%)^d . WR 43; NWR 36		
• burn	33 (5.6%). WR 29; NWR 4			29 (5.3%). WR 14; NWR 15		
• orbit & adnexa	29 (5.0%). WR 12; NWR 17			6 (1.1%). WR 6; NWR 0		
Traumatic agents						
• metal	231 (39.4%)^e . WR 146; NWR 85			153 (28.1%)^e . WR 89; NWR 64		
• quicklime	3 (0.5%) ^f . WR 2; NWR 1			40 (7.4%) ^f . WR 29; NWR 11		
• glass	4 (0.7%) ^g . WR 0; NWR 4			14 (2.6%) ^g . WR 2; NWR 12		
• elastic	66 (11.3%)^h . WR 5; NWR 61			39 (7.2%)^h . WR 3; NWR 36		
Nationality						
• italian	551 (94.0%)			435 (80%)		
• foreign	35 (6.0%)ⁱ			109 (20.0%)ⁱ		

*road: $p = 0.004$; ^bcontusion: $p = 0.001$; ^chyphema: $p < 0.001$; ^dchemical burn: $p < 0.001$; ^emetal: $p < 0.001$; ^fquicklime: $p < 0.001$; ^gglass: $p = 0.022$; ^helastic: $p = 0.023$; ⁱforeign: $p < 0.001$.

penetrating w.: penetrating wound; retinal det.: retinal detachment

WR= work related

NWR= non work related

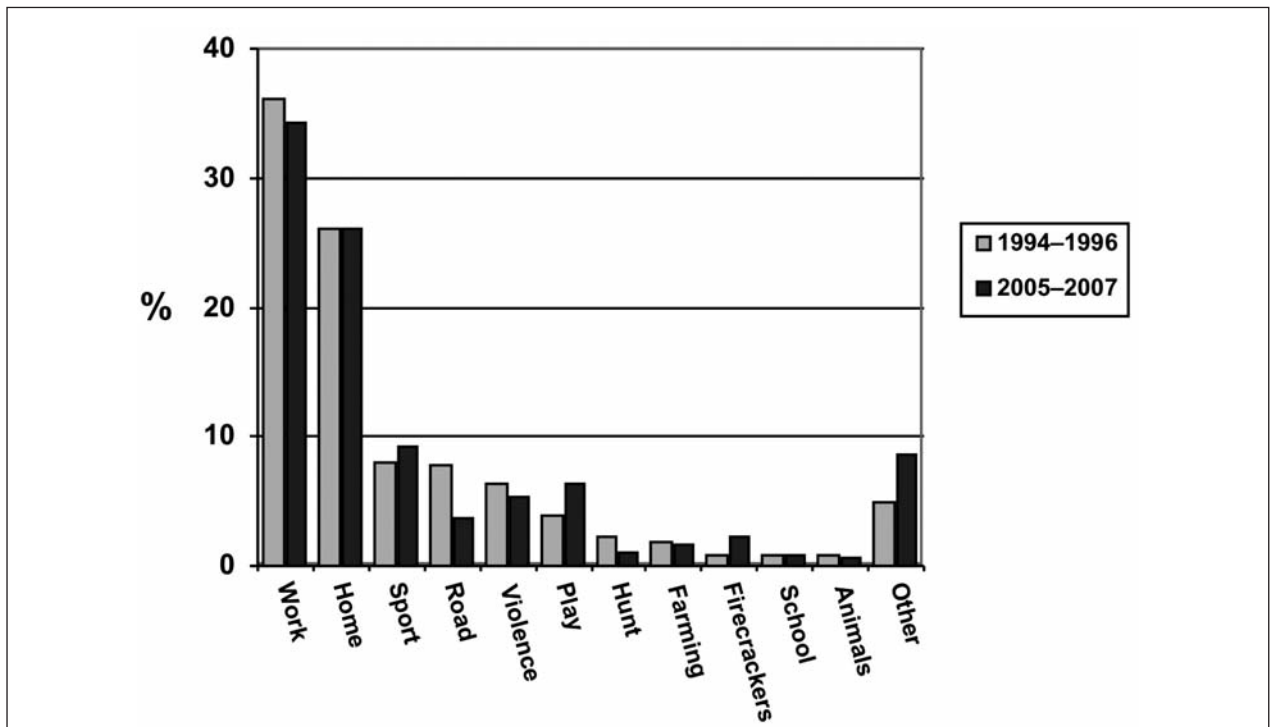


Figure 1 - Different origin of eye trauma: comparison of the two 3-year periods

According to the Birmingham Eye Trauma Terminology classification, the leading causes of eye trauma in the first 3-year period were bulbar contusions (244 patients, 41.6%), followed by lamellar lacerations (101 patients, 18.8%), and perforating wounds (69 patients, 11.8%). Intraocular foreign bodies (52 patients, 8.9%) and traumatic cataract (41 patients, 7.0%) were the most frequent serious injuries, followed by lens dislocation (20 patients, 3.4%), globe rupture (13 patients, 2.2%), retinal tear (10 patients 1.7%), and retinal detachment (9 patients, 1.5%). Hyphemas (181 patients, 30.9%) were frequent, but in most cases without any serious consequences. The leading causes of ocular trauma in the second 3-year period were bulbar contusion (162 cases, 29.8%), followed by lamellar lacerations (135 cases, 24.8%), chemical burns (79 cases, 14.5%), perforating wounds (61 cases, 11.2%), traumatic cataract (51 cases, 9.4%), retinal breaks (30 cases, 5.5%), and intraocular foreign bodies (28 cases, 5.1%). Retinal detachment and lens dislocation showed the same frequency (17 cases, 3.1%). Hyphemas (110 cases, 20.2%), non-

chemical burns (29 cases, 5.3%), and adnexa traumas (6 cases, 1.1%) were also recorded. The Birmingham Eye Trauma Terminology classification was unable to classify 16.2% of the chemical burns (33 cases, 5.6%), other burns (33 cases, 5.6%), and lesions of the orbit and adnexa (29 cases, 5.0%) in our database.

The seasonal distribution of eye injuries was analyzed in the two 3-year periods, particularly in the subclass of work-related traumas. In the first period, the distribution showed a decrease in August and during Christmas time. A growth peak occurred for work-related and non-work-related eye injuries after summer and winter holidays. In the second period, a slight decline occurred during May and July, followed by an increase during August, a decrease during Christmas time, and a significant increase in January. We also analyzed the weekly distribution of ocular trauma requiring hospitalization during the 2 periods. In the first period, sports-related and road accident-related admissions increased during weekends, while work-related injuries peaked on Fridays. In the second period, work-related admissions

peaked on Mondays and again on Wednesdays and on Fridays. Otherwise, non-work-related injuries remained steady in the first part of the week, with a steady increase on Fridays and Saturdays, followed by a decrease on Sundays.

The analysis of locations (e.g. school, home, workplace) where accidents occurred showed no particular differences between the 2 periods. Road accidents were an exception, showing a statistically significant decrease in the second period ($p < 0.004$), from 7.8% to 3.7%. In the first 3-year period, we registered 47 cases of ocular eye lesions related to sports activities, including soccer (26 cases, 55.3% of total sports trauma) and tennis matches (9 cases, 19.1% of total sports trauma). In the second 3-year period, we registered 50 cases related to sports activities, including soccer (33 cases, 64.0% of total sports trauma), and rugby (4 cases, 8.0% of total sports trauma).

Comparison of traumatic agent materials between the two 3-year periods revealed a change in distribution. Eye trauma caused by metallic agents decreased from 39.4% to 28.1% ($p < 0.001$). Alkali burns due to quicklime increased from 0.5% to 7.4% ($p < 0.001$). Eye traumas due to liquid che-

mical substances increased from 3.1% to 7.9% ($p = 0.001$). Traumas caused by glass injury increased from 0.7% to 2.6% ($p = 0.022$). Injuries caused by elastic bodies decreased ($p = 0.023$).

The analysis of the type of trauma showed a reduction in blunt traumas, from 41.6% to 29.8% ($p < 0.001$), and an increase in chemical injuries from 5.6% to 14.5% ($p < 0.001$) and actinic keratitis from 0 to 2% ($p = 0.002$) (figure 2). The number of foreign patients hospitalized for ocular injuries increased during 2005–2007 (109 cases, 20.0% of total admitted) ($p < 0.001$), compared with the period 1994–1996 (35 cases, 6% of total admitted) (figure 3). The comparison of the 2 periods regarding geographical location of the accident showed a significant reduction in traumas related to road accidents in Italian patients ($p = 0.012$). No difference was found for foreign patients ($p > 0.05$).

Hospitalizations for chemical burns (lesions not encoded in the Birmingham Eye Trauma Terminology classification) showed a significant increase ($p < 0.001$) during the second 3-year period. Hospitalization for post-traumatic hyphemas showed a significant decrease ($p = 0.002$) in the second period.

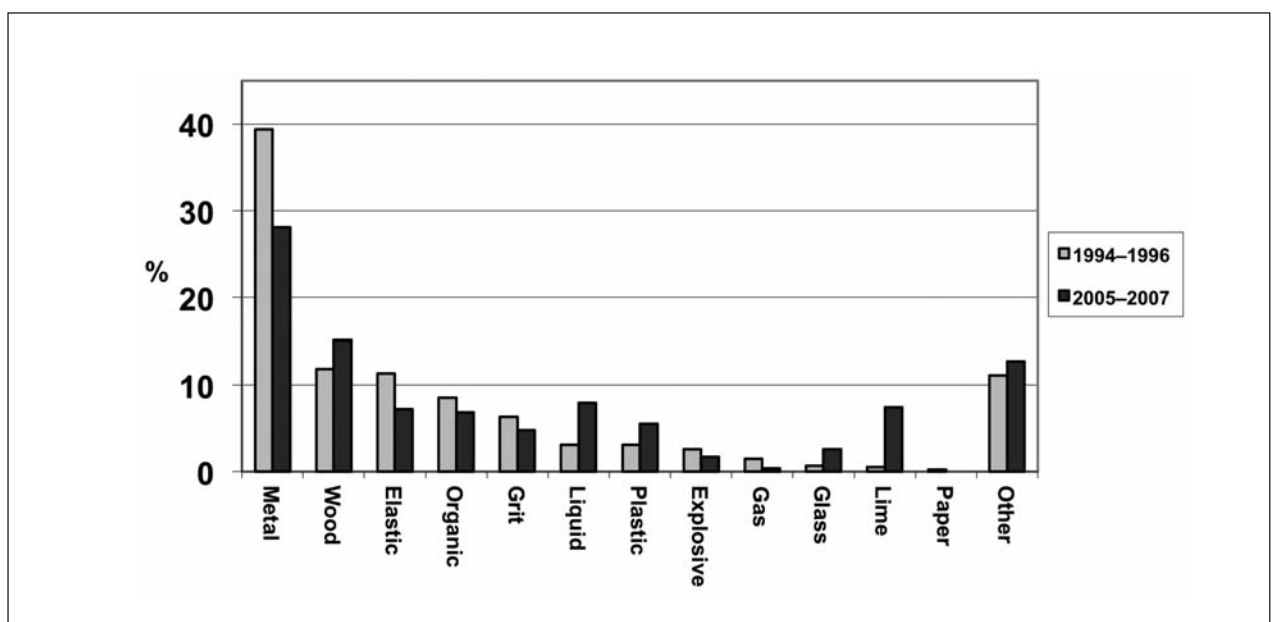


Figure 2. Different materials at the origin of eye trauma: comparison of the two 3-year periods

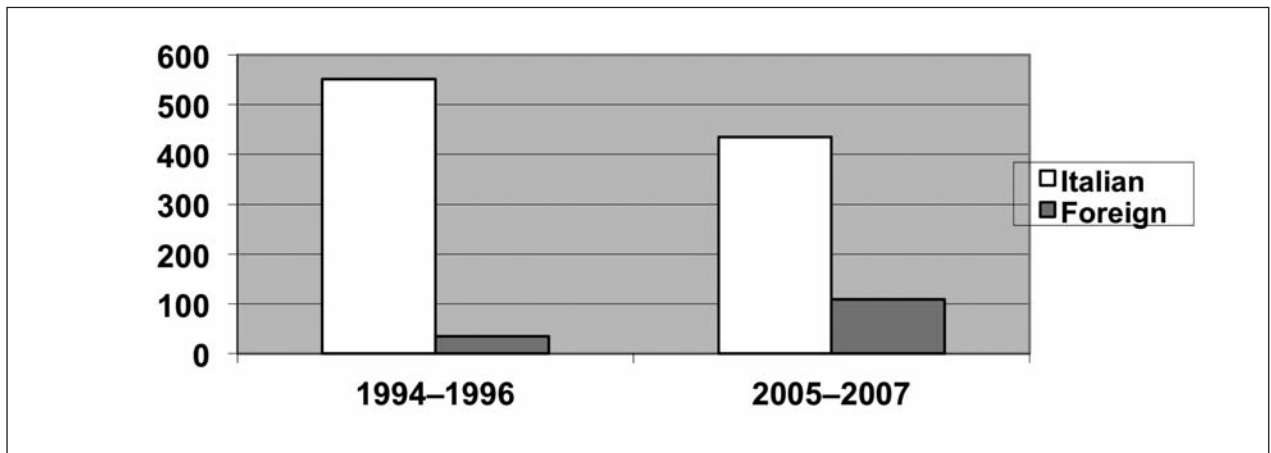


Figure 3 - Comparison of hospitalized Italian patients versus hospitalized foreign patients in the two 3-year periods

DISCUSSION

This study provides important information on clinical and epidemiological characteristics of medium and high severity work-related and non-work-related ocular traumas in the highly industrialized province of Brescia in Northern Italy. We evaluated the epidemiology of eye traumas in the same territory for 3 consecutive years, each 10 years apart. The socioeconomic characteristics of the population have changed in this third millennium, including an increase in foreign workers employed in the metallurgical and building and construction industries. A better and deeper knowledge of the characteristics and causes of eye injuries can promote efforts to improve primary prevention in this area.

Comparative statistical analysis of both 3-year periods allowed us to confirm that in this highly industrialized province, gender (male:female ratio=6.5:1), social class (work-related: 35.8%), and tasks performed (non-work-related:work-related ratio=1.04:1) were related to the frequency of eye injuries. As expected, the disaggregation of data by gender showed a higher prevalence of eye injuries in males in both periods. We also found that mean age was lower in males due to the prevalence of young men employed in 'at-risk' work. Additionally, in both the 3-year periods, the unskilled workers category suffered the most injuries, followed by skilled workers and service industry workers. The

main difference in the second 3-year period was the significant increase in the percentage of foreign patients hospitalized for eye injuries, suggesting changes in immigration trends in northern Italy. One of the most interesting findings was the increase in chemical burns ($p < 0.001$) in the second 3-year period, mostly attributable to alkaline substances such as lime or quicklime. In the second 3-year period, 14 out of 29 eye injuries due to quicklime occurred in foreign workers. The increase in foreign workers (immigration to Brescia increased from 3.3% in 1995 to 12.5% in 2005, according to Italy's National Institute for Statistics) in the building and construction sector may have contributed to this increase.

Work-related trauma was the main cause of eye injury, confirming the recent scientific literature on ocular trauma in northern Italy (5). These types of trauma are mainly responsible for loss of visual function, a serious handicap for the patient. In some of these cases, eye injury led to nearly complete vision loss or anatomical loss of the eye globe with strong aesthetic impact and consequent psychological effects. The decrease in intraocular foreign bodies in open globe injuries was particularly significant ($p = 0.02$). This decrease may be attributed to the increased use of personal protective equipment, especially in the metalworking industry and trade. The general reduction in serious ocular traumas (e.g. intraocular foreign bodies, blunt traumas, and eye injuries caused by elastic materials)

could be considered the first success registered in the second 3-year period. Severe blunt traumas also showed a significant decrease, from 41.6% in 1994–96 to 29.8% in 2005–2007 ($p < 0.001$).

According to data from the Italian National Insurance Institute for Work Accidents, 1 eye injury occurs every 10 min, 140 cases of ocular injuries are recorded every day, and of these, 4 cause permanent disability. Moreover, 1 worker out of 300 (0.37%) suffers an eye injury every year. Stricter safety standards and safety controls are important issues for work sites. Domestic eye injuries still account for a significant number of ocular traumas. The increase in Italy's elderly population and the misuse of so-called 'power tools' are well-known risk factors for eye injuries in the domestic environment. A recent Australian study showed that 47% of recorded domestic injuries were caused by tools and equipment (17). Road accident-related eye injuries showed a significant reduction in the second period, from 7.8% to 3.7% ($p < 0.004$). These data are in agreement with previous literature that reported a decrease from 25%–30% to 12%–15% in penetrating eye injuries caused by road accidents. This may be a result of changes in speed limits and the cumulative protection of seat belts and airbags (2, 11). However, despite the introduction of new safety systems, an increase in blunt trauma and facial backlash has been observed. Kuhn et al. reported a 2.5% decrease in eye injuries after the introduction of airbags (12). The decrease in work-related eye injuries from 37.3% in the first period to 35.8% in the second period was not significant.

It has been demonstrated that unilateral blindness can dramatically decrease the quality of life. Recent national legislation (e.g. D. Lgs. April 9, 2008 n. 81), in accordance with European Union guidelines, has improved safety controls and standards for workers, but prevention campaigns and diffusion of the so-called 'safety culture' must continue. Cooperation among occupational physicians and ophthalmologists can provide a better understanding of the epidemiology of work-related and non-work-related eye injuries. It can also lead to more effective primary prevention strategies. In fact, targeted scientific suggestions for the adoption

of higher safety standards, as well as information and educational campaigns both in work-related and non-work-related areas, may significantly reduce the high risk of eye injury.

NO POTENTIAL CONFLICT OF INTEREST RELEVANT TO THIS ARTICLE WAS REPORTED

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