Epidemiology of Compensable Work-Related Ocular Injuries and Illnesses: : Incidence and Risk Factors

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Abstract **Author Information** **Authors** **Article Outline** **Outline**

Incidence rates of work-related compensable ocular injuries/illnesses and associated risk factors were estimated by using a state-managed workers' compensation database. The annual incidence rate was estimated to be 537 per 100,000 employees. The majority of the ocular injuries and illnesses resulted from foreign bodies in the external eye (incidence rate 194 per 100,000 employees). Incidence rates for superficial eye injury, atopic conjunctivitis, burn, keratitis, chronic conjunctivitis, and contusion were 168.3, 30.9, 28.0, 23.4, 17.9, and 15.3 per 100,000 employees, respectively. The highest incidence rate was observed in the agricultural sector, with male employees having higher rates than female employees. Cooks, housekeepers, and food service workers had higher risk of atopic conjunctivitis (relative risk, 3.2 to 7.3) compared with other workers. The majority of the atopic conjunctivitis illnesses and burn injuries were associated with chemical exposures. Reduction of exposures and targeted intervention among high-risk workers should reduce the incidence of work-related ocular injuries and illnesses.

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Work-related ocular injuries may lead to eye lesions of all degrees of severity, ranging from transient conjunctivitis to complete destruction of the eyeball. Little is known about population-based incidence rates of various work-related ocular injuries/illnesses and associated risk factors. National estimates [1] for all ocular trauma (occupational and non-occupational) range from 1 million [2] to 2.4 million per year [3] in the United States. These estimates may represent a lower figure than the actual amount inasmuch as many trivial ocular injuries go unreported. Work-related injuries accounted for more than a quarter of all serious eye injuries; however, this estimate varies across studies. [4–6] An estimated 1000 ocular injuries occur in the workplace each day, [7–8] and the total ocular injuries resulting in temporary or permanent disability (most of which are preventable) may approach 70,000 annually. [9–10] Based on data from the National Electronic Injury Surveillance System, the National Institute for Occupational Safety and Health estimated that 900,000 occupational eye injuries occurred in 1982, 84% of which were minor and mostly caused by ocular foreign bodies. [7]

The majority of the published literature has estimated work-related ocular injuries from hospital or clinic records and is likely to capture serious cases only. [1,11–17] In addition, most published reports present data on specific occupations, industries, or age groups. [18–22] Saari and Parvi [23] estimated compensated eye injury accidents (3 or more days away from work) in Finland and found the highest rate (4.96 to 6.88 per 1000 employees) among metal industry employees. However, this figure will be an underestimate of the true incidence rate because most work-related ocular injuries or illnesses such as foreign bodies to the external eye, superficial ocular injuries, keratitis, and atopic conjunctivitis do not usually require days away from work and were excluded.

To date, the incidence and associated risk factors for ocular injuries and illnesses that resulted in documented medical treatment and/or lost wages across various occupations and industries in a total worker population have not been documented. In this study, we estimated the incidence rates of ocular injuries/illnesses and associated risk factors among the total worker population of a state. Our data captured both hospitalized and non-hospitalized injury or illness cases across major industries and occupations and, as such, represent population incidence rates and risks.

Methods

Sources of Data

West Virginia is one of the five US states that has a state-mandated workers' compensation insurance system. All regular subscriber employers to West Virginia's Workers' Compensation fund pay premiums based on total payroll, previous 3-year claims experience, and specific risk classifications. This system ensures lost time, medical expense, and disability coverage of all work-related injuries in the insured

population. A small percentage (<15%) of employers are self-insured but submit all work-related injury/illness claims and costs to the Workers Compensation Division. Therefore, the workers' compensation claims database contains most of the work-related injuries and illnesses in the state's workforce. We obtained claims data on all ocular injuries and illnesses that occurred between July 1, 1997, and June 30, 1998, and were reported to the West Virginia Workers Compensation Division. Although most claims are likely to be filed within 90 days of injury or illness, some may be reported later. We collected our data at the end of September 1999, which is 27 months after the July 1, 1997, injury/illness date and 15 months after the June 30, 1998, injury/illness date. This defines the range of follow-up for each case as between 15 to 27 months.

Estimation of Incidence Rates

The West Virginia Bureau of Employment Programs maintains data on the civilian labor force adjusted to the current population survey provided by the Bureau of Labor Statistics. The statewide data pertaining to annual covered employment and total wages paid to employees are published annually on a calendar-year basis. Industry detail is classified according to the *Standard Industrial Classification Manual* (1987) for all covered employment.

The denominator was the total number of workers in each specific industry class (based on specific industry class codes) reported to the West Virginia Bureau of Employment Programs, averaged over a 1-year period. Information on the claimant's age, occupation, and industry of employment was abstracted from claim-related data files. In addition, information on diagnosis (International Classification of Diseases, 9th Revision codes), medical costs, days of indemnity paid for lost wages, time interval until return to work, cause of accident, contributing exposure events, and sources of injury was also obtained. The cause of accident, contributing exposures, International Classification of Diseases 9th Revision diagnosis codes, occupation, and industry were grouped into several major categories.

Proportional Injury Ratios

Proportional injury ratios (PIRs) were used to estimate the relative risks. These were based on the comparison of two of the proportions: the proportion of a specific ocular injury in a specific occupation, and the proportion of a specific ocular injury in all other occupations. An example of how the PIR was estimated, using data on housekeepers, follows: PIR = (A/A+C) ÷ (B/B+D), where A = number of burn injuries to the eye among housekeepers who had any ocular injury or illness; B = number of burn injuries to the eye among all other occupations, C = number of other ocular injuries or illnesses among housekeepers; and D = number of other ocular injuries or illnesses among all other occupations.

Like the risk ratio estimated in a cohort study, the PIR estimates the probability of belonging to one group versus the other, given the attribute, which is an estimate of relative risk under certain assumptions. In the above example, we are interested in estimating the ratio of the probabilities of burn injury to the eye and other ocular injuries or illnesses, given the specific occupation. The 95% confidence interval for the PIR was estimated by the method described by Rothman. [24]

Injury/Illness-Related Characteristics

The West Virginia Workers Compensation database contains information on exposures (eg, chemicals, fume/gas, temperature, harmful substances), causal mechanisms (eg, absorption, rubbed/abrasion, struck by object), materials or surfaces involved (eg, metal objects, building materials, wood, and surfaces not otherwise classified), and specific body part injured (left eye, right eye, both eyes). A descriptive analysis to examine the distribution of these characteristics was done.

Statistical Analyses

Apart from initial descriptive analyses for demographic and injury-related characteristics, we compared selected types of ocular injuries and illnesses using proportional injury/illness ratios. For continuous variables such as age, medical costs, time interval for return to work, and number of days compensated, we used Tukey's test for multiple comparison of means. [25] All data analyses were done by using Statistical Analysis Systems PC software.

Results

Among the 60,718 work-related injuries and illnesses in West Virginia during fiscal year 1998 (between July 1, 1997, and June 30, 1998), 3699 were ocular injuries resulting in either medical care reimbursements, payments for lost wages, or permanent partial disability benefits. For the purpose of this report, we considered these cases as compensable work-related injuries and illnesses.

The annual incidence rate of work-related ocular injuries and illnesses was 567 per 100,000 employees (3699 injuries or illnesses among 652,956 employees). The industry-specific incidence rate was highest for agriculture (agriculture, forestry, and fisheries), followed by the construction and manufacturing sectors. In each industrial sector, including those that employ a greater proportion of female than male employees, male employees had a significantly higher incidence rate of ocular injuries or illnesses (Table 1). Foreign body injury to the external eye was the most common ocular injury, followed by superficial eye injury, atopic conjunctivitis, burn injury to the eye and adnexa, chronic conjunctivitis, and keratitis (Table 2). Penetrating eyeball injuries and corneal opacity were relatively rare, with incidence rates of 3.7 and 4.1 per 100,000 employees, respectively. Incidence rates for the six most common types of ocular injuries or illnesses varied according to industrial class, with the agricultural sector leading in several ocular injury/illness categories (Table 3). Although occupation-specific incidence rates for specific illness/injury category could not be calculated because of the lack of adequate denominators, the distribution of ocular injuries and illnesses by selected occupation was evaluated. Foreign body injury to the external eye and superficial eye injury were the two most common eye injuries/illnesses across all major occupations except for cooks, housekeepers, and food service workers (Table 4). Among cooks, burn injury was the most common ocular injury/illness, whereas among housekeepers, atopic conjunctivitis was the most common ocular injury/illness. Though superficial injury to the eye was the most common affliction among food service workers, atopic conjunctivitis and burn were the second and third most common ocular illness or injury, respectively.

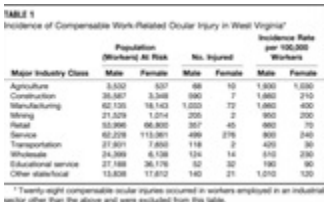
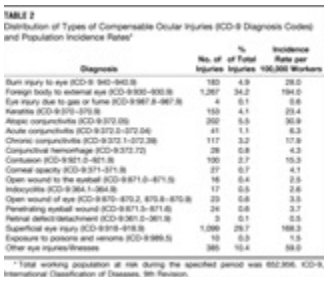


TABLE 1
Incidence of Compensable Work-Related Ocular Injury in West Virginia*

Major Industry Class	Population (Workers) At Risk		No. Injured		Incidence Rate per 100,000 Workers	
	Male	Female	Male	Female	Male	Female
Agriculture	3,532	537	48	10	1,930	1,030
Construction	35,567	3,348	590	7	1,660	210
Manufacturing	62,130	18,140	1,033	72	1,660	400
Mining	21,529	1,014	205	2	950	200
Retail	53,996	66,800	357	45	660	70
Service	62,228	113,061	499	276	800	240
Transportation	27,801	7,800	118	2	420	30
Wholesale	24,399	6,138	134	14	510	230
Educational service	27,188	36,176	52	32	190	90
Other state/local	13,838	17,812	140	21	1,010	120

* Twenty-eight compensable ocular injuries occurred in workers employed in an industrial sector other than the above and were excluded from this table.

Table 1



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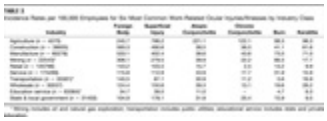

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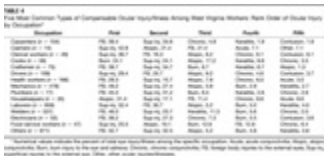


Table 4

The risk of burn and atopic conjunctivitis by occupation was assessed by using PIR. Risk of burn showed a greater than fivefold increase among cooks compared with all other occupations. Similarly, the risk of atopic conjunctivitis was increased in cooks, housekeepers, and food service workers (Table 5). Health service workers and painters also had an elevated risk of atopic conjunctivitis, and welders had an elevated risk of keratitis (data not shown). However, none of the elevated PIRs were statistically significant.

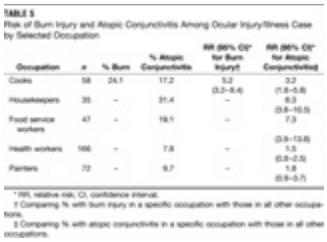
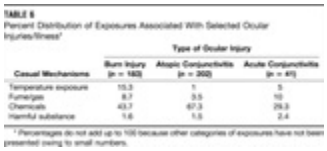


Table 5

Chemical exposure was associated with burn injury, atopic conjunctivitis, and acute conjunctivitis (Table 6). The mechanisms and processes of injury and illness varied across different types of ocular injury/illness category. However, rubbing/abrasion was the most common mechanism of injury or illness across several ocular injury/illness categories (Table 7).



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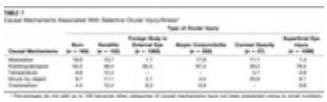

Table 7

Among ocular injury categories (foreign body injury to the external eye, superficial eye injury, and burn injury to the eye and adnexa), average medical cost was significantly greater in the burn cases than for other ocular injuries. The mean age at the time of accident was significantly lower in the burn cases compared with other ocular injuries. Similarly, among ocular illness cases (atopic conjunctivitis, keratitis, and chronic conjunctivitis), average medical cost was significantly greater in atopic conjunctivitis cases compared with other ocular illnesses (Table 8). The mean time interval until return to work and average indemnity days paid did not vary across ocular injury/illness categories.

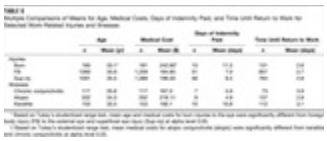

Table 8

Discussion

Although ocular injury/illness is a common occupational occurrence, incidence rate and risk of the most frequent ocular injuries or illnesses in a total worker population have not been documented previously. Most studies have focused on hospitalized ocular injuries or penetrating ocular injuries and have provided some estimation of the incidence rates of serious ocular injuries. [17,26–28] However, a vast majority of work-related ocular injuries and illnesses do not require hospitalization. Though these cases are less costly than hospitalized cases, they contribute significantly to the total burden of health care cost.

Several data sources of occupational injuries are available nationally that capture occupational ocular injury data in various forms. The National Electronic Injury Surveillance System of the Consumer Product Safety Commission [29] reports cases of occupational trauma from a representative sample of hospital emergency rooms. The Supplementary Data System of the Bureau of Labor Statistics obtains information from workers' compensation claims filed in 33 states. [30] In addition, the Annual Survey of Occupational Injuries and Illnesses conducted by the Bureau of Labor Statistics [31] and the National Safety Council [32] provides further population-based work-related injury information. The definition of "recordable injury" is not uniform across these various data sources; therefore, the incidence rate of specific injuries such as ocular injury may vary according to the sources of data. Another source of serious ocular injuries is the National Ocular Trauma System, to which information of severe ocular trauma is submitted voluntarily. [33] Because not all ocular injuries are accounted for and the occupational histories available through these systems are less than

adequate, it is difficult to precisely estimate occupation- or industry-specific incidence rates of ocular trauma. Most of these data sources either do not capture work-related ocular illnesses or do not separate them from ocular injury cases. Therefore, incidence rates of work-related ocular illnesses have not been well documented.

Several studies have estimated the proportion of foreign body injuries to the eye among total work-related eye injury cases. The documented proportions of foreign body injuries to the eye vary between 42% and 84%.[7,17,34–35] These proportions included ocular foreign body injuries to both the internal and the external eye. Our study was restricted to the proportion of foreign body injuries to the external eye, which was found to be 34% with the annual incidence rate of 194 per 100,000 employees. However, these figures are not directly comparable with the figures presented in the previous studies because they represent only ocular foreign body injuries to the external eyes. We estimated the annual incidence rates of ocular injuries to be 537 per 100,000 employees. Although we were unable to compare this incidence rate with others because of lack of data, a literature review revealed that the incidence rate of work-related ocular injury estimated among California workers in 1988 was 1.76 per 100,000 employees.[17] These two rates are not comparable because the numerator contains different inclusion criteria. In our study, we found agriculture, construction, and manufacturing industries to have higher incidence rates of ocular injury or illness than other industries. Masilamani made similar observations in a study in Malaysia.[36]

In their study of ocular injuries resulting in hospitalization, Klopfer et al[37] reported that male patients had higher rates of ocular trauma than female patients; we observed the same. This could be due to the fact that proportionately more male employees are working in higher risk occupations than female employees. In West Virginia, the construction, manufacturing, transportation, and mining industries employ more male than female employees (male:female ratio for construction, 10:1; manufacturing, 3.4:1; transportation, 3.6:1; mining, 21:1) (Table 1). In contrast, more female than male employees are employed in the service industry, education, and state and local government. Despite this shift, female employees had a significantly lower incidence rate of work-related ocular injuries or illnesses in these sectors compared with male employees. In our study, the majority of burn injuries were attributed to chemical exposures (Table 5). Similar observations were made by McCullough et al,[38] who reported that 80% of all occupational burn injuries to the eye resulted from chemical exposures.

One study that focused on penetrating eye injuries showed that the 20- to 39-year old age group had more ocular injuries than older age groups.[27] We found a similar age distribution among all compensable ocular injuries (data not shown). Our results show that the average medical cost was higher in the ocular burn injury cases than for other injuries. Similarly, the average medical cost was higher in the atopic conjunctivitis cases compared with other ocular illnesses. However, the average time interval until return to work and the average days of indemnity paid did not vary across injury or illness categories. This suggests that within broad categories of ocular injuries or illnesses there was less variation in severity.

This investigation provides an epidemiological analysis of ocular injuries and illnesses by using existing work-related injury/illness data. From these data we derived population-based incidence rates of work-related ocular injuries and illnesses. Although many of these ocular injuries are minor, 193 (5.2%) resulted in temporary total or permanent partial disabilities. The most frequent ocular injuries/illnesses and associated high-risk occupations and industries were also identified. In addition, we characterized the exposures and mechanisms associated with these injuries and illnesses. This should help formulate intervention strategies aimed at the prevention of common work-related ocular injuries and illnesses.

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