## Original Article

# Ocular Trauma in a Rural Population of North China: The Handan Eye Study*

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**Abstract**

**Objective** To determine the prevalence of ocular trauma and the proportion of blindness and visual impairment due to trauma in a rural population in northern China.

**Methods** The Handan Eye Study is a population-based cross-sectional study that surveyed 6830 Chinese people aged 30+ years from 13 randomly selected villages in Yongnian County, city of Handan, Hebei Province, in July, 2006. All participants underwent a standardized interview and extensive examinations. A structured questionnaire was used to collect information on ocular trauma.

**Results** Of the 5837 participants who filled out the questionnaire, 124 subjects [2.1%; 95% confidence interval (CI), 1.8%-2.5%] reported a history of ocular trauma in either eye, including 19 (0.3%) persons reporting trauma in both eyes. Men were more likely to have an eye injury than women [odds ratio (OR), 3.3; 2.2-4.9]. In multiple logistic regression models, ocular trauma was significantly more frequent among normotensive participants when compared with hypertensive participants (hypertensive *vs.* normotensive: OR, 0.6; 0.4-0.9) and among participants who had a history of falls (OR, 2.4; 1.2-4.8). The proportion of unilateral visual impairment and unilateral blindness due to trauma were 10.5% (13 subjects) and 21.0% (26 subjects), respectively.

**Conclusion** Our study reports the prevalence of severe ocular trauma among adults in rural China, revealing a high proportion of blindness and visual impairment due to trauma. These findings suggest the need for educational strategies to increase eye health awareness in this rural population with focus on providing at least appropriate first aid care to reduce blindness due to trauma.

**Key words:** Ocular trauma; Population-based survey; Prevalence; Risk factor; Handan Eye Study

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## INTRODUCTION

Ocular trauma is an important, preventable public health problem worldwide. As many as half a million people in the world are blind as a result of ocular injuries. Moreover, it is a major cause of monocular vision impairment and blindness[1-2]. Studies on ocular trauma have shown a higher prevalence of trauma in younger, more active age groups and among people with lower socioeconomic status and relatively lower levels of education[3-9]. Despite the public health significance of this problem, few population-based studies have been conducted on the prevalence and risk factors of ocular trauma, and most of these studies were performed in Western countries[1,7,10-12]. However, a paucity of data remains on the prevalence of ocular trauma in developing countries such as China, and reliable epidemiological data on eye injuries are relatively scarce or are totally lacking in rural China[13]. Much of the information available is based on data provided by outpatient departments, hospital admission/ discharge forms, or emergency departments[14-15], and this methodological approach does not actually estimate the magnitude of eye injuries in the general population. Given that the rural population in China comprises approximately 64% (800 million) of the total population, and this population is generally illiterate, more engaged in agriculture labor, and economically underdeveloped and has less access to eye care services, it is likely that rural populations have a greater burden of vision impairment or blindness caused by trauma.

The objectives of the Handan Eye Study were to determine the prevalence and causes of blindness and visual impairment, the risk factors associated with major eye diseases, the barriers to eye care services, and the quality of life in the visually impaired. In this report, we describe the prevalence, risk factors, and proportion of blindness and visual impairment due to ocular trauma in a rural population in northern China.

## METHODS

The Handan Eye Study is a population-based, cross-sectional study of 6830 (90.4% response) Chinese adults aged 30 years and older that was conducted in July in 2006 from 13 randomly selected villages in Yongnian County, city of Handan, Hebei Province. The details of the study design, sampling plan, and baseline data have been reported elsewhere[16-18]. A total of 13 villages were randomly selected by using a clustered sampling technique with probabilities proportionate to the size of the population in each cluster. A door-to-door census procedure was used to screen 8653 names listed in the selected villages, and 7557 persons were confirmed as eligible. All of the eligible subjects were invited to visit Yongnian County Hospital for a detailed examination including a standardized interview, a comprehensive eye and systemic examination, and laboratory investigations. Of 7557 eligible persons, 6830 (90.4%) participants took part in our study.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The Beijing Tongren Hospital Ethical Committee approved the study, and we obtained written informed consent from all participants. We offered comprehensive ocular examinations at the central clinic in the county hospital, including vision examinations with Early Treatment of Diabetic Retinopathy Study charts, refraction, anterior segment examinations with slit-lamp biomicroscopy, intraocular pressure measurements with applanation tonometry, dilated posterior segment examinations with direct and indirect ophthalmoscopy, and digital fundus photography.

### *Interview*

In order to overcome language barriers and trust issues, all interviewers and coordinators were employed from local hospital or medical schools. Trained interviewees administered standardized questionnaires to obtain demographic information, medical history, family history of eye diseases and systemic diseases, and information about visual function.

A structured questionnaire was used to collect information on ocular trauma. During the course of the interview, the participants were asked specific questions related to ocular trauma that had been validated in previous studies[3,7,19]. The first question related to ocular trauma was, 'Have you ever had any eye injury that caused enough discomfort for you to seek treatment?' If the response was 'Yes', the subject was asked in which eye(s) the injury had occurred. The subject also was asked how many times he or she had experienced ocular trauma. The questions that followed pertained to the most severe trauma in cases of multiple episodes of ocular trauma. The time that had elapsed since the most severe trauma was documented. The subject was

then asked to select the cause of the trauma from a list of possible causes on the questionnaire. These causes included being hit by a blunt object like a fist or a ball, which was defined in our study as trauma caused by blunt objects, injury from a sharp object, glass, knife, or something that penetrated the eye, which was defined as sharp object trauma, and injury due to a chemical burn like acid or lye, which was defined as chemical trauma. Histories of ocular trauma were ascertained by using 7 questions and were defined as any eye injury serious enough to require medical attention from a doctor.

We also validated the self-reported ocular trauma history by cross-checking findings from the results of ocular examinations performed for this study, clinical examination comments, diagnoses related to the causes of visual impairment, visual acuity (VA) levels, and cornea abnormalities such as 'cornea scar' and 'laceration'.

***Vision Loss due to Trauma***

An eye was considered to be blind due to trauma if the best-corrected distance VA was worse than 6/60 due to trauma[20]. If the VA was worse than 6/12 due to trauma, this was considered visual impairment due to trauma. An ophthalmologist determined whether the vision loss and visual impairment was due to trauma based on the history and clinical findings.

***Statistical Analysis***

Data analysis was performed by using Stata version 9.0 for Windows (Stata Corp, TX, USA) and SPSS version 14.0 (SPSS Inc., USA). Logistic regression models were used to assess factors associated with ocular trauma with adjustments for age and sex and additional adjustments for income, occupation, education, marital status, and the presence of diabetes and hypertension. The odds ratios (OR) and 95% confidence intervals (CI) are presented.

## RESULTS

Of the 6830 eligible participants, 5837 (85.5%) completed the detailed interview regarding ocular trauma, and 124 subjects (2.1%; CI, 1.8%-2.5%) reported a history of ocular trauma in either eye, including 19 (0.3%) persons with bilateral ocular trauma. The mean current age of persons reporting a history of ocular trauma was 60.3±8.6 years. Ocular trauma was more common in men (*n*=90; 72.6%) overall as well as for each type of mechanism of injury. Sharp injuries (*n*=42; 33.9%) were the major cause of trauma reported in this population, followed by trauma from a blunt object in 29.0% (*n*=36), chemical burns in 15.3% (*n*=19), and plantrelated trauma in 10.5% (*n*=13). The remaining cases were because of 'other reasons' (*n*=14) (Table 1).

Men had a higher prevalence of ocular trauma than women (age-adjusted OR, 3.3; CI, 2.2-5.0). Younger persons were more likely to have ocular trauma than older persons (per interquartile range increase in age: sex-adjusted OR, 0.83; CI, 0.70-0.97). Moreover, a linear trend was observed between the risk of ocular trauma and decreasing age (trend test, $P<0.001$; Table 2). After adjusting for age and sex, a history of falls was associated with a higher likelihood of having ocular injury (adjusted OR, 2.6; CI 1.3-5.1). Hypertension was associated with a reduced likelihood of ocular trauma (adjusted OR, 0.6; CI, 0.4-0.9; Table 1).

In a multiple logistic regression model that included age, gender, hypertension, and a history of falls, the odds for trauma were significantly higher for males (OR, 3.0; 95% CI, 2.0-4.5). Further, ocular trauma was significantly more frequent among normotensive participants when compared with hypertensive participants (hypertensive versus normotensive: OR, 0.6; 95% CI, 0.4-0.9) and among participants who had a history of falls (OR, 2.4; 95% CI, 1.2-4.8). We found no significant associations between ocular trauma and the presence of diabetes, marital status, types of occupation, individual yearly income, socioeconomic status or education levels, and cigarette smoking after age-sex adjustment (Table 3). The risk factor pattern was similar across different types of trauma.

We identified trauma as the underlying cause for monocular vision impairment (vision between 6/18 and 3/60 after best correction for that eye) in 39 (31.5%) eyes, including 26 of 39 eyes (21.0%) that were considered blind (vision worse than 3/60 after best correction for that eye). Among the 26 eyes that were blind with trauma identified as the underlying cause, 7 (26.9%) eyes had traumatic cataract, 5 (19.2%) eyes were phthisical, 5 (19.2%) eyes had corneal scarring, 4 (15.4%) eyes had surgical anophthalmia, 2 (7.7%) eyes had optic atrophy, 2 (7.7%) eyes were aphakic, and 1 (3.8%) eye had traumatic maculopathy. Trauma was not attributed as an underlying cause for any person with bilateral visual impairment or blindness.

A higher proportion of participants injured by

sharp objects had a best-corrected VA<6/12 (38.1%) compared with those injured by blunt objects (25%) or chemical materials (15.8%). A significant proportion of subjects with trauma [*n*=29 (27.5%)] did not seek further ophthalmologic treatment. Most participants with trauma [*n*=76 (72.4%)] sought treatment from a traditional or local healer.

Of the 107 subjects with a history of ocular trauma, 93 (87.0%) reported a single episode of trauma, 5 (4.7%) reported 2 episodes of trauma, 4 (3.7%) reported 3 episodes, and 4 (3.7%) reported multiple episodes (at least 4 times). Data on the number of traumatic episodes were not available for 17 (1.4%) subjects.

## DISCUSSION

The current study provides data on the prevalence and characteristics of ocular trauma in a Chinese rural population aged 30 years or older in northern mainland China. The age-standardized prevalence of ocular trauma was 2.1%, and the proportion of unilateral visual impairment and unilateral blindness due to trauma were 10.5% (13 subjects, 0.6% of the population) and 21.0% (26 subjects, 0.6% of the population), respectively. A significant proportion [*n*=29 (27.5%)] of subjects with trauma did not seek ophthalmologic treatment.

The prevalence of self-reported ocular trauma in our study is relatively lower than that reported by other population-based studies conducted in Asia or Western countries[1,4,7,10]. However, our prevalence is similar to that reported in Indian studies[5,8]. These differences between countries and populations may be due to variations in age structures and prevalent occupations or may be because of the possibility of recall bias in a cross-sectional study[1,3-8,10,19] (Table 4).

**Table 1.** Prevalence of Ocular Trauma by Age Group and Sex in the Handan Eye Study

| Trauma | *n* | Number of Cases (%) | | | | | | *P*-value for Age Trend | *P*-value for Sex |
|---|---|---|---|---|---|---|---|---|---|
| | | Prevalence (95% CI) | Age Groups (y) | | | | | | |
| | | | 30-39 | 40-49 | 50-59 | 60-69 | 70-80 | | |
| Any ocular trauma | | | | | | | | | <0.0001 |
| All | 124 | 2.1 (1.8-2.5) | 28 (2.8) | 29 (2.4) | 42 (1.9) | 20 (2.0) | 5 (1.1) | 0.03 | |
| Men | 90 | 3.4 (2.7-4.1) | 18 (4.3) | 18 (3.9) | 33 (3.3) | 17 (3.5) | 4 (1.9) | 0.23 | |
| Women | 34 | 1.1 (0.7-1.4) | 10 (1.7) | 11 (1.7) | 9 (0.7) | 3 (0.6) | 1 (0.4) | 0.01 | |
| Blunt object | | | | | | | | | 0.003 |
| All | 36 | 0.6 (0.4-0.8) | 7 (0.7) | 12 (1.0) | 12 (0.5) | 4 (0.4) | 1 (0.2) | 0.09 | |
| Men | 25 | 1.0 (0.6-1.3) | 4 (1.0) | 6 (1.1) | 11 (1.1) | 3 (0.6) | 1 (0.5) | 0.43 | |
| Women | 11 | 0.3 (0.1-0.6) | 3 (0.5) | 6 (0.9) | 1 (0.1) | 1 (0.2) | 0 (0.0) | 0.03 | |
| Sharp object | | | | | | | | | 0.002 |
| All | 42 | 0.7 (0.5-0.9) | 9 (0.9) | 8 (0.7) | 15 (0.7) | 8 (0.8) | 2 (0.5) | 0.55 | |
| Men | 29 | 1.1 (0.7-1.5) | 5 (1.2) | 5 (0.9) | 10 (1.0) | 7 (1.4) | 2 (1.0) | 0.85 | |
| Women | 13 | 0.4 (0.2-0.6) | 4 (0.7) | 3 (0.5) | 5 (0.4) | 1 (0.2) | 0 (0.0) | 0.12 | |
| Chemical burn | | | | | | | | | 0.003 |
| All | 19 | 0.3 (0.2-0.5) | 5 (0.5) | 4 (0.3) | 6 (0.3) | 3 (0.3) | 1 (0.2) | 0.35 | |
| Men | 15 | 0.6 (0.3-0.9) | 3 (0.7) | 2 (0.4) | 6 (0.6) | 3 (0.6) | 1 (0.5) | 0.94 | |
| Women | 4 | 0.1 (0.0-0.3) | 2 (0.3) | 2 (0.3) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.03 | |

**Table 2.** The Association Between Age and the Risk of Ocular Trauma in the Handan Eye Study

| Age (y) | *N* | Cases (%) | Crude | | Adjusted† | |
|---|---|---|---|---|---|---|
| | | | OR (95% CI) | *P* | OR (95% CI) | *P* |
| 1st quartile (30-41) | 1342 | 39 (2.91) | 1 | Ref. | 1 | Ref. |
| 2nd quartile (42-51) | 1368 | 29 (2.12) | 0.72 (0.45-1.18) | 0.193 | 0.7 (0.43-1.14) | 0.155 |
| 3rd quartile (52-58) | 1546 | 27 (1.75) | 0.59 (0.36-0.98) | 0.040 | 0.58 (0.35-0.95) | 0.031 |
| 4th quartile (59-97) | 1581 | 29 (1.83) | 0.62 (0.38-1.02) | 0.058 | 0.58 (0.35-0.94) | 0.026 |
| Trend test | | | | 0.038 | | <0.001 |
| Per IQR increase | 5837 | 124 (2.12) | 0.85 (0.72-0.99) | 0.038 | 0.83 (0.70-0.97) | 0.019 |

***Note.*** † Adjusted for sex, housing type, hypertension status, and history of falls; IQR indicates the interquartile range.

We feel that the prevalence of ocular trauma in our study is most likely an underestimate of the true rate because some subjects may not have remembered past ocular trauma. It is possible that only very severe ocular trauma requiring referral to an ophthalmologist or even hospitalization was reported since the acute nature and the associated symptoms may drive people with ocular injuries to seek eye care. Because much of the information on trauma was collected by recall, people may not have reported minor injuries or injuries sustained at younger ages, especially during childhood.

**Table 3.** Risk Factors Associated with Any Ocular Trauma in the Handan Eye Study

| Characteristics | *n* | Any Ocular Trauma | | | | |
|---|---|---|---|---|---|---|
| | | *n* (%) with self-reported Ocular Trauma | Age-sex-adjusted OR (95% CI) | *P*-value | Multivariable-adjusted† OR (95% CI) | *P*-value |
| Age (y) | 5837 | 124 (2.1) | 0.98 (0.96-0.99) | 0.01 | 0.99 (0.98-1.01) | 0.47 |
| Gender | | | | | | |
| Male | 2643 | 90 (3.4) | 3.3 (2.2-5.0) | <0.001 | 3.0 (2.0-4.5) | <0.001 |
| Female | 3194 | 34 (1.1) | 1.0 | | | |
| Hypertension | | | | | | |
| Yes | 2862 | 41 (1.4) | 0.6 (0.4-0.9) | 0.01 | 0.6 (0.4-0.9) | 0.01 |
| No | 2973 | 83 (2.8) | 1.0 | | | |
| Any falls | | | | | | |
| Yes | 213 | 10 (4.7) | 2.6 (1.3-5.1) | 0.00 | 2.4 (1.2-4.8) | 0.02 |
| No | 5619 | 114 (2.0) | 1.0 | | | |
| Housing type | | | | | | |
| 1-4 rooms | 1121 | 12 (1.1) | 0.5 (0.3-1.0) | 0.05 | 0.6 (0.3-1.1) | 0.10 |
| >4 rooms | 4699 | 111 (2.4) | 1.0 | | | |
| Living alone | | | | | | |
| Yes | 154 | 2 (1.3) | 1.1 (0.3-4.7) | 0.86 | | |
| No | 5672 | 122 (2.2) | 1.0 | | | |
| Marital status | | | | | | |
| Other | 597 | 7 (1.2) | 0.6 (0.3-1.3) | 0.16 | | |
| Married | 5240 | 117 (2.2) | 1.0 | | | |
| Alcohol intake | | | | | | |
| Yes | 1265 | 64 (3.5) | 1.2 (0.8-1.9) | 0.34 | | |
| Never | 4570 | 75 (1.6) | 1.0 | | | |
| Smoking status | | | | | | |
| Ever smoked | 1834 | 62 (3.4) | 1.1 (0.7-1.8) | 0.64 | | |
| Never smoked | 4003 | 60 (1.5) | 1.0 | | | |
| Diabetes | | | | | | |
| Yes | 355 | 6 (1.7) | 1.1 (0.5-2.5) | 0.87 | | |
| No | 4831 | 95 (2.0) | 1.0 | | | |
| Occupation | | | | | | |
| White collar | 210 | 7 (3.3) | 1.0 | | | |
| Blue collar | 713 | 33 (4.6) | 1.3 (0.6-2.9) | 0.58 | | |
| Farm | 3419 | 66 (1.9) | 0.7 (0.3-1.7) | 0.47 | | |
| Without occupation | 1362 | 15 (1.1) | 0.7 (0.3-1.8) | 0.42 | | |
| Individual yearly income | | | | | | |
| ≥5000 RMB | 2349 | 66 (2.8) | 1.0 | | | |
| <5000 RMB | 2483 | 38 (1.5) | 1.2 (0.7-2.0) | 0.43 | | |

***Note.*** †Multivariable logistic regression model adjusting for age, sex, housing type, hypertension status, and history of falls. CI, confidence interval; OR, odds ratio.

However, less severe eye injuries not requiring acute hospital admission are equally important because of direct and indirect costs related to their treatment, as well as the fact that minor eye injuries are often preventable with the use of simple protective eyewear and modification of worksite environments. In the Wisconsin Study, 97.8% of the 188 cases with work-related trauma were classified as minor or moderate[21].

The lower prevalence, and the higher proportion of trauma-induced visual impairment, and the fact that almost 30% of subjects with trauma did not seek further ophthalmologic treatment indicate poor eye health awareness, low knowledge levels regarding the prevention and management of eye trauma, and lack of available and affordable eye care services in this rural population. Modern injury prevention theory does not support the claim that injuries are 'accidents' or 'bad luck'. Most ocular trauma occurs in well-defined, predictable, and consistent settings and is, therefore, potentially preventable. Educational efforts should be aimed at improving knowledge and increasing eye health awareness in this rural population in China to prevent blindness due to trauma, particularly in the lower socioeconomic strata. Strategies to provide care to rural populations for ocular trauma may need to be developed within primary eye or health care centers with focus on providing at least appropriate first aid care. Addressing blindness from ocular trauma, which is preventable and unwarranted, has to be a priority of eye care programs in the region. Education, increased awareness, and policies and legislation are possible important interventions for implementing protective eyewear in the workplace.

Only age, sex, hypertension, and a history of falls were found to be significantly associated with a history of ocular trauma in our sample. Male sex and younger age are common risk factors for ocular trauma. The Handan eye study is a population-based study focusing on a representative rural population in North China with a predominance of males who are mostly involved in the same occupational setting (agriculture). The setting of injury in our study was similar to that reported in other rural population studies (Nepal, India), in which domestic or agricultural injuries were the most common type[6]. Given the high frequency of occupational or outdoor exposure in men and the nearly identical occupation types and lifestyle preferences of the study participants, we found no significant association with occupation after age-sex adjustment. The finding that hypertension was associated with a reduced likelihood of having ocular injury may be because people with hypertension are less likely to be involved in occupations that could result in injury.

Door-to-door enumeration and high response rates from subjects who were randomly selected is a major strength of our study. However, this study also had several limitations. First, this was a cross-sectional study, and we can only speculate on the causal relationships from the associations we found retrospectively. Second, because ocular trauma was self-reported on a questionnaire, possible recall bias could not be excluded; however,

**Table 4.** Prevalence and Significant Risk Factors of Ocular Trauma from Major Population-based Studies

| Study | Year | Population | Overall Prevalence | Significant Factors with Higher Risk | Remarks |
|---|---|---|---|---|---|
| VIP Study, Australia[1] | 1992-1994 | 3271, >40 years old | 21.1% | Male sex; rural setting | Urban/rural population |
| Beaver Dam Study, USA[7] | 1988-1990 | 4926, 43-84 years old | Lifetime prevalence of 19.8% | Male sex; blue-collar workers | Rural setting |
| Aravind, India[5] | 1995-1997 | 5150, >40 years old | 4.5% | Male sex; lower literacy laborers | Rural population |
| Andhra Pradesh, India[8] | 1996-1997 | 2522, >40 years old | 3.97% | Male sex; laborers | Urban population |
| Andhra Pradesh, India[4] | 1996-2000 | 7771, all ages | 10.6% | Male sex | Rural population |
| Singapore Malay Eye Study (SiMES)[3] | 2004-2006 | 3280, 40-80 years | 5.0% | Younger age; male gender; alcohol consumption | Urban setting |
| Singapore Indian Eye Study[22] | 2007-2009 | 3400, 40-80 years | 5.1% | Male gender; smoking status | Urban setting |
| Handan Eye Study (current study) | 2006-2007 | 6830, >30 years old | 2.1% | Younger age; male gender; history of falls | Rural population |

recall bias would be highly unlikely in cases of severe injury requiring medical attention. Finally, we acknowledge the lack of specific information on whether the trauma occurred in the context of work, sports, assault, etc., in the questionnaire used in our study.

In conclusion, this study reports the prevalence of severe ocular trauma among the adult population in rural China, revealing a high proportion of blindness and visual impairment due to ocular trauma. These findings underscore a pressing need for eye care programs targeting rural populations to increase eye health awareness while improving the management of eye trauma to reduce blindness due to trauma.

## CONFLICT OF INTEREST

The authors have no conflicts of interest with regard to the article.

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