

## CHANGING PARADIGM IN OCULAR TRAUMA OVER 15 YEARS

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### Abstract:

Background: Changing profile of work force can give rise different types of injuries Purpose: To analyze causative factors (Host-Agent-Event) in ocular trauma over last 15 years Methods: Hospital based prospective study during 1997-2012. Detailed information on nature of trauma; agent and setting were recorded. Results: Cohort included 12365 eye injuries, 1241 serious cases. Prevalence - 0.45 /10000 Mean age 45.8 with bi- modal pattern of incidence, 3:1 male –female ratio. 80% closed globe, 48% workplace injury (90% in marginal laborers with an exponential annual increase). 10% cases from garage mechanics. 60% of eye injuries in female were related to “social violence”. Multivariate analysis has detected new causative agents. Conclusion: Significant change in parameters of trauma (Host-Agent-Event) is resulting in paradigm shift in eye injury. Unorganized unaccustomed labor in workplace injury and “social trauma” in females has become an important cause of eye injury.

**Keywords:** Injury, Eye injury, Ocular Trauma.

### Introduction

The word "injury" came from the Latin words "in+jus" which mean “not right”. This refers to human damage from acute exposure to physical and chemical agents. Worldwide eye injury is a major cause of monocular visual impairment but this often misses the epidemiologist’s list as it rarely makes a person blind. The impact of ocular trauma can be enormous as population at risk is usually the productive age groups. Moreover, potential person- day’s loss of work associated with treatment of the

sequel of the trauma can have significant impact. <sup>[1, 2]</sup>

Advanced therapeutic modalities over the last decade along with increased public awareness and automation helped significantly to reduce ocular morbidity. But incidence of ocular trauma particularly industrial eye injuries has not declined. Rapidly dwindling regular workforce, replaced by contract /marginal worker worldwide can give an explanation to this paradox. According to census (2011) population of marginal workers has increased to 26% from 22%. In absolute

term, out of 480 million workers 120 million are engaged as contract basis who contributes significantly to one of the fastest growing GDP in the world.<sup>[3]</sup> They are less trained and by definition work for less than six months, so more prone to injuries often leading to more disastrous consequences both physically and economically.

Due to population growth, massive migration in the labor force from rural to urban and from agriculture to industry accompanied by a heavy dependence on the service sector has become very common. As a result, more and more people are becoming exposed to injury producing agents such as mechanical, electrical, thermal or chemical energy. In the world today, mechanical energy has remained the most important cause of injury but the paradigm is changing as far as the host –agent factors are concerned.<sup>[3, 4]</sup>

Another category of ocular trauma, least addressed is injury in females which can be considered as tip of Iceberg.<sup>[5]</sup>

Looking up into the literature, we could not find any study on ocular trauma in these categories.<sup>[6]</sup>

On this background we conducted a prospective study on ocular trauma at our health service network as an on-going project. Bokaro in Jharkhand is the most industrialized zone in India with biggest steel plant in Asia. In next five years half of Indian steel will be produced here. Marginal labor in Jharkhand is highest in India. Ocular trauma in and around steel plant has impact on this.<sup>[7]</sup>

Methods:

A prospective interventional study on all cases of ocular trauma attending our healthcare network has been going on since 1995.

Detailed information on nature of trauma, agent and setting are analyzed during 1997-2012. Serious cases are those who had visual impairment on presentation/advised rest for more than 24 hours/hospitalized for treatment.

All injuries are accidental in nature except those uncategorized injuries which are inflicted upon with an ulterior motive.<sup>[8]</sup> This last group has never been studied or included in any literature

Population covered by this study includes different categories of workers catered by extensive healthcare network which includes 910 bedded super-specialty hospitals, Occupational Health Service center, health centers and peripheral developmental centers. Thus, any study using this healthcare service system represents a proper worker profile who sustain ocular trauma during last 15 years. A comprehensive ocular examination is carried out at the main hospital after obtaining necessary informed consent. Detailed demographic, medical, and surgical history from each participating subject is recorded. Past history of ocular trauma in any eye from subjects participating in the study was elicited using the question “Have you ever suffered from any eye injury in the past?” Details of the most recent event of trauma as recalled by the subject, including the type of injury, the age at trauma, the setting of injury, and place of initial intervention were recorded. The ophthalmologist rechecked for a history of injury if signs of ocular trauma were evident on clinical examination but a history was not available on patient interviews. The ophthalmologist also determined whether trauma was an underlying cause for decrease in visual acuity for subjects with visual acuity worse than 6/18 in any eye.

Statistical Analysis:

Patient who requires hospitalization/rest from duties for 24 hour or visual impairment is categorized as serious injury. Vision impairment is defined as best-corrected visual acuity between 6/18 and 3/60 in the better eye, and blindness as best corrected visual acuity worse than 3/60 in the better eye.<sup>[7]</sup> Estimation of the age-adjusted (adjusting to population of India as per Census2011) prevalence with 95% confidence intervals (CI) for blindness

caused by trauma was done. Confidence intervals for prevalence estimates and odds ratios (OR) was calculated from the regression analyses. The chi-square and Fisher exact test is applied to look for significance between categorical variables as appropriate. We used the youngest age at trauma to determine the mean age at trauma and for analysis involving age at trauma for subjects with trauma in both eyes.<sup>[8]</sup> We estimated the OR (95% CI) for factors associated with trauma and with blindness from trauma in a multiple logistic regression model that included gender, education, and occupation as variables. Mantel-Haenszel Odds Ratios were estimated to determine whether the type of trauma, education of subjects, or occupation determined the use of services from an eye specialist or a traditional healer. We considered P values 0.05 as significant.

All analyses were conducted after applying the appropriate record weights. For each year (1997–2012), eye injury incidence rates were calculated both overall and according to gender, race, using denominators obtained from India Census 2011. As everyone in the population was theoretically at risk for eye injury, this denominator is appropriate.<sup>[6]</sup> Frequency distributions were created for injury type and cause. Poisson regression was used to calculate the trend in the rate of eye injury over the study period.

#### Results:

As ocular trauma is an outcome of host-event-agent interaction, results of this study are analyzed systematically.

#### Who (cases):

During last 15 years (1997 to 2012), 12365 eye injuries were registered in this prospective Study. Mean age is 45.8 with bi-modal pattern of incidence highest among 3rd and 6<sup>th</sup> decade., 3:1 male – female ratio. (n9273: n3092). Mean incidence of ocular trauma remained almost stationary over 15 years and tabulated in Figure 1. Mean incidence remained around 824.

5936 cases (48%) workplace injury included 5333 cases or 90% in marginal laborers with an exponential annual increase. 595 cases or 10% cases from garage mechanics. (Figure 2)

1862 cases or 60% of eye injuries in female were related to “social violence”. Multivariate analysis has detected new risk factors

#### What (types of injury)?

Commonest injury was of non-serious category which had no visual impairment or did not require hospitalization or rest from duties (n111234). This category includes corneal abrasion, traumatic conjunctivitis, sub-conjunctival hemorrhages, hydraulic oil spillage. Out of 1241 serious cases, 80% had closed globe injury. Open globe injuries included perforation with metal splinter, road traffic accident (Figure 10), roadside accident (stone flying from speeding wheels)

Pediatric age group (<16yrs): no serious injury case is registered but characteristic injuries include abrasion from fingernail and blouse hooks. Older children had more serious eye injuries mostly sports related (gilli danda, shuttle cork, cricket ball, cycle handles etc.). Self-inflicted injuries were registered among school goers without serious consequences.<sup>[8]</sup>

Over the counter medicines in agricultural eye injuries had blinding corneal ulceration which leads to intractable panophthalmitis in 12 cases which led to evisceration in 80% cases.<sup>[9]</sup>

#### When:

Mean yearly incidence of serious Festivity injuries is 18.5 which include fireworks injury (unexploded firecracker, falling rocket sticks etc. during Diwali, serious ophthalmia nodosum due to caterpillar while collecting banana trees for festivity. During Holi fall on hand pumping tub well caused blinding open globe injury in 4 cases (Figure 12). Muharrum time injuries include perforating injuries by fluorescent tube lights, sharp weapons.

**Nature:** Prevalence - 0.45 /1000 (Bokaro population 2011: 20 lakhs) 80% closed

globe, mean yearly Incidence of injury 824 cases /year which has not changed significantly during the study period (1997-2012). From the study population, calculated prevalence is .045/1000. Necessary correction was applied as this was not a population based study.

Eye injury in marginal workers was increased from 280 cases in 1997-2000 to 680 in 2000-12 which is highly significant statistically ( $p < 0.01$ ) depicted graphically in Figure:2.

Social injury in females has also shown a distressing and statistically signifying rise from 180 in 1997-2000, to 232 in 2000-2012 shown by a bar diagram in Figure2.

This can be explained by increase in female marginal workers and social violence

In male, incidence is rising due to marginal labor increase, increase in agricultural laborers as compared to cultivator.<sup>[2]</sup>

Household industry related injuries increased from 8 cases in 1997 to 24 in 2012 mainly due to unaccustomed laborer, use free distribution of “gifts” (bicycles which are poorly maintained) and preventive articles (mosquito nets for malaria, dengue without proper back up where strings are often very sharp).

Motor vehicle specially bikes related injury registered a leap from 12 in 1997 to 82 in 2012 due to untrained and unauthorized workshops. 50% of which result in visual impairment

Fencing related injury has increased from 12 cases in 1997 to 24 in 2012 due to use of metallic sheets in place of hedge/bamboo.

Incidence of blinding eye injuries remain study with 1.6 cases /year, however outcome has improved in potentially blinding trauma due to better surgical infrastructures.<sup>[9, 10, 11]</sup> Significant reduction in excision of eyeball has been seen (2.1 cases/year during half of this study period and only 1 case in second half).<sup>[12]</sup>

Complicated old injuries (Figure 12): Closed globe wound due to blunt trauma,

firecracker gradually deteriorated to intractable glaucoma in 12 cases out of 1241 serious injuries whereas old perforating injuries progressed to retinal detachment and phthisis bulbi in 18 cases.<sup>[13, 16]</sup>

### Discussion:

Ocular trauma is a major cause for monocular vision impairment and blindness worldwide but does not cause bilateral visual loss or, hence, blindness except in rare situations.<sup>[12,13]</sup> However, considering the impact of blindness, that the population at risk is usually the productive age groups, and the potential person- day's loss of work associated with treatment of the sequel of the trauma, the impact of ocular trauma can be enormous.<sup>[14]</sup> It has become more important as rapidly declining regular workforce, replaced by contract /marginalized laborer. During last decade (2001-2011 census data), India GDP has become one of the fastest in world economy. However, participation by marginal laborers has increased from 22% to 26% of total workers (120 million out of total 480 million workforces in India. As they are less trained and by definition work for less than six months, is more prone to injuries and more disastrous consequences both physically and economically. Executive report of Census 2011 has highlighted following facts which is the probable explanation for this paradigm shift: <sup>[1]</sup>

- a. Broad categories of economic activities also known as four-fold classification of the workers (Figure 7), are, Cultivators (CL), Agricultural Laborer's (AL), working in Household Industries (HHI) and Other Workers (OW). The cultivators and agricultural laborer's broadly show the workers engaged in the agricultural sector, except those engaged in plantation activities, which, over the Censuses, have been considered as a part of 'other workers'.
- b. In Census 2011. out of 481.7 million total workers, 118.7 million are cultivators and another 144.3 million are

agricultural laborer's. Thus, nearly 55 per cent of the workers are engaged in agricultural activities compared to 58.2 per cent in Census 2001. About one-in-two males and two of every three females are engaged in agricultural activities either as a cultivator or an agricultural laborer. Of the remaining workers, 18.3 million are in household industries and 200.4 million are other workers.

- c. During the decade 2001-11, the Census results show a fall of about 9 million in cultivators and an increase of about 38 million in agricultural laborer's. The household industries have shown an increase of 1.4 million and other workers have increased by nearly 49 million.
- d. The fall in the number of cultivators, during the decade 2001-11, was less pronounced among the male workers. In census 2011, the number of male workers decreased to 82.7 million from 85.4 million in Census 2001. Among the females, the number of cultivators has reduced to 36.0 million in Census 2011 from 41.9 million in Census 2001.
- e. Among the States/UTs, Uttar Pradesh has reported the highest numbers in all the categories of workers, with 19.1 million cultivators, 19.9 million agricultural laborers', and 3.9 million in household industries and 22.9 million as other workers.

Bokaro in Jharkhand is the most industrialized zone in India with biggest steel plant in Asia. In next five years half of Indian steel will be produced here. Ocular trauma in and around steel plant has impact on economy. Hence an on-going prospective interventional study is going on since 1997. Incidence and prevalence in this study is comparable to world literature. Eye injuries in marginal workers has increased significantly over the last decade which can explained from the census data of India registering steady increase in marginal workers .90% of work related injuries were seen in this group of workers.

(Figure 3,4) But as there is no published literature on this, our data cannot be compared. Jharkhand has the highest population of marginal laborer's (26% of India) which can explain higher and increasing trend in eye injuries.<sup>[1]</sup>

It is well-known fact that every 15 seconds, a worker dies from a work-related accident or disease and every 15 seconds, 160 workers have a work-related accident every day, 6,300 people die as a result of occupational accidents or work-related diseases – more than 2.3 million deaths per year. 317 million accidents occur on the job annually; many of these resulting in extended absences from work.<sup>[8]</sup> The human cost of this daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated at 4 per cent of global Gross Domestic Product each year. The safety and health conditions at work are very different between countries, economic sectors and social groups. Deaths and injuries take a particularly heavy toll in developing countries, where a large part of the population is engaged in hazardous activities, such as agriculture, fishing and mining. Throughout the world, the poorest and least protected - often women, children and migrants - are among the most affected.

Since long, injuries were considered synonymous with "accidents" implying that occurrence of such events was sudden and caused by external factors.<sup>[7]</sup> Assuming that these factors were random and uncontrollable acts of fate and luck, injuries remained a neglected field of research in the past. Some studies have been carried out in developed countries to estimate the magnitude, severity and consequences of injuries and accordingly appropriate safety measures, laws and regulations have been devised to prevent them. Recently, the epidemiologist of developed countries has expanded their area of etiology of diseases to include injury and have contributed towards the understanding of causal relationships



among risk factors, events and the outcomes of injury. In contrast, so far not much attention has been paid to injury awareness, prevention and control in the developing countries. Not many efforts are made to learn from the experiences of developed nations and a very few open fora are organized in the developing countries for the dissemination of research findings of the developed nations.

Pioneering work on defining agents of injury was done by J.E. Gordon; he suggested that injuries behaved like classic infectious diseases and were characterized by epidemic episodes, seasonal variation, and long-term trends and demographics distribution.<sup>[1]</sup> He further argued that each injury was the product not of one cause, but of forces from at least three sources which are the host, the agent itself and the environment in which host and agent find themselves.<sup>[5]</sup> Our results can clearly be explained by Gordon's theory.

According to Haddon,<sup>[14]</sup> unlike disease, the exposure causing injury is sudden and the damage is quick and severe; besides energy induced or exposed, injury also results from absence of essentials such as lack of oxygen or heat. Haddon further expanded the work of Gordon by including time dimension in injury producing factors and created a landmark in the prevention measures of injury; often referred to in the literature as "the Haddon Matrix". The matrix includes three phases of injury as "pre-event", "event", and "post-event" as rows and the interacting factors, which cause injury over time as columns, include host, agent (or vector) and environment (physical and socioeconomic).<sup>[14]</sup> The World Health Organization (1977) in its International Classification of Diseases tried to explain the typology of injuries in terms of external causes (agents) and associated pathological outcomes.<sup>[6]</sup> The classification has helped a great deal in addressing the issues of acute effects and long-term disability resulting from injury; however, it failed to provide adequate

attention to the associated socioeconomic and psychological consequences.

Domestic violence is rooted in a dynamic of unequal power and control that escalates to physical, Sexual, or psychological abuse. In homosexual relationships, this dynamic is often compounded by homophobia and the victim's fear that sexual orientation will be exposed. Domestic violence is the second leading cause of injury to all US women and is the leading cause of injury to American women 15 to 44 years old.<sup>[5]</sup> Approximately 25% to 45% of abused women are beaten during pregnancy. Of women seeking medical assistance at emergency departments, 22% to 35% are there because of domestic abuse, and of these, only 5% have their situations correctly identified. Partner abuse observes no ethnic, geographic, religious, or socioeconomic boundaries. Some studies suggest that abusers probably experienced violence during their own childhoods and probably abuse alcohol. (Figure 14)

Our study result has shown disturbing in "social "eye injuries due to acid attacks, dowry exploitation etc. This is very important finding of this study (hitherto unreported) as intervention at this stage can prevent lethal consequences.<sup>[2, 5]</sup>

Furthermore, most of the social injuries in females and work injuries in marginal workers are not "notified "to appropriate administrative authorities but treated with secrecy from abuser/employer due to complex socioeconomic reasons.<sup>[13]</sup> Hence this study emphasizes bigger role of an eye care provider in days to come. (Figure 5,6) The greatest change in the paradigm of ocular trauma is yet to come: understanding ever-changing pattern in "host-agent-event reaction" in eye injury will enable us to prevent, treat and rehabilitate the affected.

#### **Conclusion:**

Increasing eye injuries in marginal workers and rising "social injury "to female eyes are indicators of socioeconomic imbalance. An accident is an opportune time for secondary

prevention messages. Ocular trauma at workplace is a sentinel event, indicative of failure of protection in that system – an eye care provider should capitalize on this opportunity to send a strong message to the employer, administration and society. (Dr Frost)” Ophthalmologists have a huge role to play to dramatize the problem. They see the drama of failure. You can look at statistics, rate in graphs and charts, but one photo or description of the devastation of an eye injury to get people ponder blindness is very powerful. The horror of the Medical outcome speaks very loudly”.

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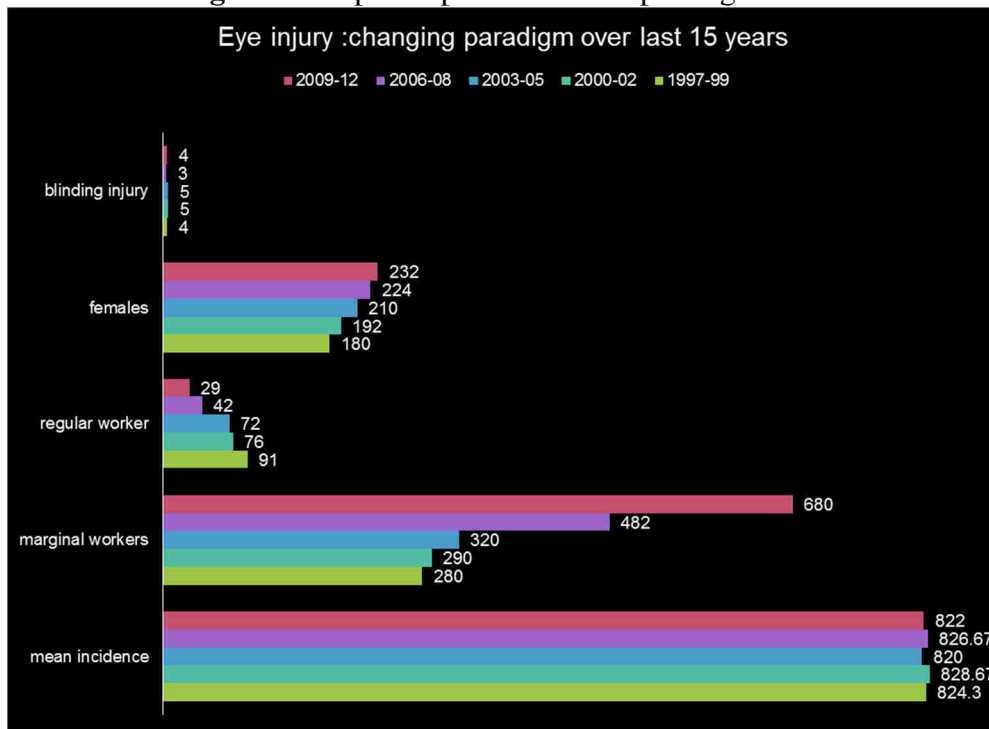
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**Figure-1** Incidence of ocular trauma over one and half decade: paradigm shift

	1997-99	2000-02	2003-05	2006-08	2009-12
Mean	824.3	828.6	820	826.7	822
Standard deviation	2.0	2.0	2.0	2.0	2.0
Sample size	2473	2486	2460	2480	2466
Std. error of mean(SEM)	0.04	0.04	0.04	0.04	0.04
Lower 95% conf. limit	824.25	828.58	819.92	826.58	821.92
Upper 95% conf. limit	824.41	828.74	820.08	826.74	822.08



**Figure-2** Graphical presentation of paradigm shift



**Figure-3** Increasing incidence of eye injuries in marginal workers

	1997-1999	2009 -12	total
Ocular trauma in marginal workers	280(11%)	680(26%)	960(37%)
Mean incidence of trauma	824(32%)	822(32%)	1646(63%)
Total	1104(42%)	1502 (68%)	2606(100%)

**Fisher's Exact Test**

The numbers are too large for Fisher's exact test. The chi-square approximation was performed instead.

The one-sided P value is < 0.0001, considered extremely significant.

The row/column association is statistically significant.

Calculation details:

Chi-square statistic (with Yates correction) = 107.56

Degrees of freedom = 1

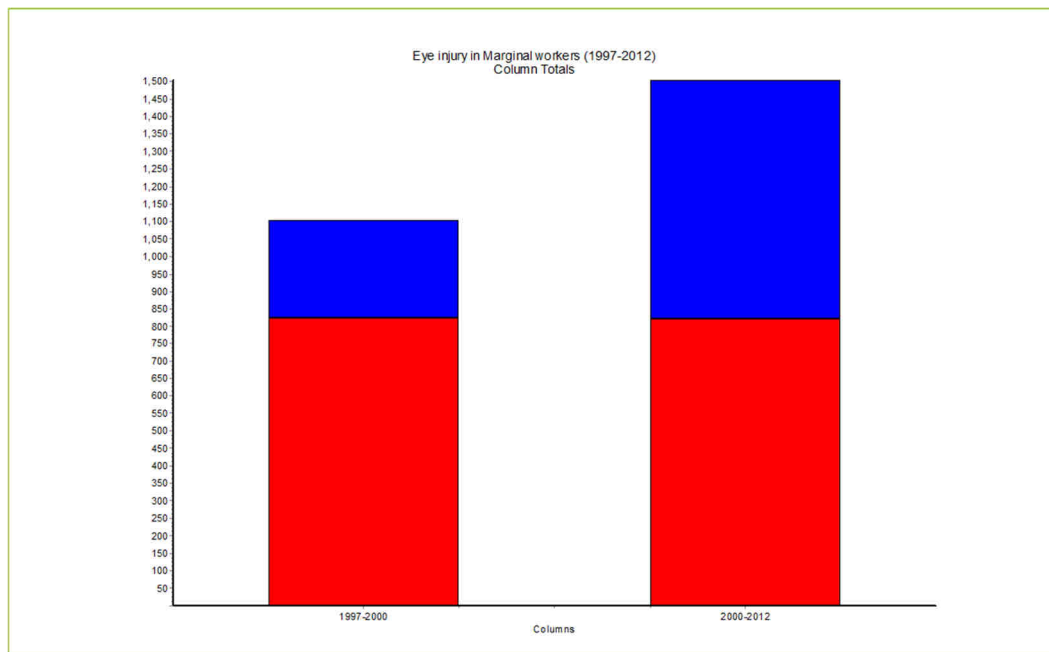
Odds Ratio

Odds ratio= 0.4108

95% Confidence Interval: 0.3467 to 0.4866

(Using the approximation of Woolf.)

**Figure-4** Eye injuries in marginal workers over a decade

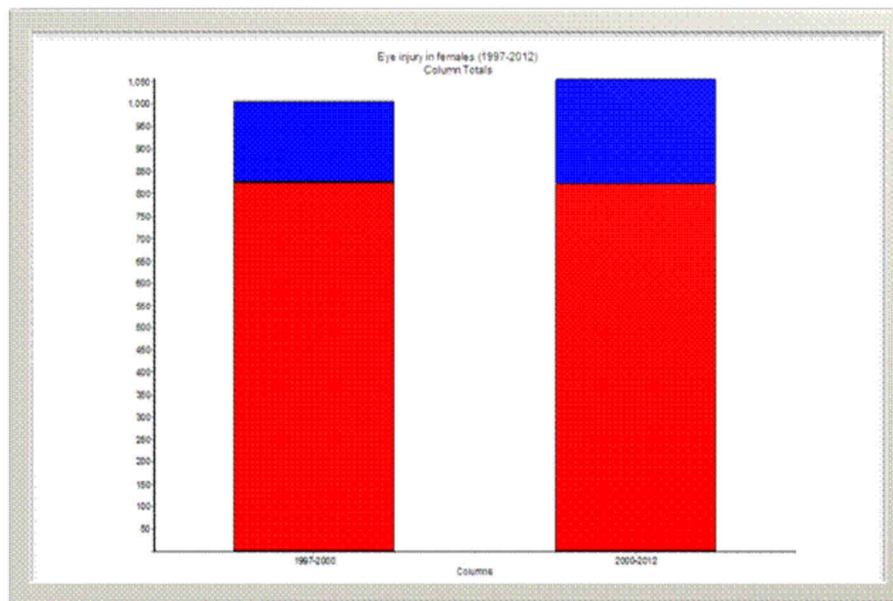


**Figure-5** Incidence of ocular trauma in females

	1997-1999	2009-12	total
Ocular trauma in females	180(9%)	232(11%)	412 (20%)
Mean incidence of trauma	824(40%)	822(40%)	1646(80%)
Total	1004(49%)	1054 (51%)	2058 (100%)

**Chi-square Test**  
 The two-sided P value is 0.0239, considered significant.  
 The row/column association is statistically significant.  
 Calculation details: Chi-square statistic (with Yates correction) = 5.102. Degrees of freedom = 1  
 Relative risk = 0.8727, 95% Confidence Interval: 0.7742 to 0.9838 (using the approximation of Katz.)  
 Difference between the two proportions  
 Top row (females):  
 Fraction in the left column: 0.4369  
 95% Confidence Interval of that fraction: 0.3887 to 0.4866  
 Bottom row (Mean incidence):  
 Fraction in the left column: 0.5006  
 95% Confidence Interval of that fraction: 0.4770 to 0.5242  
 Difference:  
 Difference between the fractions: 0.06371  
 Standard error of the difference: 0.02754  
 95% confidence interval of difference: 0.009731 to 0.1177

**Figure-6** Rising incidence of "social eye injuries" in females



**Figure-7** Diverse categories of Marginal workers due to rapid urbanisation



**Figure-8** Reducing incidence and severity of fireworks injuries due to seasonal intervention



**Figure-9** Unaccustomed labour has become an important cause of eye injuries worldwide





**Figure-10** Bad roads and over crowding flouting safety norms are important risk factors



**Figure-11** Faulty protection devices are important cause of industrial injuries



**Figure-12** Injury with handle of tube well due to slippery floor around is an important cause of blinding eye injury



**Figure-13** Better outcome due to surgical precision and early intervention



**Figure-14** Increasing female marginal workers and violence against women particularly acid attack victims are adding to paradigm shift in ocular trauma

