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# BMJ Open

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

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Professor Dr. Rokiah Omar: Designed the manuscript construct, interpreted investigative data, wrote the manuscript and critically reviewed the manuscript

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Chiranjib Majumder: Analysed and interpreted investigative data, reviewed the manuscript.

Victor Feizal Knight: designed the manuscript construct, critically reviewed the manuscript.

All authors have read and approved the final manuscript.

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

### Abstract:

**Purpose:** The purpose of this study is to determine the characteristics of eye injuries, medical costs and return to work status among industrial workers, in order to recommend and provide for better vision rehabilitative services.

**Methods:** A retrospective study using case records of industrial workers suffering from eye injury registered with the Social Security Organization (SOCSO) using layered random sampling method were selected. The Birmingham Eye Injury Terminology System (BETTS) classification and the Malaysian Standard Industry Classification (MSIC) 2008 version 1.0 were used to for classification and the data were analysed.

**Results:** A total of 884 from 8861 case files workplace accidents involving eye injury registered with Social Security Services (SOCSO) were identified. The mean age of the injured workers was 35±10 years. The highest incidence of work-related eye injury occurred in the age group 30 to 39 years. Malays ethnics had the highest incidence of work-related eye injury cases. Males are affected more than females' workers. The highest cause of eye injury was impact from a moving object excluding falling objects (89.2%) and anterior segment injuries occurred more than posterior segment injuries.

**Conclusion:** Majority workers suffered from low category of eye injury. A significant relationship was found between the severity of eye injury and employee work status. The indirect cost of medical and vision rehabilitation was higher than the direct cost. Awareness and vision rehabilitation program at workplace need to be address for a better prevention and rehabilitative service.

**Key words:** Ocular Trauma, Work related injury, Industrial worker, Severity

## Article Summary

### Strength:

- This study has compared eye injuries based on industry type and by states in Malaysia which was not done before too extensively.
- This study also highlighted the average medical cost of treating patients with work related eye injuries and the return to work status among industrial workers in Malaysia which was not reported earlier.
- Moreover, it also highlighted the need of vision rehabilitation which was not addressed by the earlier studies.

### Limitation:

- The details of vision rehabilitation is not considered for further analysis because it was a retrospective case files study.

## Introduction

The human eye has a physiologically highly precise and distinct role. To perceive images of objects clearly, it is necessary for all components of the eye to work normally. Good visual function is essential in almost all tasks in activities of daily living, especially those related to employment. Eye injury is one of the major causes of blindness that worldwide encompasses nearly half a million people, while many others experience partial loss of vision from these injuries. Eye injury is a primary cause of unilateral vision loss in developing countries. It has been found that males are more likely to have eye injury compared to females and this is a trend that is noticed even from childhood. Moreover, eye injuries tend to be more associated with lower socioeconomic conditions.<sup>1</sup> Each year the USA reports approximately 2.4 million new eye injury cases.<sup>2</sup> Out of these, 40,000 to 60,000 patients eventually experience blindness due to eye injuries.<sup>3-4</sup> The global pattern of eye injuries shows approximately 55 million eye injuries occurring causing work day losses of more than one-day every year. Out of these injury occurrences, annually 750,000 cases will require in-patient care. Furthermore, approximately 1.6 million people become blind from these eye injuries with an additional 2.3 million people develop bilateral low vision. In Pahang, Malaysia the prevalence of eye injury was 9.8%.<sup>5</sup>

Eye injury is commonly occurring in the workplace (38.5%), road accidents (20.5%), sports (29%) and during quarrel (5%). A penetrating injury occurred in 72.5% cases whereas blunt injury accounted for 27.5% cases.<sup>6</sup> A study conducted in Brazil reported 56.7% of eye injuries occurred in the workplace followed by those occurring at home (28.3%). Surprisingly it was found that 82.9% of the victims of eye injury did not wear any eye protective devices at the time of their accidents.<sup>7</sup> A review study from Malaysia reported a higher prevalence of eye injury among males with their mean age being 35 years. The common place where eye injury was suffered among adults was in the workplace while for children it was at home.<sup>8</sup> An earlier



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3 study reported that work-related eye injuries in east Malaysia accounted for 36.9% of the total  
4 eye injury cases reported. However, work-related eye injuries reported in Singapore represented  
5 71.4% of cases of total eye injury visiting casualty units there. Out of all the eye injuries  
6 reported, 90% arose from industrial activities such as drilling, grinding, and cutting metals.<sup>9</sup> A  
7 earlier prospective study conducted in Malaysia reported work-related eye injury rate of 43.6%  
8 among patients attended the medical centre. The causes of eye injury involved the usage of  
9 high-powered machines (30.8%), motor vehicle accidents (23.1%) and domestic accidents  
10 (17.7%). However, only 2.5% used an eye-protective device (EPD) at the time of injury.<sup>10</sup>  
11 Madhusudhan et al. (2014) in his study reported that eye injuries most commonly involved the  
12 home (51.8%) and workplace (23.4%) in Malaysia.<sup>11</sup> Similarly, a previous study by Mallika et  
13 al. (2008) among adults in Kuching, Sarawak also found that areas such as home (34.3%) and  
14 industrial premises (31.8%) were the most common locations where eye injury occurred.<sup>12</sup>  
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33 Eye injuries can cause the loss of working days among workers which causes a loss of  
34 productivity and this then becomes a burden to the economy. It is important to understand the  
35 implication of eye injuries and how it affects workers, family members, industries and the  
36 nation. Emphasis on providing vision rehabilitation will help affected workers to continue their  
37 work.<sup>13</sup> Vision rehabilitation includes the prescription of glasses, contact lenses, prisms, and  
38 low vision rehabilitative services. However, return to work requires a multi-disciplinary  
39 approach and can be a challenge to implement comprehensively. Little information is available  
40 of the characteristics of eye injuries, their associated medical costs and return to work status  
41 among industrial workers who get injured.<sup>13</sup> We postulate that comprehensive visual  
42 rehabilitation services for industrial workers with eye injuries needs to be available in order that  
43 productivity can be maintained. Therefore, the objective of this study is to identify the  
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3 characteristics of eye injuries, medical costs and return to work status among industrial workers  
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5 in Malaysia so that better visual rehabilitation services can be recommended and provided for.  
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## 10 **Methodology**

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12 This was a retrospective study conducted using case records of eye injuries among industrial  
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14 workers registered with the Social Security Organization (SOCSO). This research was  
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16 approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee  
17  
18 and followed the tenants of Helsinki Declaration. Permission to conduct this research was also  
19  
20 obtained from the Medical Division of SOCSO Headquarters and the data authorised for use  
21  
22 was those in the calendar years 2004-2008. SOCSO was chosen as the source of reference for  
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24 secondary data files because SOCSO has the most comprehensive collection of work place  
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26 medical records in Peninsular Malaysia. SOCSO appoints trained medical doctors as their panel  
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28 doctors organisation and these doctors must completed a comprehensive 72 hour training  
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30 program before being certified as an occupational health doctor and eligible to be registered  
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32 with the Department of Occupational Health and Safety, Ministry of Human Resources.  
33  
34 SOCSO is a statutory body set up to provide medical and financial assistance to workers whose  
35  
36 ability to work have been affected by accident or illness. SOCSO also helps workers'  
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38 dependents in the event of their death through a pension scheme. Inclusion criteria for this study  
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40 included eye injury cases occurring in Peninsular Malaysia, cases being eye injury related to  
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42 the workplace reported between 2004 to 2008.  
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### 49 ***Patient and Public Involvement:***

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51 No patient Involved. Only case files were reviewed and analysed.  
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### 54 ***Sampling Technique and Methods:***

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56 The cases were selected through a process of layered random sampling where each 10-  
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58 count interval of cases was selected. Case files that did not meet the inclusion criteria were  
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3 excluded from this study. All case files identified for inclusion were kept confidential and  
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5 anonymous. The information extracted from the case files included date of first consultation,  
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7 age and gender, cause of the eye problem suffered, location of the eye injury, level of vision,  
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9 date and time of hospital admission, clinical diagnosis, eye and vision recovery data, eye  
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11 function data, available medical care and costs involved, recovery time and number of days the  
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13 subject was not able to work. The eye injury classification used for this study was adopted from  
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15 the standard international classification system, i.e. the Birmingham Eye Injury Terminology  
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17 System (BETTS) and the classification of 21 industry types in Malaysia was based on the  
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19 Malaysian Standard Industry Classification (MSIC) 2008 version 1.0 used by the Department  
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21 of Statistics Malaysia.<sup>14</sup> Descriptive tests were used to analyze the study data covering mean,  
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23 percentage, median and standard deviation. The relationship between the severity of eye injuries  
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25 and employee employment status was also determined.  
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## 33 RESULTS

### 34 35 *Characteristics of work-related eye injury*

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37 From 2004 to 2008, a total of 8,861 workplace accidents involving eye injuries were registered  
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39 with SOCSO. A total of 884 eye injury case files were randomly selected which fulfilled the  
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41 selection criteria for this study. A summary of information on the worker profile, severity of  
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43 work-related eye injury and work status based on age among industrial workers registered with  
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45 SOCSO is shown in Table 1.  
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**Table 1. Profile, severity of work-related eye injury and work status based on age among industrial workers registered with SOCSO 2004-2008**

Age Group	Gender (n / %)		Ethnic (n / %)				Level of Severity (n / %)			Work Status (n / %)	
	Male	Female	Malay	Chinese	Indian	Others	Low	Moderate	High	Working	Stop Working
<b>10 – 19 (n = 30)</b>	27 (90.0)	3 (10.0)	8 (26.7)	15 (50.0)	7 (23.3)	0 (0)	18 (60.0)	8 (26.7)	4 (13.3)	26 (86.7)	4 (13.3)
<b>20 – 29 (n = 263)</b>	250 (95.1)	13 (4.9)	121 (46.0)	107 (40.7)	32 (12.2)	3 (1.1)	137 (52.1)	91 (34.6)	35 (13.3)	247 (93.9)	16 (6.1)
<b>30 – 39 (n = 309)</b>	296 (95.8)	13 (4.2)	141 (45.6)	118 (38.2)	45 (14.6)	5 (1.6)	141 (45.6)	128 (41.4)	40 (12.9)	296 (95.8)	13 (4.2)
<b>40 – 49 (n = 196)</b>	178 (90.8)	18 (9.2)	78 (39.8)	73 (37.2)	44 (22.4)	1 (0.5)	77 (39.3)	70 (35.7)	49 (25.0)	189 (96.4)	7 (3.6)
<b>50 – 59 (n = 71)</b>	64 (90.1)	7 (9.9)	25 (35.2)	30 (42.3)	16 (22.5)	0 (0.0)	22 (31.0)	24 (33.8)	25 (35.2)	65 (91.5)	6 (8.5)
<b>60 – 69 (n = 15)</b>	11 (73.3)	4 (26.7)	1 (6.7)	11 (73.3)	3 (30.0)	0 (0.0)	3 (20.0)	4 (26.7)	8 (53.2)	12 (80.0)	3 (20.0)
<b>Total (n = 884)</b>	826 (93.0)	58 (7.0)	374 (42.3)	354 (40.0)	147 (16.6)	9 (1.0)	398 (45.0)	325 (36.8)	161 (18.2)	835 (94.5)	49 (5.5)

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3 Most of these workplace eye injury cases registered with SOCSO involved male workers in a  
4 ratio of 14:1 compared to female workers. The average age of all employees was 35±10 years.  
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6 Their age range was from 16 years to 67 years. While the average age for male workers was  
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8 34±10 years, the average age for female workers was 38±12 years. The highest incidence of  
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10 work-related eye injuries occurred in the age group of 30 to 39 years old. This is followed by  
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12 the age group 20 to 29 years and lastly the 40 to 49 years old. When analysed by gender, similar  
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14 findings were noted among male workers. However, among female workers, the highest  
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16 incidence of work-related eye injuries occur in the age group 40 to 49 years. The workers age  
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18 group with the least number of work-related eye injuries was the 60 to 69 years age range with  
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20 a total of 15 cases. In terms of ethnicity, Malays had the highest incidence of work-related eye  
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22 injury cases, followed by Chinese, Indian and finally the Others.  
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31 The eye injury cases were categorized according to their causes and the characteristics  
32 of work-related eye injury experienced by the injured workers. The causes of work-related eye  
33 injury and the characteristics of work-related eye injury were divided into nine and eight  
34 subtypes respectively. The highest number of eye injuries occurred from incidents that resulted  
35 in the impact from a moving object but excluding incidents that involved a falling object  
36 (89.2%). These moving objects include fragments or flying particles near or within the working  
37 environment of the worker. Eye surface injury (51.6%) were the most common cause of injury  
38 among these industrial workers. Eye surface injuries include causes such as splinters entering  
39 the eyes, corneal abrasions, scratches and bites by non-invasive insects that lead to injuries to  
40 the surface of the eye and adnexa. The details of the types and characteristics of work-related  
41 eye injury among industrial workers are shown in Table 2.  
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**Table 2: Types and characteristics of work-related eye injury among industrial workers registered with SOCSO 2004-2008**

Characteristics	Number (n=884)	Percentage (%)		
<b>Anatomy of Eye</b>				
Cornea	472	53.4		
Multiple injury	232	26.2		
Conjunctiva	98	11.1		
Eyelid	30	3.4		
Eyebrow	20	2.3		
Crystalline lens	7	0.8		
Orbital	7	0.8		
Retina	6	0.7		
Sclera	4	0.5		
Anterior chamber	4	0.5		
Nasolacrimal gland	2	0.2		
Uvea	1	0.1		
Optic nerve	1	0.1		
<b>Affected Eye</b>				
Right eye	373	42.2		
Left eye	419	47.4		
Both eye	75	8.5		
No record	17	1.9		
<b>Level of Severity</b>				
Low	530	45.0		
Moderate	236	36.8		
High	118	18.2		
<b>Causes</b>				
Impact from a moving object excluding falling objects	788	89.2		
Impact from a static object	33	3.7		
Impact from a falling object during work	30	3.3		
Impact from a moving object	9	1.0		
Falling from a higher place	7	0.8		
Falling from the same height or lower place	7	0.8		
Other impacts from falling object	5	0.6		
Exposure to ionizing radiation	4	0.5		
Other accidents	1	0.1		
<b>Types of Eye Injury</b>				
Eye surface injury	456	51.8		
Other injury	182	20.6		
Blow	105	11.8		
Burn	88	10.1		
Bruise	46	5.3		
Radiation effect	3	0.3		
Fracture	2	0.2		
<b>Start Treatment Day</b>				
Same day	602	68.3		
≤3 day	241	27.3		
≤7 day	26	2.9		
≤14 day	7	0.8		
≤30 day	4	0.5		
>30 day	4	0.5		
<b>Vision Acuity Level</b>	<b>Initial Assessment (n = 266)</b>		<b>Final Assessment (n=360)</b>	
	<b>RE</b>	<b>LE</b>	<b>RE</b>	<b>LE</b>
Good (6/4.5-6/6)	39.8%	38.3%	66.7%	61.7%
Mild (6/7.5-6/18)	30.8%	33.1%	21.7%	23.1%
Moderate (6/24-6/60)	14.7%	14.7%	3.9%	6.9%
Severe (5/60-NPL)	14.7%	13.9%	7.8%	8.3%

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3 The severity of the work-related eye injury is categorized into five categories which include the  
4 anatomy of the eye, affected eye, level of severity of injury experienced, onset of treatment  
5 given and level of vision of the worker with the eye injury.  
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12 About 70% of the work-related eye injuries in Peninsular Malaysia that were filed with  
13 SOCSO from 2004 to 2008 affected the anterior segment of the eye. Out of all these anterior  
14 segment injuries, corneal injury was the highest (53.4%). However, multiple injuries also  
15 occurred, these comprised 26.2% of cases which were the second highest number of cases  
16 reported. In this study, the left eye (47.4%) was more affected than the right eye (42.2%).  
17 Monocular work-related eye injuries were found more likely to occur than binocular eye injury  
18 (Chi-square test;  $df = 3$ ,  $p < 0.05$ ). The severity of work-related eye injury was categorized into  
19 three distinct levels, namely low, moderate and high levels. The majority of workers suffered  
20 from low level work-related eye injuries (45.0%) followed by moderate (36.8%) and severe  
21 (18.2%) levels. Analysis using the Chi-squared test showed a significant difference ( $df=2$ ,  
22  $p < 0.05$ ) between the severity of the work-related eye injury levels. In terms of time of treatment  
23 for the injury, about 70% of workers received their treatment on the same day ( $0.8 \pm 3.5$  days)  
24 as the date of their work-related eye injury while the remaining mostly sought treatment within  
25 3 days of injury. However, there were also a small number of injured workers who took a very  
26 long time to seek treatment, some up to more than a month after injury. The level of visual  
27 acuity of the injured workers during their initial vision assessment was categorized into either  
28 good, mild, moderate and severe visual acuity. The majority of the work-related eye injury  
29 workers had good to mild level of visual impairment on the day of their initial visual acuity  
30 assessment.  
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### *Trend of work-related eye injury*

Figure 1 shows a decreasing trend of eye injury occurring from 2004 to 2008. The trend of employment-related eye injuries when analysed by industry type, the manufacturing industry showed that the highest number of cases occurred in trading and public services. On the other hand, the lowest percentage of cases were from the mining, financial and electrical, gas and water industries as shown in Figure 2.

When the trends of distribution of eye injuries was analysed by their State location of occurrence in Peninsular Malaysia, the State of Selangor had the highest number of cases of eye injury followed by Penang. However, the lowest number of eye injuries in Peninsular Malaysia was found in the State of Terengganu as shown in Table 3. The work-related eye injury had an increased trend in public services from the year 2004-2008 as shown in Figure 3.



Table 3: Eye injury trends according to the type of industry in each State in Peninsular Malaysia and by age group

Eye Injury	Types of Industry										Total
	A	B	C	D	E	F	G	H	I	J	
States of Peninsular Malaysia	Selangor	57	22	6	25	36	27	11	1	0	189
	Pulau Pinang	91	26	1	22	9	5	5	0	0	161
	Johor	59	18	9	12	29	10	9	1	1	148
	Kedah	52	18	9	14	5	5	0	1	0	104
	Perak	36	20	8	15	8	8	4	1	0	100
	Pahang	10	10	7	15	2	3	2	1	0	50
	Kuala Lumpur	8	9	0	11	4	6	2	0	0	40
	Negeri Sembilan	13	4	3	9	5	0	2	0	0	36
	Melaka	12	2	3	3	1	2	0	0	0	24
	Kelantan	2	3	0	3	4	0	0	1	0	13
	Perlis	1	2	0	2	0	5	0	0	0	11
	Terengganu	1	1	3	2	0	0	1	0	0	8
	<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>	<b>884</b>
Age Group (year)	10 - 19	14	6	1	6	1	2	0	0	0	30
	20 - 29	97	43	7	44	37	24	7	3	0	263
	30 - 39	126	52	12	41	37	29	10	1	1	309
	40 - 49	71	22	22	31	22	12	9	1	0	196
	50 - 59	27	10	5	10	6	3	8	1	0	71
	60 - 69	7	2	2	1	0	1	2	0	0	15
	<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>	<b>884</b>

- A Manufacturing
- B Trading
- C Agriculture, Forestry & Fisheries
- D Public services
- E Services
- F Construction
- G Transportation
- H Mining
- I Electric, Gas & Water supply
- J Financial

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### **Method, cost and efficacy of recovery**

The manner of recovery, cost of medical expenses and the rate of injured workers returning to work are shown in Table 4. The costs of treatment determined in this study refers to the standardised maximum reimbursable hospital rates used by SOCSO for payment for treatment of workplace injury. Whereas the types of treatment received by workers with eye injuries registered in SOCSO are listed in Table 4.

Worker recovery from injury is divided into 2 groups. The first group depicts medical recovery from injury which would include surgery (if needed), outpatient follow-up and medication. The second group depicts vision recovery methods which include spectacles, prostheses and recovery references. In the medical recovery group, the Type C and Type B surgery treatment modalities were the most common options reported for treating eye injury (> 50 cases). It is also noted that the biggest number of cases were moderate types of eye injuries with moderate types of treatment needed. The indirect costs are derived from the value of temporary disability or the number of workers' days off from work, and the value of permanent disability or workers' compensation costs. This study showed that 94.5% workers returned to work after their recovery from injury. However, the remaining 5.5% did not go back to work. The age wise distribution of eye injury severity and occupational status showed the highest percentage of return to work was for the age groups 30 to 39 years and 40 to 49 years which were 95.8% and 96.4% respectively. Although the severity of injury was found to be higher among workers over the age of 50 years, nonetheless most of them were able to return to work. Whereas, the younger age group, 10-19 years, stopped working more often compared to the older age groups except for the age group 60-69 years as shown in Table 1.

**Table 4. Estimated costs of medical, and vision recovery for industrial workers registered with SOCSO**

Cost Category	No.	Costs (RM)	Total (RM)
<b>Direct Costs of Medical Recovery</b>			<b>1,108,098.00</b>
Surgery B	64	750.00	48,000.00
Surgery C	79	500.00	39,500.00
Surgery D	17	188.00	3,196.00
Outpatient (mild cases)	75	40.00	3,000.00
Outpatient (moderate cases)	393	70.00	27,510.00
Outpatient (severe cases)	19	100.00	1,900.00
Medication (mild treatment)	72	50.00	17,850.00
Medication (moderate treatment)	125	70.00	136,268.00
Medication (severe treatment)	40	100.00	254,900.00
<b>Ward Cost</b>	-	32.00	540,374.00
<b>Vision Recovery</b>			
Spectacles	25	400.00	10,000.00
Prosthesis	6	3,600.00	21,600.00
Spectacles + Prosthesis	1	4,000.00	4,000.00
Recovery references	1	-	-
<b>Indirect Costs</b>			<b>4,150,140.00</b>
Value of temporary disability			805,268.00
Value of permanent disability			3,344,872.00
<b>TOTAL RECOVERY COSTS</b>			<b>5,258,238.00</b>

### **Severity of eye injury and effectiveness of vision recovery**

The relationship between the severity of eye injury and the ability of the employee to return to work was analysed. Table 5 displays the relationship between the injured employee (registered with SOCSO) employment status with the severity of the eye injury they experience. It was found that most workers injured in Peninsular Malaysia suffered mild (n = 398) and moderate (n = 325) eye injuries. Of that number, 96% of them were able to return to work. In contrast, 14% of workers with severe eye injuries were unable to return to work. To prove the correlation between this data, a chi-square test was performed. The results of the chi-square test ( $\chi^2 = 24.938$ ,  $df = 2$ ,  $p < 0.05$ ) showed that there was a significant relationship between the severity of eye injury and employee work status. This indicates that, when the degree of injury of the employee's eyes worsens or the total number of days of sick leave exceeds 1 month, the chances of the workers returning to work declines.

**Table 5. Frequency of employment status based on severity of work related eye injury**

Work Status	Severity Level of Eye Injury			Total
	Low	Moderate	High	
Working	382	314	139	835
Stopped working	16	11	22	49
<b>Total</b>	<b>398</b>	<b>325</b>	<b>161</b>	<b>884</b>

\* $\chi^2 = 24.938$ ,  $df = 2$ ,  $p < 0.05$

## DISCUSSION

This study showed a male preponderance of eye injuries which is congruent with the study conducted in Malaysia by Soong et al. 2008 where he found 88.1% cases occurred among males. Similarly, other studies also supported this male predominance.<sup>1,5,7,10,11,12,15-20</sup> The ethnic distribution of cases showed that Malays (42.30%) had a higher percentage of work-related eye injury followed by the Chinese (40.04%), Indian (16.62%) and Other ethnicities (1.01%). The study by Soong et al. (2008) reported a similar ethnic distribution of eye injury with the percentage of Malay, Indian, Chinese and Other ethnicities being 31.9%, 12.2%, 9.7%, and 2.1% respectively.<sup>10</sup> This study found that the highest number of eye injuries occurred from impact with a moving object (excluding falling objects) (89.2%) followed by impact from a static object (3.7%), impact from falling objects during operation (work) (3.3%), and impact from moving objects (1%) which contradicted another Malaysian study which reported 30.8% of injuries were from activities such as grinding or cutting metal (15.8%), welding (6.9%), hammering on metal (3.7%), carpentry (2.6%), and nailing (1.8%).<sup>10</sup> Moreover, injury to the surface of the eye was more common and accounted for 51.6% of eye injuries. Of the anterior segment eye injuries, corneal injury was the major cause (53.4%) followed by multiple injury causes (26.2%). These study findings were supported by two other studies also conducted in Malaysia which reported 61.5% of eye injuries were corneal laceration and other study reporting that the common anatomical site of injury was the cornea (43.6%) followed by the conjunctiva (39.5%).<sup>5,10</sup>

In this present study, unocular work-related injuries were more common than binocular injuries and the left eye was more affected (47.4%) compared to the right eye (42.2%). It was also reported that about 70% of workers received treatment on the same day while the remainder mostly sought treatment within 3 days of injury. However, an earlier study conducted in

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3 Malaysia contradicted these findings where that study found that right eye injury was more  
4 common, followed by the left eye and then both eyes but was in agreement with the fact that  
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6 73.4% presented within 24 hours of the injury and that a further 23.9% presented between 1–3  
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8 days from the day of the injury.<sup>10</sup> Furthermore, the trend of eye injury decreased from 2004 to  
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10 2008 and the manufacturing industry recorded the highest number of cases of eye injuries  
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12 followed by trading and public services. It was noted that Selangor state had the highest number  
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14 of cases of eye injury followed by Penang. Thus far, no other such study has compared eye  
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16 injuries based on industry type and by State in Malaysia previously.  
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24 In a previous study, the average working day loss was reported as 3.4 days.<sup>21</sup> The study  
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26 of Chi and colleagues (2007) reported that the duration of hospital treatment was from 4 to 7  
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28 days, with the average cost of medical treatment being New Taiwan Dollar 43,609 +/- 30,660  
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30 (RM130,827 +/- 91,980).<sup>22</sup> Another study recorded that over US \$ 300 million a year was lost  
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32 comprising total lost time and income, medical expenses and employee compensation.<sup>23</sup> Almost  
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34 90% of all occupational eye injuries can be prevented through the use of appropriate safety  
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36 equipment. Using appropriate safety equipment can indirectly save total costs of eye injuries  
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38 such as the related legal fees, the cost of repairing the damage resulting from the circumstances  
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40 related to the injury in the work premises and the necessary employee training fees has been  
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42 estimated at more than US \$ 934 million annually in America.<sup>24</sup> In this study it was found that  
43  
44 the costs of medical and vision recovery was about Ringgit Malaysia 5 million where the direct  
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46 costs amounted to more than Ringgit Malaysia 1 million and indirect costs were more than  
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48 Ringgit Malaysia 4 million. This study helps provides an understanding of the economic  
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50 importance of work-related eye injuries in Malaysia which has not been explored before. Both  
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52 employers and employees must be aware of the relationship between visual health and  
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54 productivity in the workplace. Employees who experience a significant decrease in their vision  
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3 can contribute to increased rates of negligence in the workplace and losses of working days.  
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5 Negligence can make a work premise a place where workers are at high risk of danger. This  
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7 situation happens because of employees with a decrease in their visual ability may find it  
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9 difficult to adapt to their reduced visual state and this in turn can lead to frustrations with their  
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11 jobs or tasks. This employee than would have to deal with fatigue, headaches and constant stress  
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13 on a daily basis caused by their vision dysfunction. This circumstance may then lead to the  
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15 employee's income becoming compromised if this situation persists over a period of time. If  
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17 there are many workers involved, this situation can then threaten the economic stability of  
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19 industries and eventually countries while being likely to cause a rising unemployed population.  
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21 The employer also bears huge losses from this loss of experienced and trained work persons  
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23 who face these vision limitations.  
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31 In this study, it was found that about 96% of workers suffering from eye injury suffered  
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33 from low to moderate injury which in turn increased their indirect medical costs in comparison  
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35 to their direct medical costs and their chances of returning to work. Although 14% of workers  
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37 had suffered severe injury, still the percentage of their not returning to work was low, being  
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39 5.5%. There are a number of factors that can affect the severity of an employee's eye injury.  
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41 These factors include the quality of safety protection devices, mechanisms of accidents, types  
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43 of eye injuries, when treatment was started, the type of medical treatment given and so on. For  
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45 those with low severity injuries, the visual status of these injured workers was assisted and  
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47 improved through refractive error correction using glasses or contact lens. This method  
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49 however can only help in certain cases, depending on the effects of the injury sustained. Work-  
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51 related eye injuries are not only affected by refractive errors, but also includes vision field  
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53 problems, stereopsis and other more extensive and complicated problems. Therefore, to provide  
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55 for more detailed and comprehensive management, a functional recovery or rehabilitation  
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3 program should be developed to address the disability or dysfunction sustained by the affected  
4 worker. The rehabilitation performed needs to be tailored to address all the problems  
5 encountered by the injured worker including any loss of field of vision or eye muscle imbalance.  
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7 The results of the chi-square test on the data from the injured workers in this study showed that  
8 the degree of severity of the eye injuries affected that injured worker's ability to return to work.  
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10 The greater the severity of the eye injury, the chances of that worker returning to work became  
11 less. Vision rehabilitation therapy can improve an injured employee's vision to a better level. It  
12 must be noted that since most of these injured workers receive an injury involving only one  
13 eye, they are typically not eligible to be classified as an individual with limited vision (since  
14 the uninjured eye has typically normal vision, thus not fulfilling the criteria for limited vision.  
15  
16 Adaptation to vision loss among workers usually occurs rapidly. This is because occupational  
17 eye injuries usually happen to younger adult individuals and those who have the physical ability  
18 to continue working. This can be seen from the findings of this study where most of the injured  
19 workers return to work. This situation has the potential to create a higher risk to employees with  
20 their current vision status not reaching the actual standards needed for the job they do, especially  
21 when they need to handle or operate hazardous equipment. Often there is no specific assessment  
22 of the safety of the employee in his duties when they return to duty after injury.  
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45 To further strengthen Malaysia's position within the global economic community with  
46 strong and progressive economic and industrial development policies, worker safety issues in  
47 the workplace should be given due attention and should address worker safety from all angles.  
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49 This should not only involve just accident prevention measures in workplaces but should also  
50 address post-injury rehabilitation for those who are injured in their course of their work which  
51 should also encompass vision recovery methods. The experience from other developed  
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3 countries can be studied, and wherever appropriate these experiences can implement prudently  
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5 in the Malaysian work environment.  
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## 10 **CONCLUSION**

11  
12 This study concludes that males are more affected than females and have highest percentage of  
13 work-related eye injuries. It was observed that work-related eye injuries were most likely to  
14 occur among Malay workers compared to the other Malaysian ethnicities. The highest number  
15 of eye injuries arose from the impact of moving objects (excluding those caused by falling  
16 objects) (89.2%) followed by eye surface injury (51.6%) where commonly corneal injury was  
17 seen. The State of Selangor had the highest number of cases of eye injury followed by the state  
18 of Penang over the study period, 2004-2008. It was found that in this period, more workers  
19 suffered from eye injuries in the low category (45.0%) more followed by the moderate (36.8%)  
20 and severe (18.2%) categories. About 70% workers received treatment for their eye injuries on  
21 the same day as their injury occurred while the remaining mostly sought treatment within 3  
22 days of injury. Indirect medical costs were found to be higher than direct medical costs and the  
23 percentage of workers returning to work after receiving treatment was 94.5%. Awareness and  
24 vision rehabilitation program at work place need to be address for a better prevention and  
25 rehabilitative service.  
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### Availability of data and materials

The data used in this study is available with the author.

### Ethics approval and consent to participate

This study received approval from University Kebangsaan Malaysia Research Ethics Committee UKM 1.5.3.5/244/SPP2/NN/187/2010.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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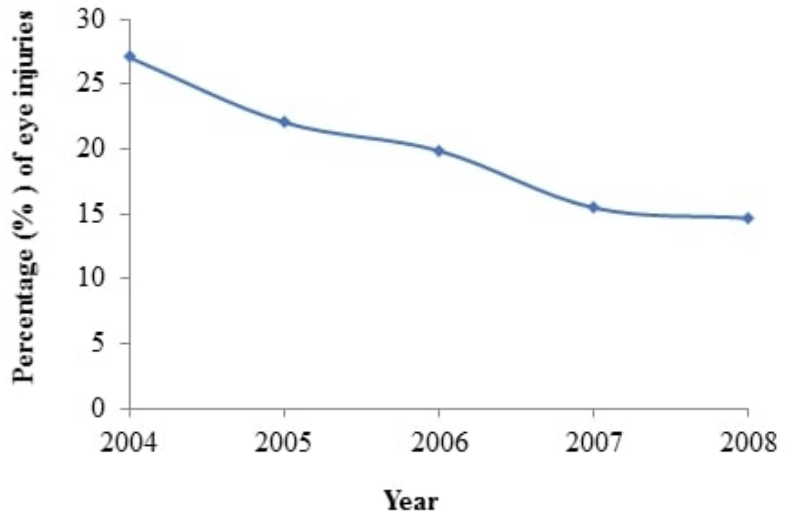
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22 **Figure 1: The trend of eye injuries in percentage from 2004 to 2008 registered with**  
23 **SOCSO**

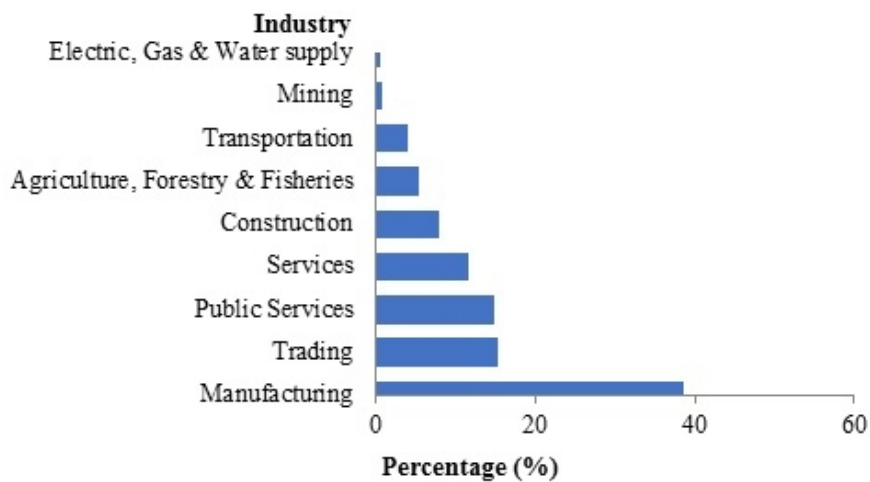
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25 **Figure 2: Percentage of workers with work-related eye injury among subjects registered**  
26 **with SOCSO 2004-2008**

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28 **Figure 3. The trend in distribution of eye injury by industry for the period 2004 to 2008**  
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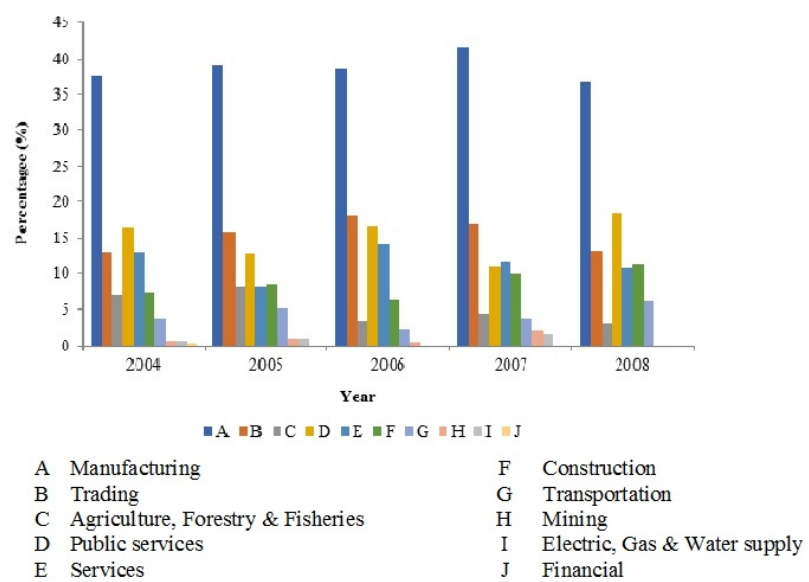
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# BMJ Open

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

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3 **Type:** Original Research  
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5 **Title:** Characteristics of eye injuries, medical cost and return to work status among industrial  
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Chiranjib Majumder: Analysed and interpreted investigative data, reviewed the manuscript.

Victor Feizal Knight: designed the manuscript construct, critically reviewed the manuscript.

All authors have read and approved the final manuscript.

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

### Abstract:

**Purpose:** The purpose of this study is to determine the characteristics of eye injuries, medical costs, and return to work status among industrial workers, in order to recommend and provide for better vision rehabilitative services.

**Methods:** A retrospective study using case records of industrial workers suffering from eye injury registered with the Social Security Organization (SOCSO) using layered random sampling method were selected. The Birmingham Eye Injury Terminology System (BETTS) classification and the Malaysian Standard Industry Classification (MSIC) 2008 version 1.0 were used for classification and the data were analysed.

**Results:** A total of 884 from 8861 case files workplace accidents involving eye injury registered with Social Security Services (SOCSO) were identified. The mean age of the injured workers was  $35\pm 10$  years. The highest incidence of work-related eye injury occurred in the age group 30 to 39 years. Malays ethnics had the highest incidence of work-related eye injury cases. Males are affected more than females' workers. The highest cause of eye injury was the impact from a moving object excluding falling objects (89.2%) and anterior segment injuries occurred more than posterior segment injuries.

**Conclusion:** The majority of workers suffered from the low category of eye injury. A significant relationship was found between the severity of eye injury and employee work status. The indirect cost of medical and vision rehabilitation was higher than the direct cost. Awareness and vision rehabilitation programs at the workplace need to be addressed for better prevention and rehabilitative service.

**Key words:** Ocular Trauma, Work related injury, Industrial worker, Severity

## Article Summary

### Strength:

- This study has compared eye injuries based on industry type and by states in Malaysia which were not done before too extensively.
- This study also highlighted the average medical cost of treating patients with work-related eye injuries and the return to work status among industrial workers in Malaysia which was not reported earlier.
- Moreover, it also highlighted the need for vision rehabilitation which was not addressed by the earlier studies.

### Limitation:

- The details of vision rehabilitation are not considered for further analysis because it was a retrospective case files study.

## Introduction

The human eye has a physiologically highly precise and distinct role. To perceive images of objects clearly, it is necessary for all components of the eye to work normally. Good visual function is essential in almost all tasks in activities of daily living, especially those related to employment. Eye injury is one of the major causes of blindness that worldwide encompasses nearly half a million people, while many others experience partial loss of vision from these injuries.<sup>1</sup> Eye injury is a primary cause of unilateral vision loss in developing countries. It has been found that males are more likely to have eye injury compared to females and this is a trend that is noticed even from childhood. Moreover, eye injuries tend to be more associated with lower socioeconomic conditions.<sup>1</sup> Each year the USA reports approximately 2.4 million new eye injury cases.<sup>2</sup> Out of these, 40,000 to 60,000 patients eventually experience blindness due to eye injuries.<sup>3-4</sup> The global pattern of eye injuries shows approximately 55 million eye injuries occurring causing work day losses of more than one-day every year. Out of these injury occurrences, annually 750,000 cases will require in-patient care. Furthermore, approximately 1.6 million people become blind from these eye injuries with an additional 2.3 million people develop bilateral low vision. In Pahang, Malaysia the prevalence of eye injury was 9.8%.<sup>5</sup>

Eye injury is commonly occurring in the workplace (38.5%), road accidents (20.5%), sports (29%) and during quarrel (5%). A penetrating injury occurred in 72.5% cases whereas blunt injury accounted for 27.5% cases.<sup>6</sup> A study conducted in Brazil reported 56.7% of eye injuries occurred in the workplace followed by those occurring at home (28.3%). Surprisingly it was found that 82.9% of the victims of eye injury did not wear any eye protective devices at the time of their accidents.<sup>7</sup> A review study from Malaysia reported a higher prevalence of eye injury among males with their mean age being 35 years. The common place where eye injury was suffered among adults was in the workplace while for children it was at home.<sup>8</sup> An earlier

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3 study reported that work-related eye injuries in east Malaysia accounted for 36.9% of the total  
4 eye injury cases reported. However, work-related eye injuries reported in Singapore represented  
5 71.4% of cases of total eye injury visiting casualty units there. Out of all the eye injuries  
6 reported, 90% arose from industrial activities such as drilling, grinding, and cutting metals.<sup>9</sup> A  
7 earlier prospective study conducted in Malaysia reported work-related eye injury rate of 43.6%  
8 among patients attended the medical centre. The causes of eye injury involved the usage of  
9 high-powered machines (30.8%), motor vehicle accidents (23.1%) and domestic accidents  
10 (17.7%). However, only 2.5% used an eye-protective device (EPD) at the time of injury.<sup>10</sup>  
11 Madhusudhan et al. (2014) in his study reported that eye injuries most commonly involved the  
12 home (51.8%) and workplace (23.4%) in Malaysia.<sup>11</sup> Similarly, a previous study by Mallika et  
13 al. (2008) among adults in Kuching, Sarawak also found that areas such as home (34.3%) and  
14 industrial premises (31.8%) were the most common locations where eye injury occurred.<sup>12</sup>  
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33 Eye injuries can cause the loss of working days among workers which causes a loss of  
34 productivity and this then becomes a burden to the economy. It is important to understand the  
35 implication of eye injuries and how it affects workers, family members, industries and the  
36 nation. Emphasis on providing vision rehabilitation will help affected workers to continue their  
37 work.<sup>13</sup> Vision rehabilitation includes the prescription of glasses, contact lenses, prisms, and  
38 low vision rehabilitative services. However, return to work requires a multi-disciplinary  
39 approach and can be a challenge to implement comprehensively. Little information is available  
40 of the characteristics of eye injuries, their associated medical costs and return to work status  
41 among industrial workers who get injured.<sup>13</sup> We postulate that comprehensive visual  
42 rehabilitation services for industrial workers with eye injuries needs to be available in order that  
43 productivity can be maintained. Therefore, the objective of this study is to identify the  
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3 characteristics of eye injuries, medical costs and return to work status among industrial workers  
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5 in Malaysia so that better visual rehabilitation services can be recommended and provided for.  
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## 10 **Methodology**

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12 This was a retrospective study conducted using case records of eye injuries among industrial  
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14 workers registered with the Social Security Organization (SOCSO). This research was  
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16 approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee  
17  
18 and followed the tenants of Helsinki Declaration. Permission to conduct this research was also  
19  
20 obtained from the Medical Division of SOCSO Headquarters and the data authorised for use  
21  
22 was those in the calendar years 2004-2008. SOCSO was chosen as the source of reference for  
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24 secondary data files because SOCSO has the most comprehensive collection of work place  
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26 medical records in Peninsular Malaysia. SOCSO appoints trained medical doctors as their panel  
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28 doctors organisation and these doctors must completed a comprehensive 72 hour training  
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30 program before being certified as an occupational health doctor and eligible to be registered  
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32 with the Department of Occupational Health and Safety, Ministry of Human Resources.  
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34 SOCSO is a statutory body set up to provide medical and financial assistance to workers whose  
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36 ability to work have been affected by accident or illness. SOCSO also helps workers'  
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38 dependents in the event of their death through a pension scheme. Inclusion criteria for this study  
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40 included eye injury cases occurring in Peninsular Malaysia, cases being eye injury related to  
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42 the workplace reported between 2004 to 2008.  
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### 49 ***Patient and Public Involvement:***

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51 No patient Involved. Only case files were reviewed and analysed.  
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### 54 ***Sampling Technique and Methods:***

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56 The cases were selected through a process of stratified random sampling where each 10  
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58 data set was considered as stratum and one fine from each stratum was selected randomly. Cases  
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3 of workplace related eye injuries that did not occur in Peninsular Malaysia, and not reported  
4 between 2004 to 2008 were excluded from this study. All case files identified for inclusion were  
5 kept confidential and anonymous. The information extracted from the case files included date  
6 of first consultation, age and gender, cause of the eye problem suffered, location of the eye  
7 injury, level of vision, date and time of hospital admission, clinical diagnosis, eye and vision  
8 recovery data, eye function data, available medical care and costs involved, recovery time and  
9 number of days the subject was not able to work. The eye injury classification used for this  
10 study was adopted from the standard international classification system, i.e. the Birmingham  
11 Eye Injury Terminology System (BETTS) and modified to come up with the suitable SOCSO  
12 classification and the classification of 21 industry types in Malaysia was based on the Malaysian  
13 Standard Industry Classification (MSIC) 2008 version 1.0 used by the Department of Statistics  
14 Malaysia.<sup>14</sup> The International Classification of Diseases 11 (2018), Visual impairment  
15 categorized into Mild (VA <6/12 to 6/18), Moderate ( VA<6/18-6/60), Severe (VA<6/60-3/60)  
16 and Blindness (VA <3/60).<sup>15</sup> The Severe and blind is merged into severe group for this study.

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36 The data was analysed by using IBM SPSS Statistics for Windows, Version 25.  
37 Descriptive tests were used to analyze the study data covering mean, percentage, median and  
38 standard deviation. The relationship between the severity of eye injury and the ability of the  
39 employee to return to work was analysed by using Chi-Square Test. A p value of <0.05  
40 considered significant.  
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## 50 RESULTS

### 51 52 *Characteristics of work-related eye injury*

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54 From 2004 to 2008, a total of 8,861 workplace accidents involving eye injuries were registered  
55 with SOCSO. A total of 884 eye injury case files were randomly selected which fulfilled the  
56 selection criteria for this study. A summary of information on the worker profile, severity of  
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3 work-related eye injury and work status based on age among industrial workers registered with  
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5 SOCSO is shown in Table 1.  
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For peer review only

**Table 1. Profile, severity of work-related eye injury and work status based on age among industrial workers registered with SOCSO 2004-2008**

Age Group	Gender (n / %)		Ethnic (n / %)				Level of Severity (n / %)			Work Status (n / %)	
	Male	Female	Malay	Chinese	Indian	Others	Low	Moderate	High	Working	Stop Working
<b>10 – 19 (n = 30)</b>	27 (90.0)	3 (10.0)	8 (26.7)	15 (50.0)	7 (23.3)	0 (0)	18 (60.0)	8 (26.7)	4 (13.3)	26 (86.7)	4 (13.3)
<b>20 – 29 (n = 263)</b>	250 (95.1)	13 (4.9)	121 (46.0)	107 (40.7)	32 (12.2)	3 (1.1)	137 (52.1)	91 (34.6)	35 (13.3)	247 (93.9)	16 (6.1)
<b>30 – 39 (n = 309)</b>	296 (95.8)	13 (4.2)	141 (45.6)	118 (38.2)	45 (14.6)	5 (1.6)	141 (45.6)	128 (41.4)	40 (12.9)	296 (95.8)	13 (4.2)
<b>40 – 49 (n = 196)</b>	178 (90.8)	18 (9.2)	78 (39.8)	73 (37.2)	44 (22.4)	1 (0.5)	77 (39.3)	70 (35.7)	49 (25.0)	189 (96.4)	7 (3.6)
<b>50 – 59 (n = 71)</b>	64 (90.1)	7 (9.9)	25 (35.2)	30 (42.3)	16 (22.5)	0 (0.0)	22 (31.0)	24 (33.8)	25 (35.2)	65 (91.5)	6 (8.5)
<b>60 – 69 (n = 15)</b>	11 (73.3)	4 (26.7)	1 (6.7)	11 (73.3)	3 (30.0)	0 (0.0)	3 (20.0)	4 (26.7)	8 (53.2)	12 (80.0)	3 (20.0)
<b>Total (n = 884)</b>	826 (93.0)	58 (7.0)	374 (42.3)	354 (40.0)	147 (16.6)	9 (1.0)	398 (45.0)	325 (36.8)	161 (18.2)	835 (94.5)	49 (5.5)

\* Row percentage referred here

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3 Most of these workplace eye injury cases registered with SOCSO involved male workers in a  
4 ratio of 14:1 compared to female workers. The average age of all employees was 35±10 years.  
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6 The average age for male and female workers were 34±10 and 38±12 years. The highest  
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8 proportion of work-related eye injuries occurred in the age group of 30 to 39 years old. In terms  
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10 of ethnicity, Malays had the highest proportion of work-related eye injury cases.  
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17 The eye injury cases were categorized according to their causes and the characteristics  
18 of work-related eye injury experienced by the injured workers. The causes of work-related eye  
19 injury and the characteristics of work-related eye injury were divided into nine and eight  
20 subtypes respectively. The highest number of eye injuries occurred from incidents that resulted  
21 in the impact from a moving object but excluding incidents that involved a falling object  
22 (89.2%). These moving objects include fragments or flying particles near or within the working  
23 environment of the worker. Eye surface injury (51.6%) were the most common cause of injury  
24 among these industrial workers. Eye surface injuries include causes such as splinters entering  
25 the eyes, corneal abrasions, scratches and bites by non-invasive insects that lead to injuries to  
26 the surface of the eye and adnexa. The details of the types and characteristics of work-related  
27 eye injury among industrial workers are shown in Table 2.  
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**Table 2: Types and characteristics of work-related eye injury among industrial workers registered with SOCSO 2004-2008**

Characteristics	Number (n=884)	Percentage (%)		
<b>Anatomy of Eye</b>				
Cornea	472	53.4		
Multiple injury	232	26.2		
Conjunctiva	98	11.1		
Eyelid	30	3.4		
Eyebrow	20	2.3		
Crystalline lens	7	0.8		
Orbital	7	0.8		
Retina	6	0.7		
Sclera	4	0.5		
Anterior chamber	4	0.5		
Nasolacrimal gland	2	0.2		
Uvea	1	0.1		
Optic nerve	1	0.1		
<b>Affected Eye</b>				
Left eye	419	47.4		
Right eye	373	42.2		
Both eye	75	8.5		
No record	17	1.9		
<b>Level of Severity</b>				
Low	530	45.0		
Moderate	236	36.8		
High	118	18.2		
<b>Causes</b>				
Impact from a moving object excluding falling objects	788	89.2		
Impact from a static object	33	3.7		
Impact from a falling object during work	30	3.3		
Impact from a moving object	9	1.0		
Falling from a higher place	7	0.8		
Falling from the same height or lower place	7	0.8		
Other impacts from falling object	5	0.6		
Exposure to ionizing radiation	4	0.5		
Other accidents	1	0.1		
<b>Types of Eye Injury</b>				
Eye surface injury	456	51.8		
Other injury	182	20.6		
Blow	105	11.8		
Burn	88	10.1		
Bruise	46	5.3		
Radiation effect	3	0.3		
Fracture	2	0.2		
<b>Start Treatment Day</b>				
Same day	602	68.3		
≤3 day	241	27.3		
≤7 day	26	2.9		
≤14 day	7	0.8		
≤30 day	4	0.5		
>30 day	4	0.5		
Vision Acuity Level	<b>Initial Assessment (n = 266)</b>		<b>Final Assessment (n=360)</b>	
	<b>RE</b>	<b>LE</b>	<b>RE</b>	<b>LE</b>
Good (6/4.5-6/6)	39.8%	38.3%	66.7%	61.7%
Mild (6/7.5-6/18)	30.8%	33.1%	21.7%	23.1%
Moderate (<6/18-6/60)	14.7%	14.7%	3.9%	6.9%
Severe (<6/60-NPL)	14.7%	13.9%	7.8%	8.3%

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3 The severity of the work-related eye injury is categorized into five categories which include the  
4 anatomy of the eye, affected eye, level of severity of injury experienced, onset of treatment  
5 given and level of vision of the worker with the eye injury.  
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12 About 70% of the work-related eye injuries in Peninsular Malaysia that were filed with  
13 SOCSO from 2004 to 2008 affected the anterior segment of the eye. Out of all these anterior  
14 segment injuries, corneal injury was the highest (53.4%). In this study, the left eye (47.4%) was  
15 more affected than the right eye (42.2%). The severity of work-related eye injury was  
16 categorized into three distinct levels, namely low, moderate, and high levels. Monocular work-  
17 related eye injuries were found more likely to occur than binocular eye injury ( $\chi^2 = 566.69$ ,  $df$   
18  $= 3$ ,  $p < 0.05$ ). The severity of work-related eye injury was categorized into three distinct levels,  
19 namely low, moderate, and high levels. Majority workers suffered from low level work-related  
20 eye injuries (45.0%). Analysis using the Chi-squared test showed a significant difference ( $\chi^2 =$   
21  $99.99$ ,  $df=2$ ,  $p < 0.05$ ) between the severity of the work-related eye injury levels. In terms of time  
22 of treatment for the injury, about 70% of workers received their treatment on the same day ( $0.8$   
23  $\pm 3.5$  days) as the date of their work-related eye injury while the remaining mostly sought  
24 treatment within 3 days of injury. The majority of the work-related eye injury workers had good  
25 to mild level of visual impairment on the day of their initial visual acuity assessment.  
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#### 47 **Trend of work-related eye injury**

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49 Figure 1 shows a decreasing trend of eye injury occurring from 2004 to 2008. The proportion  
50 of employment-related eye injuries when analysed by industry type, the manufacturing industry  
51 (38.69%) showed that the highest number of cases followed by trading (15.27%) and public  
52 services (15.04%). On the other hand, the lowest percentage of cases were from the mining  
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3 (0.90%), financial (0.67%) and electrical, gas and water industries (0.11%) as shown is in  
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5 Figure 2.  
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10 When the proportion of eye injuries was analysed by their state location of occurrence  
11 in Peninsular Malaysia, the State of Selangor (21.38%) had the highest number of cases of eye  
12 injury and state of Terengganu (0.90%) showed lowest as shown in Table 3. The work-related  
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17 eye injury had an increased trend in public services from the year 2004-2008 as shown in  
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**Table 3: Eye injury trends according to the type of industry in each State in Peninsular Malaysia and by age group**

Eye Injury	Types of Industry										Total
	A	B	C	D	E	F	G	H	I	J	
Selangor	57	22	6	25	36	27	11	1	0		189
Pulau Pinang	91	26	1	22	9	5	5	0	0		161
Johor	59	18	9	12	29	10	9	1	1		148
Kedah	52	18	9	14	5	5	0	1	0		104
Perak	36	20	8	15	8	8	4	1	0		100
Pahang	10	10	7	15	2	3	2	1	0		50
Kuala Lumpur	8	9	0	11	4	6	2	0	0		40
Negeri Sembilan	13	4	3	9	5	0	2	0	0		36
Melaka	12	2	3	3	1	2	0	0	0		24
Kelantan	2	3	0	3	4	0	0	1	0		13
Perlis	1	2	0	2	0	5	0	0	0		11
Terengganu	1	1	3	2	0	0	1	0	0		8
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>
10 - 19	14	6	1	6	1	2	0	0	0		30
20 - 29	97	43	7	44	37	24	7	3	0		263
30 - 39	126	52	12	41	37	29	10	1	1		309
40 - 49	71	22	22	31	22	12	9	1	0		196
50 - 59	27	10	5	10	6	3	8	1	0		71
60 - 69	7	2	2	1	0	1	2	0	0		15
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>

A Manufacturing

B Trading

C Agriculture, Forestry &amp; Fisheries

D Public services

E Services

F Construction

G Transportation

H Mining

I Electric, Gas &amp; Water supply

J Financial



### **Method, cost and efficacy of recovery**

The manner of recovery, cost of medical expenses and the rate of injured workers returning to work are shown in Table 4. The costs of treatment determined in this study refers to the standardised maximum reimbursable hospital rates used by SOCSO for payment for treatment of workplace injury. Whereas the types of treatment received by workers with eye injuries registered in SOCSO are listed in Table 4.

Worker recovery from injury is divided into 2 groups. The first group depicts medical recovery from injury which would include surgery (if needed), outpatient follow-up and medication. The second group depicts vision recovery methods which include spectacles, prostheses and recovery references. In the medical recovery group, the Type C and Type B surgery treatment modalities were the most common options reported for treating eye injury (> 50 cases). It is also noted that the biggest number of cases were moderate types of eye injuries with moderate types of treatment needed. The Type B included Intraocular lens implant Keratoplasty: Lamellar or penetrating Retinal detachment surgery Intraocular foreign body removal Strabismus surgery Repair of severe perforating injuries of the eyeball Glaucoma surgery Dacryocystorhinostomy Dacryocystectomy Repair of several lachrymal passages Exenteration of orbit. Type C included Cataract extraction : intracapsular and extracapsular Repair of eyelid deformities Extraction of dislocated / subluxated lens Discission Paracentesis Excision of orbital or ocular tumours Iridectomy : peripheral or optical Cryopexy as prophylaxis against retinal detachment and glaucoma Evisceration Enucleation Ectropion or Entropion correction Tarsorrhaphy Repair of severe laceration of eyelid and / or region around the eyes Pterygium surgery Excision biopsy Release of symblepharon / mucous membrane graft Repair of lachrymal puncta or canalicular obstruction Repair of moderate perforating injury of eyeball Laser Coagulation and Type D included Incision and curettage of chalazion Excision of granulomas Removal of corneal or conjunctival foreign body Catholysis / epilation of trichiasis Repair of minor lacerations of

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3 eyelids and / or region around the eyes Syringing / probing of lachrymal apparatus Repair of  
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5 minor perforating injury of eyeball.  
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9 The indirect costs are derived from the value of temporary disability or the number of workers'  
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11 days off from work, and the value of permanent disability or workers' compensation costs. This  
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13 study showed that 94.5% workers returned to work after their recovery from injury. However,  
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15 the remaining 5.5% did not go back to work as derived from Table no.5. The age wise  
16  
17 distribution of eye injury severity and occupational status showed the highest percentage of  
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19 return to work was for the age groups 30 to 39 years and 40 to 49 years which were 95.8% and  
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21 96.4% respectively. Although the severity of injury was found to be higher among workers over  
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23 the age of 50 years, nonetheless most of them were able to return to work. Whereas, the younger  
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25 age group, 10-19 years, stopped working more often compared to the older age groups except  
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27 for the age group 60-69 years as shown in Table 1.  
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**Table 4. Estimated costs of medical, and vision recovery for industrial workers registered with SOCSO**

Cost Category	No.	Costs (RM)	Total (RM)
<b>Direct Costs of Medical Recovery</b>			<b>1,108,098.00</b>
Surgery B	64	750.00	48,000.00
Surgery C	79	500.00	39,500.00
Surgery D	17	188.00	3,196.00
Outpatient (mild cases)	75	40.00	3,000.00
Outpatient (moderate cases)	393	70.00	27,510.00
Outpatient (severe cases)	19	100.00	1,900.00
Medication (mild treatment)	72	50.00	17,850.00
Medication (moderate treatment)	125	70.00	136,268.00
Medication (severe treatment)	40	100.00	254,900.00
<b>Ward Cost</b>	-	32.00	540,374.00
<b>Vision Recovery</b>			
Spectacles	25	400.00	10,000.00
Prosthesis	6	3,600.00	21,600.00
Spectacles + Prosthesis	1	4,000.00	4,000.00
Recovery references	1	-	-
<b>Indirect Costs</b>			<b>4,150,140.00</b>
Value of temporary disability			805,268.00
Value of permanent disability			3,344,872.00
<b>TOTAL RECOVERY COSTS</b>			<b>5,258,238.00</b>

### **Severity of eye injury and effectiveness of vision recovery**

The relationship between the severity of eye injury and the ability of the employee to return to work was analysed. Table 5 displays the relationship between the injured employee (registered with SOCSO) employment status with the severity of the eye injury they experience. It was found that most workers injured in Peninsular Malaysia suffered mild (n = 398) and moderate (n = 325) eye injuries. Of that number, 96% of them were able to return to work. In contrast, 14% of workers with severe eye injuries were unable to return to work. To prove the correlation between this data, a chi-square test was performed. The results of the chi-square test ( $\chi^2 = 24.938$ ,  $df = 2$ ,  $p < 0.05$ ) showed that there was a significant relationship between the severity of eye injury and employee work status. This indicates that, when the degree of injury of the employee's eyes worsens or the total number of days of sick leave exceeds 1 month, the chances of the workers returning to work declines.

**Table 5. Frequency of employment status based on severity of work related eye injury**

Work Status	Severity Level of Eye Injury			Total
	Low	Moderate	High	
Working	382	314	139	835
Stopped working	16	11	22	49
<b>Total</b>	<b>398</b>	<b>325</b>	<b>161</b>	<b>884</b>

\* $\chi^2 = 24.938$ ,  $df = 2$ ,  $p < 0.05$

## DISCUSSION

This study showed a male preponderance of eye injuries which is congruent with the study conducted in Malaysia by Soong et al. 2008 where he found 88.1% cases occurred among males. Similarly, other studies also supported this male predominance.<sup>1,5,7,10,11,12,16-21</sup> The ethnic distribution of cases showed that Malays (42.30%) had a higher percentage of work-related eye injury followed by the Chinese, Indian and Other ethnicities. The study by Soong et al. (2008) reported a similar ethnic distribution of eye injury with the percentage of Malay, Indian, Chinese and Other ethnicities being 31.9%, 12.2%, 9.7%, and 2.1% respectively.<sup>10</sup> This study found that the highest number of eye injuries occurred from impact with a moving object (excluding falling objects) (89.2%) followed by impact from a static object, impact from falling objects during operation (work), and impact from moving objects which contradicted another Malaysian study which reported 30.8% of injuries were from activities such as grinding or cutting metal (15.8%), welding (6.9%), hammering on metal (3.7%), carpentry (2.6%), and nailing (1.8%).<sup>10</sup> Moreover, injury to the surface of the eye was more common and accounted for 51.6% of eye injuries. Of the anterior segment eye injuries, corneal injury was the major cause followed by multiple injury causes. These study findings were supported by two other studies also conducted in Malaysia which reported 61.5% of eye injuries were corneal laceration and other study reporting that the common anatomical site of injury was the cornea (43.6%) followed by the conjunctiva (39.5%).<sup>5,10</sup>

In this present study, unocular work-related injuries were more common than binocular injuries and the left eye was more affected compared to the right eye. It was also reported that about 70% of workers received treatment on the same day while the remainder mostly sought treatment within 3 days of injury. However, an earlier study conducted in Malaysia contradicted these findings where that study found that right eye injury was more common, followed by the

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3 left eye and then both eyes but was in agreement with the fact that 73.4% presented within 24  
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5 hours of the injury and that a further 23.9% presented between 1–3 days from the day of the  
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7 injury.<sup>10</sup> Furthermore, the trend of eye injury decreased from 2004 to 2008 and the  
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9 manufacturing industry recorded the highest number of cases of eye injuries followed by trading  
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11 and public services. It was noted that Selangor state had the highest number of cases of eye  
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13 injury followed by Penang. Thus far, no other such study has compared eye injuries based on  
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15 industry type and by State in Malaysia previously.  
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22 In a previous study, the average working day loss was reported as 3.4 days.<sup>22</sup> The study  
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24 of Chi and colleagues (2007) reported that the duration of hospital treatment was from 4 to 7  
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26 days, with the average cost of medical treatment being New Taiwan Dollar 43,609 +/- 30,660  
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28 (6635.05 +/- 4664.87 or 1567.46 +/- 1102.03 USD).<sup>23</sup> Another study recorded that over US \$  
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30 300 million a year was lost comprising total lost time and income, medical expenses and  
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32 employee compensation.<sup>24</sup> Almost 90% of all occupational eye injuries can be prevented  
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34 through the use of appropriate safety equipment. Using appropriate safety equipment can  
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36 indirectly save total costs of eye injuries such as the related legal fees, the cost of repairing the  
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38 damage resulting from the circumstances related to the injury in the work premises and the  
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40 necessary employee training fees has been estimated at more than US \$ 934 million annually  
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42 in America.<sup>25</sup> In this study it was found that the costs of medical and vision recovery was about  
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44 Ringgit Malaysia 5 million where the direct costs amounted to more than Ringgit Malaysia 1  
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46 million and indirect costs were more than Ringgit Malaysia 4 million. This study helps provides  
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48 an understanding of the economic importance of work-related eye injuries in Malaysia which  
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50 has not been explored before. Both employers and employees must be aware of the relationship  
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52 between visual health and productivity in the workplace. Employees who experience a  
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54 significant decrease in their vision can contribute to increased rates of negligence in the  
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3 workplace and losses of working days. Negligence can make a work premise a place where  
4 workers are at high risk of danger. This situation happens because of employees with a decrease  
5 in their visual ability may find it difficult to adapt to their reduced visual state and this in turn  
6 can lead to frustrations with their jobs or tasks. This employee than would have to deal with  
7 fatigue, headaches and constant stress on a daily basis caused by their vision dysfunction. This  
8 circumstance may then lead to the employee's income becoming compromised if this situation  
9 persists over a period of time. If there are many workers involved, this situation can then  
10 threaten the economic stability of industries and eventually countries while being likely to cause  
11 a rising unemployed population. The employer also bears huge losses from this loss of  
12 experienced and trained work persons who face these vision limitations.  
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28 In this study, it was found that about 96% of workers suffering from eye injury suffered  
29 from low to moderate injury which in turn increased their indirect medical costs in comparison  
30 to their direct medical costs and their chances of returning to work. Although 14% of workers  
31 had suffered severe injury, still the percentage of their not returning to work was low, being  
32 5.5%. There are a number of factors that can affect the severity of an employee's eye injury.  
33 These factors include the quality of safety protection devices, mechanisms of accidents, types  
34 of eye injuries, when treatment was started, the type of medical treatment given and so on. For  
35 those with low severity injuries, the visual status of these injured workers was assisted and  
36 improved through refractive error correction using glasses or contact lens. This method  
37 however can only help in certain cases, depending on the effects of the injury sustained. Work-  
38 related eye injuries are not only affected by refractive errors, but also includes visual field  
39 problems, stereopsis and other more extensive and complicated problems. The rehabilitation is  
40 not just prescribing glasses, there are multiple factors that decides the success rate of the  
41 rehabilitation. The rehabilitation performed needs to be tailored to address all the problems  
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3 encountered by the injured worker including any loss of field of vision or eye muscle imbalance.  
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5 The results of the chi-square test on the data from the injured workers in this study showed that  
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7 the degree of severity of the eye injuries affected that injured worker's ability to return to work.  
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10 The greater the severity of the eye injury, the chances of that worker returning to work became  
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12 less. Vision rehabilitation therapy can improve an injured employee's vision to a better level. It  
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14 must be noted that since most of these injured workers receive an injury involving only one  
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16 eye, they are typically not eligible to be classified as an individual with limited vision (since  
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18 the uninjured eye has typically normal vision, thus not fulfilling the criteria for limited vision.  
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21 Adaptation to vision loss among workers usually occurs rapidly. This is because occupational  
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23 eye injuries usually happen to younger adult individuals and those who have the physical ability  
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25 to continue working. This can be seen from the findings of this study where most of the injured  
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27 workers return to work. This situation has the potential to create a higher risk to employees with  
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29 their current vision status not reaching the actual standards needed for the job they do, especially  
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31 when they need to handle or operate hazardous equipment. Often there is no specific assessment  
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33 of the safety of the employee in his duties when they return to duty after injury.  
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40 To further strengthen Malaysia's position within the global economic community with  
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42 strong and progressive economic and industrial development policies, worker safety issues in  
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44 the workplace should be given due attention and should address worker safety from all angles.  
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46 This should not only involve just accident prevention measures in workplaces but should also  
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48 address post-injury rehabilitation for those who are injured in their course of their work which  
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50 should also encompass vision recovery methods. The experience from other developed  
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52 countries can be studied, and wherever appropriate these experiences can implement prudently  
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54 in the Malaysian work environment.  
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3 The limitation of the study includes lack of data availability after the year 2008. Besides,  
4 other important components of vision named stereopsis, contrast sensitivity, color vision, and  
5 visual field data not included in the study. However, the details of vision rehabilitation are not  
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9 considered for further analysis because it was a retrospective case files study.  
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## 13 14 **CONCLUSION**

15  
16 This study concludes that males are more affected than females and have highest percentage of  
17 work-related eye injuries. It was observed that work-related eye injuries were most likely to  
18 occur among Malay workers compared to the other Malaysian ethnicities. The highest number  
19 of eye injuries arose from the impact of moving objects (excluding those caused by falling  
20 objects) (89.2%) followed by eye surface injury (51.6%) where commonly corneal injury was  
21 seen. The State of Selangor had the highest number of cases of eye injury followed by the state  
22 of Penang over the study period, 2004-2008. It was found that in this period, more workers  
23 suffered from eye injuries in the low category (45.0%) more followed by the moderate (36.8%)  
24 and severe (18.2%) categories. About 70% workers received treatment for their eye injuries on  
25 the same day as their injury occurred while the remaining mostly sought treatment within 3  
26 days of injury. Indirect medical costs were found to be higher than direct medical costs and the  
27 percentage of workers returning to work after receiving treatment was 94.5%. Awareness and  
28 vision rehabilitation program at work place need to be address for a better prevention and  
29 rehabilitative service.  
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52 providing data access for the years 2004-2008.  
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#### 5 **Availability of data and materials**

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7 The data used in this study is available with the author.  
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#### 9 **Ethics approval and consent to participate**

10 This study received approval from University Kebangsaan Malaysia Research Ethics  
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#### 17 **Consent for publication**

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Not applicable.

#### 21 **Competing interests**

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The authors declare that they have no competing interests.

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**Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO**

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**Figure 2: Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008**

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**Figure 3. The proportion of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

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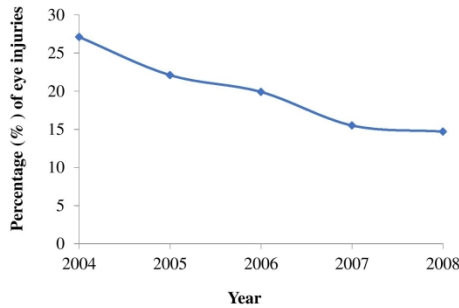
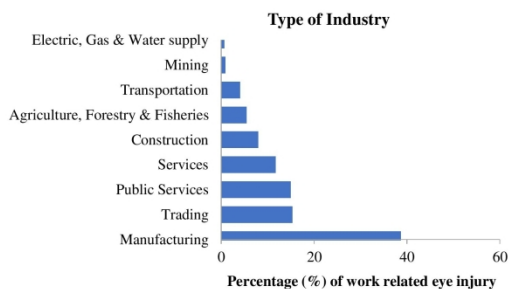


Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO

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**Figure 2:** Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008

209x297mm (300 x 300 DPI)

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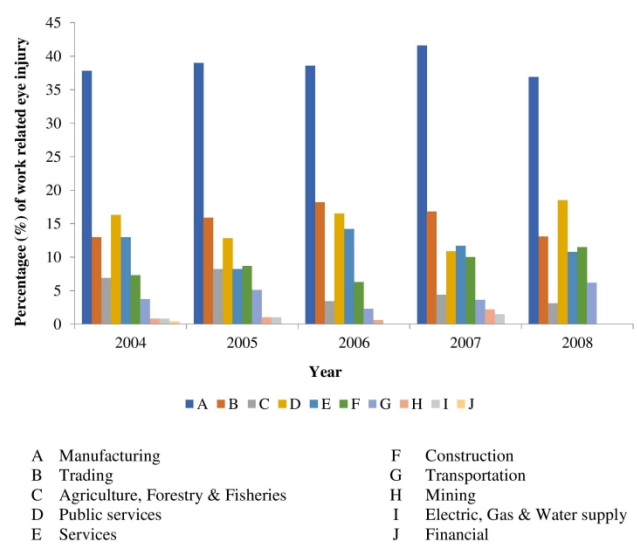


Figure 3. The trend in distribution of eye injury by industry for the period 2004 to 2008 registered with SOCSO

209x297mm (300 x 300 DPI)

# BMJ Open

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

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5 2 **Title:** Characteristics of eye injuries, medical cost and return to work status among industrial  
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7 workers  
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32 16 Professor Dr. Rokiah Omar: Designed the manuscript construct, interpreted investigative data,  
33 17 wrote the manuscript and critically reviewed the manuscript  
34

35  
36 18 Nur Syamilah Anan: Examined, analysed and interpreted investigative data  
37

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40 20 Chiranjib Majumder: Analysed and interpreted investigative data, reviewed the manuscript.  
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42 21 Victor Feizal Knight: Designed the manuscript construct, interpreted investigative data  
43 22 critically reviewed the manuscript.  
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## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

### Abstract:

**Objective:** The aim of this study is to determine the characteristics of eye injuries, medical costs, and return to work status among industrial workers to provide better vision rehabilitative services.

**Setting:** The data collection was done in one of the government university of Malaysia using case records of eye injuries among industrial workers registered with the Social Security Organization (SOCSO).

**Participants:** The study did not involve any active participant. However, case files of ocular injury patents were reviewed and analysed. The cases were selected through a process of stratified random sampling where one file from each stratum was selected randomly.

**Primary and secondary outcome measures:** The primary outcome of the study was to evaluate the characteristics of eye injuries and medical costs related to the eye injury. However, the secondary outcome planned to report the return-to-work status among industrial workers.

**Results:** A total of 884 from 8861 case files workplace accidents involving eye injury registered with Social Security Services (SOCSO) were identified. The mean age was 35±10 years and the highest incidence of work-related eye injury occurred in the age group 30 to 39 years and among Malay ethnics. Males are affected more than females' workers. The highest cause of eye injury was the impact from a moving object excluding falling objects (89.2%) and anterior segment injuries occurred more than posterior segment injuries. The total direct and Indirect medical cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20).

**Conclusion:** The majority of workers suffered from the low level of eye injury. A significant relationship was found between the severity of eye injury and employee work status. The indirect cost of medical and vision rehabilitation was higher than the direct cost. Awareness and vision rehabilitation programs at the workplace need to be addressed for better prevention and rehabilitative service.

**Key words:** Ocular Trauma, Work related injury, Industrial worker, Severity

## 1 Article Summary

### Strength:

- This study has compared eye injuries based on industry type and by states in Malaysia which were not done before too extensively.
- This study also highlighted the average medical cost of treating patients with work-related eye injuries and the return to work status among industrial workers in Malaysia which was not reported earlier.
- Moreover, it also highlighted the need for vision rehabilitation which was not addressed by the earlier studies.

### Limitation:

- The details of vision rehabilitation are not considered for further analysis because it was a retrospective case files study.

## 1 Introduction

2 The human eye has a physiologically highly precise and distinct role. To perceive images of  
3 objects clearly, it is necessary for all components of the eye to work normally. Good visual  
4 function is essential in almost all tasks in activities of daily living, especially those related to  
5 employment. Eye injury is one of the major causes of blindness that worldwide encompasses  
6 nearly half a million people, while many others experience partial loss of vision from these  
7 injuries.<sup>1</sup> Eye injury is a primary cause of unilateral vision loss in developing countries. It has  
8 been found that males are more likely to have eye injury compared to females and this is a trend  
9 that is noticed even from childhood. Moreover, eye injuries tend to be more associated with  
10 lower socioeconomic conditions.<sup>1</sup> Each year the USA reports approximately 2.4 million new  
11 eye injury cases.<sup>2</sup> Out of these, 40,000 to 60,000 patients eventually experience blindness due  
12 to eye injuries.<sup>3-4</sup> The global pattern of eye injuries shows approximately 55 million eye injuries  
13 occurring causing work day losses of more than one-day every year. Out of these injury  
14 occurrences, annually 750,000 cases will require in-patient care. Furthermore, approximately  
15 1.6 million people become blind from these eye injuries with an additional 2.3 million people  
16 develop bilateral low vision. In Pahang, Malaysia the prevalence of eye injury was 9.80%.<sup>5</sup>

17  
18 Eye injury is commonly occurring in the workplace (38.50%), road accidents (20.50%),  
19 sports (29%) and during quarrel (5%). A penetrating injury occurred in 72.50% cases whereas  
20 blunt injury accounted for 27.50% cases.<sup>6</sup> A study conducted in Brazil reported 56.70% of eye  
21 injuries occurred in the workplace followed by those occurring at home (28.30%). Surprisingly  
22 it was found that 82.90% of the victims of eye injury did not wear any eye protective devices  
23 at the time of their accidents.<sup>7</sup> A review study from Malaysia reported a higher prevalence of  
24 eye injury among males with their mean age being 35 years. The common place where eye  
25 injury was suffered among adults was in the workplace while for children it was at home.<sup>8</sup> An

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3 1 earlier study reported that work-related eye injuries in east Malaysia accounted for 36.90% of  
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5 2 the total eye injury cases reported. However, work-related eye injuries reported in Singapore  
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7 3 represented 71.40% of cases of total eye injury visiting casualty units there. Out of all the eye  
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9 4 injuries reported, 90% arose from industrial activities such as drilling, grinding, and cutting  
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11 5 metals.<sup>9</sup> A earlier prospective study conducted in Malaysia reported work-related eye injury  
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13 6 rate of 43.6% among patients attended the medical centre. The causes of eye injury involved  
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15 7 the usage of high-powered machines (30.8%), motor vehicle accidents (23.10%) and domestic  
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17 8 accidents (17.70%). However, only 2.50% used an eye-protective device (EPD) at the time of  
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19 9 injury.<sup>10</sup> Madhusudhan et al. (2014) in his study reported that eye injuries most commonly  
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21 10 involved the home (51.80%) and workplace (23.40%) in Malaysia.<sup>11</sup> Similarly, a previous study  
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23 11 by Mallika et al. (2008) among adults in Kuching, Sarawak also found that areas such as home  
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25 12 (34.30%) and industrial premises (31.80%) were the most common locations where eye injury  
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27 13 occurred.<sup>12</sup>  
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35 15 Eye injuries can cause the loss of working days among workers which causes a loss of  
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37 16 productivity and this then becomes a burden to the economy. It is important to understand the  
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39 17 implication of eye injuries and how it affects workers, family members, industries and the  
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41 18 nation. Emphasis on providing vision rehabilitation will help affected workers to continue their  
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43 19 work.<sup>13</sup> Vision rehabilitation includes the prescription of glasses, contact lenses, prisms, and  
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45 20 low vision rehabilitative services. However, return to work requires a multi-disciplinary  
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47 21 approach and can be a challenge to implement comprehensively. Little information is available  
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49 22 of the characteristics of eye injuries, their associated medical costs and return to work status  
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51 23 among industrial workers who get injured.<sup>13</sup> We postulate that comprehensive visual  
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53 24 rehabilitation services for industrial workers with eye injuries needs to be available in order that  
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55 25 productivity can be maintained. Therefore, the objective of this study is to identify the  
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1 characteristics of eye injuries, medical costs and return to work status among industrial workers  
2 in Malaysia so that better visual rehabilitation services can be recommended and provided for.

#### 3 4 **Methodology**

5 This was a retrospective study conducted using case records of eye injuries among industrial  
6 workers registered with the Social Security Organization (SOCSO). This research was  
7 approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee  
8 and followed the tenants of Helsinki Declaration. Permission to conduct this research was also  
9 obtained from the Medical Division of SOCSO Headquarters and the data authorised for use  
10 was those in the calendar years 2004-2008. SOCSO was chosen as the source of reference for  
11 secondary data files because SOCSO has the most comprehensive collection of work place  
12 medical records in Peninsular Malaysia. SOCSO appoints trained medical doctors as their panel  
13 doctors organisation and these doctors must completed a comprehensive 72 hour training  
14 program before being certified as an occupational health doctor and eligible to be registered  
15 with the Department of Occupational Health and Safety, Ministry of Human Resources.

16  
17 SOCSO is a statutory body set up its own remuneration system to provide medical and  
18 financial assistance to workers whose ability to work have been affected by accident or illness.  
19 The main function of SOCSO is to provide social security protection to employees and their  
20 dependants through the Employment Injury Scheme and the Invalidity Scheme (Act 4). All  
21 workers will contribute to the scheme and the employers also have to contribute as well. The  
22 workers include private workers, contract and temporary government officers. The workers are  
23 mandatory to contribute to the SOCSO and register to the SOCSO according to the law of  
24 Malaysia. The Employment Injury Scheme provides protection to employees from occupational  
25 injuries including occupational diseases and commuting accident during travel in connection



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3 1 with employment. The Invalidity Scheme provides 24-hour protection to employees against  
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5 2 invalidity or death due to causes occurring outside working hours. SOCSO protection scheme  
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7 3 provide cash benefits to employees and their dependants in the event of unforeseen incidents,  
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9 4 in addition to providing medical treatment, physical rehabilitation or vocational training.  
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11 5 SOCSO also conducts accident prevention activities through occupational safety and health  
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13 6 awareness programmes among employees and employers. Besides, Self-Employment Social  
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15 7 Security Scheme [Act 789] provided protection under the Employment Injury Scheme to self-  
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17 8 employed taxi drivers and individuals providing similar services including Uber and Grab Car  
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19 9 drivers. Another services provided is the Employment Insurance System Act [Act 800] for the  
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21 10 purpose of protecting and helping workers who have lost their employment using two (2) main  
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23 11 components namely, Employment Insurance and Employment Services to promote active labor  
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25 12 market policies. The Employment Insurance System (EIS) is a new protection scheme for  
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27 13 workers who have lost their employment by replacing lost income, providing reskilling and  
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29 14 upskilling training to enable them to find new jobs as well as providing job-search services, so  
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31 15 that they can gain suitable employment more expediently. To qualify for such benefits, the  
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33 16 Insured Person must fulfil the contribution eligibility in accordance with the claim, that is, a  
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35 17 minimum of 12 months' contribution in a period of 24 months and such benefits shall be  
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37 18 payable beginning 1st of January 2019. However, the Insured Person must meet the eligibility  
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39 19 requirements and must be capable and ready to work as well as actively search for employment.  
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49 21 The panel of doctors are appointed by the SOCSO organization. When any injury  
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51 22 reported by the worker, they need to go and see the doctor allotted from the panel clinic or  
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53 23 hospital. The report given by the panel is then transcribed into electronic form. SOCSO also  
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55 24 helps workers' dependents in the event of their death through a pension scheme. Inclusion  
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3 1 criteria for this study included eye injury cases occurring in Peninsular Malaysia, cases being  
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5 2 eye injury related to the workplace reported between 2004 to 2008.  
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10 4 ***Patient and Public Involvement:***

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12 5 No patient Involved. Only case files were reviewed and analysed.  
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17 7 ***Sampling Technique and Methods:***

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19 8 The cases were selected through a process of stratified random sampling where every 10 cases  
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21 9 files were selected as stratum and one case file from each stratum was selected randomly. Cases  
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23 10 of workplace related eye injuries that did not occur in Peninsular Malaysia, and not reported  
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25 11 between 2004 to 2008 were excluded from this study. All case files identified for inclusion were  
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27 12 kept confidential and anonymous. The information extracted from the case files included date  
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29 13 of first consultation, age and gender, cause of the eye problem suffered, location of the eye  
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31 14 injury, level of vision, date and time of hospital admission, clinical diagnosis, eye and vision  
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33 15 recovery data, eye function data, available medical care and costs involved, recovery time and  
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35 16 number of days the subject was not able to work. The eye injury classification used for this  
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37 17 study was adopted from the standard international classification system, i.e. the Birmingham  
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39 18 Eye Injury Terminology System (BETTS) and modified to come up with the suitable SOCSO  
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41 19 classification and the classification of 21 industry types in Malaysia was based on the Malaysian  
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43 20 Standard Industry Classification (MSIC) 2008 version 1.0 used by the Department of Statistics  
44  
45 21 Malaysia.<sup>14</sup> The International Classification of Diseases (ICD) 11 (2018) classified visual  
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47 22 impairment into mild impairment (VA <6/12 to 6/18), moderate impairment ( VA<6/18-6/60),  
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49 23 severe impairment (VA<6/60-3/60) and blindness (VA <3/60).<sup>15</sup> The Severe impairment, and  
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51 24 blind is merged into severe impairment category for this study. The data was analysed using  
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53 25 IBM SPSS Statistics for Windows, Version 25. Descriptive tests were used to analyze the study  
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3 1 data covering mean, percentage, median and standard deviation. The relationship between the  
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5 2 severity of eye injury and the ability of the employee to return to work was analysed using Chi-  
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7 3 Square Test.  
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## 11 5 **RESULTS**

### 12 6 *Characteristics of work-related eye injury*

13 7 From 2004 to 2008, a total of 8,861 workplace accidents involving eye injuries were registered  
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15 8 with SOCSO. A total of 884 eye injury case files were randomly selected which fulfilled the  
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17 9 selection criteria for this study. A summary of information on the worker profile, severity of  
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19 10 work-related eye injury and work status based on age among industrial workers registered with  
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21 11 SOCSO is shown in Table 1.  
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31 13 Most of these workplace eye injury cases registered with SOCSO involved male  
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33 14 workers in a ratio of 14:1 compared to female workers. The average age of all employees was  
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35 15 35±10 years. The average age for male and female workers were 34±10 and 38±12 years. The  
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37 16 highest proportion of work-related eye injuries occurred in the age group of 30 to 39 years old.  
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40 17 In terms of ethnicity, Malays had the highest proportion of work-related eye injury cases.  
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**Table 1. Profile, severity of work-related eye injury and work status based on age among industrial workers registered with SOCSO 2004-2008**

Age Group	Gender (n / %)		Ethnic (n / %)				Eye Injury Level of Severity (n / %)			Work Status (n / %)	
	Male	Female	Malay	Chinese	Indian	Others	Mild	Moderate	Severe	Working	Stop Working
<b>10 – 19</b> (n = 30)	27 (90.00)	3 (10.00)	8 (26.70)	15 (50.00)	7 (23.30)	0 (0.00)	18 (60.00)	8 (26.70)	4 (13.30)	26 (86.70)	4 (13.30)
<b>20 – 29</b> (n = 263)	250 (95.10)	13 (4.90)	121 (46.00)	107 (40.70)	32 (12.20)	3 (1.10)	137 (52.10)	91 (34.60)	35 (13.30)	247 (93.90)	16 (6.10)
<b>30 – 39</b> (n = 309)	296 (95.80)	13 (4.20)	141 (45.60)	118 (38.20)	45 (14.60)	5 (1.60)	141 (45.60)	128 (41.40)	40 (12.90)	296 (95.80)	13 (4.20)
<b>40 – 49</b> (n = 196)	178 (90.80)	18 (9.20)	78 (39.80)	73 (37.20)	44 (22.40)	1 (0.50)	77 (39.30)	70 (35.70)	49 (25.00)	189 (96.40)	7 (3.60)
<b>50 – 59</b> (n = 71)	64 (90.10)	7 (9.90)	25 (35.20)	30 (42.30)	16 (22.50)	0 (0.00)	22 (31.00)	24 (33.80)	25 (35.20)	65 (91.50)	6 (8.50)
<b>60 – 69</b> (n = 15)	11 (73.30)	4 (26.70)	1 (6.70)	11 (73.30)	3 (30.00)	0 (0.00)	3 (20.00)	4 (26.70)	8 (53.20)	12 (80.00)	3 (20.00)
<b>Total</b> (n = 884))	<b>826</b> (93.00)	<b>58</b> (7.00)	<b>374</b> (42.30)	<b>354</b> (40.00)	<b>147</b> (16.60)	<b>9</b> (1.00)	<b>398</b> (45.00)	<b>325</b> (36.80)	<b>166</b> (18.20)	<b>835</b> (94.50)	<b>49</b> (5.50)

\* Row percentage referred here

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3 1 The eye injury cases were categorized according to their causes and the characteristics  
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5 2 of work-related eye injury experienced by the injured workers. The causes of work-related eye  
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7 3 injury and the characteristics of work-related eye injury were divided into nine and eight  
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9 4 subtypes respectively. The highest number of eye injuries occurred from incidents that resulted  
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11 5 in the impact from a moving object but excluding incidents that involved a falling object  
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13 6 (89.20%). These moving objects include fragments or flying particles near or within the  
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15 7 working environment of the worker. Eye surface injury (51.60%) were the most common cause  
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17 8 of injury among these industrial workers. Eye surface injuries include causes such as splinters  
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19 9 entering the eyes, corneal abrasions, scratches and bites by non-invasive insects that lead to  
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21 10 injuries to the surface of the eye and adnexa. The details of the types and characteristics of  
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23 11 work-related eye injury among industrial workers are shown in Table 2. The characteristics of  
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25 12 the work-related eye injury is categorized into five categories which include the anatomy of the  
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27 13 eye, affected eye, level of severity of injury experienced, onset of treatment given and level of  
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29 14 vision of the worker with the eye injury.  
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16 About 70% of the work-related eye injuries in Peninsular Malaysia that were filed with  
17 SOCSO from 2004 to 2008 affected the anterior segment of the eye. Out of all these anterior  
18 segment injuries, corneal injury was the highest (53.40%). In this study, the left eye (47.40%)  
19 was more affected than the right eye (42.20%). The severity of work-related eye injury was  
20 categorized into three distinct levels, namely mild, moderate, and severe levels. Monocular  
21 work-related eye injuries were found more likely to occur than binocular eye injury ( $\chi^2 =$   
22  $566.69$ ,  $df = 3$ ,  $p < 0.001$ ). Majority i.e 45.00% workers in the present study suffered from mild  
23 level work-related eye injuries (Table 2). Analysis using the Chi-squared test showed a  
24 significant difference ( $\chi^2 = 99.99$ ,  $df = 2$ ,  $p < 0.001$ ) between the severity of the work-related eye  
25 injury levels. In terms of time of treatment for the injury, about 70% of workers received their

1 treatment on the same day ( $0.8 \pm 3.5$  days) as the date of their work-related eye injury while the  
2 remaining mostly sought treatment within 3 days of injury. The majority of the work-related  
3 eye injury workers had good to mild level of visual impairment on the day of their initial visual  
4 acuity assessment.

### 6 **Trend of work-related eye injury**

7 Figure 1 shows a decreasing trend of eye injury occurring from 2004 to 2008. The percentage  
8 of employment-related eye injuries when analysed by industry type, the manufacturing industry  
9 (38.70%) showed that the highest number of cases followed by trading (15.30%) and public  
10 services (15.00%). On the other hand, the lowest percentage of cases were from the mining  
11 (0.90%), financial (0.60%) and electrical, gas and water industries (0.10%) as shown is in  
12 Figure 2.

13  
14 When the proportion of eye injuries was analysed by their state location of occurrence  
15 in Peninsular Malaysia, the State of Selangor (21.40%) had the highest number of cases of eye  
16 injury and state of Terengganu (0.90%) showed lowest as shown in Table 3. The work-related  
17 eye injury had an increased trend in public services from the year 2004-2008 as shown in Figure  
18 3.

**Table 2: Types and characteristics of work-related eye injury among industrial workers registered with SOCSO 2004-2008**

Characteristics	Number (n=884)	Percentage (%)		
<b>Anatomy of Eye</b>				
Cornea	472	53.40		
Multiple injury	232	26.20		
Conjunctiva	98	11.10		
Eyelid	30	3.40		
Eyebrow	20	2.30		
Crystalline lens	7	0.80		
Orbital	7	0.80		
Retina	6	0.70		
Sclera	4	0.50		
Anterior chamber	4	0.50		
Nasolacrimal gland	2	0.20		
Uvea	1	0.10		
Optic nerve	1	0.10		
<b>Affected Eye</b>				
Left eye	419	47.40		
Right eye	373	42.20		
Both eye	75	8.50		
No record	17	1.90		
<b>Eye Injury Level of Severity</b>				
Mild	530	45.00		
Moderate	236	36.80		
Severe	118	18.20		
<b>Causes</b>				
Impact from a moving object excluding falling objects	788	89.20		
Impact from a static object	33	3.70		
Impact from a falling object during work	30	3.30		
Impact from a moving object	9	1.00		
Falling from a higher place	7	0.80		
Falling from the same height or lower place	7	0.80		
Other impacts from falling object	5	0.60		
Exposure to ionizing radiation	4	0.50		
Other accidents	1	0.10		
<b>Types of Eye Injury</b>				
Eye surface injury	456	51.80		
Other injury	182	20.60		
Blow	105	11.80		
Burn	88	10.10		
Bruise	46	5.30		
Radiation effect	3	0.30		
Fracture	2	0.20		
<b>Start Treatment Day</b>				
Same day	602	68.30		
≤3 day	241	27.30		
≤7 day	26	2.90		
≤14 day	7	0.80		
≤30 day	4	0.50		
>30 day	4	0.50		
<b>Vision Acuity Level</b>	<b>Initial Assessment (n = 266)</b>		<b>Final Assessment (n=360)</b>	
	<b>RE</b>	<b>LE</b>	<b>RE</b>	<b>LE</b>
Good (6/4.5-6/6)	39.80%	38.30%	66.70%	61.70%
Mild (6/7.5-6/18)	30.80%	33.10%	21.70%	23.10%
Moderate (<6/18-6/60)	14.70%	14.70%	3.90%	6.90%
Severe (<6/60-NPL)	14.70%	13.90%	7.80%	8.30%

**Table 3: Eye injury trends according to the type of industry in each State in Peninsular Malaysia and by age group**

Eye Injury	Types of Industry										Total
	A	B	C	D	E	F	G	H	I	J	
States of Peninsular Malaysia	Selangor	57	22	6	25	36	27	11	1	0	189
	Pulau Pinang	91	26	1	22	9	5	5	0	0	161
	Johor	59	18	9	12	29	10	9	1	1	148
	Kedah	52	18	9	14	5	5	0	1	0	104
	Perak	36	20	8	15	8	8	4	1	0	100
	Pahang	10	10	7	15	2	3	2	1	0	50
	Kuala Lumpur	8	9	0	11	4	6	2	0	0	40
	Negeri Sembilan	13	4	3	9	5	0	2	0	0	36
	Melaka	12	2	3	3	1	2	0	0	0	24
	Kelantan	2	3	0	3	4	0	0	1	0	13
	Perlis	1	2	0	2	0	5	0	0	0	11
	Terengganu	1	1	3	2	0	0	1	0	0	8
	<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>	<b>884</b>
Age Group (year)	10 - 19	14	6	1	6	1	2	0	0	0	30
	20 - 29	97	43	7	44	37	24	7	3	0	263
	30 - 39	126	52	12	41	37	29	10	1	1	309
	40 - 49	71	22	22	31	22	12	9	1	0	196
	50 - 59	27	10	5	10	6	3	8	1	0	71
	60 - 69	7	2	2	1	0	1	2	0	0	15
	<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>	<b>884</b>

A Manufacturing

B Trading

C Agriculture, Forestry &amp; Fisheries

D Public services

E Services

F Construction

G Transportation

H Mining

I Electric, Gas &amp; Water supply

J Financial



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2  
3 1 **Method, cost and efficacy of recovery**  
4

5 2 The manner of recovery, cost of medical expenses and the rate of injured workers returning to  
6  
7 3 work are shown in Table 4. The costs of treatment determined in this study refers to the  
8  
9 4 standardised maximum reimbursable hospital rates used by SOCSO for payment for treatment  
10  
11 5 of workplace injury. Whereas the types of treatment received by workers with eye injuries  
12  
13 6 registered in SOCSO are listed in Table 4.  
14

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16  
17 7 Worker recovery from injury is divided into 2 groups. The first group depicts medical  
18  
19 8 recovery from injury which would include surgery (if needed), outpatient follow-up and  
20  
21 9 medication. The second group depicts vision recovery methods which include spectacles,  
22  
23 10 prostheses and recovery references. In the medical recovery group, the Type C and Type B  
24  
25 11 surgery treatment modalities were the most common options reported for treating eye injury (>  
26  
27 12 50 cases). It is also noted that the biggest number of cases were moderate types of eye injuries  
28  
29 13 with moderate types of treatment needed. The Type B included Intraocular lens implant  
30  
31 14 Keratoplasty: Lamellar or penetrating Retinal detachment surgery, Intraocular foreign body  
32  
33 15 removal, Strabismus surgery, Repair of severe perforating injuries of the eyeball, Glaucoma  
34  
35 16 surgery, Dacryocystorhinostomy, Dacryocystectomy Repair of several lachrymal passages  
36  
37 17 Exenteration of orbit. Type C included Cataract extraction: intracapsular and extracapsular,  
38  
39 18 Repair of eyelid deformities, Extraction of dislocated / subluxated lens, Discission Paracentesis  
40  
41 19 Excision of orbital or ocular tumours Iridectomy: peripheral or optical Cryopexy as prophylaxis  
42  
43 20 against retinal detachment and glaucoma Evisceration, Enucleation, Ectropion or Entropion  
44  
45 21 correction, Tarsorrhaphy Repair of severe laceration of eyelid and / or region around the eyes,  
46  
47 22 Pterygium surgery, Excision biopsy Release of symblepharon / mucous membrane graft, Repair  
48  
49 23 of lachrymal puncta or canalicular obstruction, Repair of moderate perforating injury of eyeball,  
50  
51 24 Laser Coagulation and Type D included Incision and curettage of chalazion, Excision of  
52  
53 25 granulomas, Removal of corneal or conjunctival foreign body Catholysis / epilation of  
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1 trichiasis, Repair of minor lacerations of eyelids and / or region around the eyes, Syringing /  
2 probing of lachrymal apparatus, Repair of minor perforating injury of eyeball.

3           The indirect costs are derived from the value of temporary disability or the number of  
4 workers' days off from work, and the value of permanent disability or workers' compensation  
5 costs. This study showed that 94.50% workers returned to work after their recovery from injury.  
6 However, the remaining 5.50% did not go back to work as derived from Table 5. The age wise  
7 distribution of eye injury severity and occupational status showed the highest percentage of  
8 return to work was for the age groups 30 to 39 years and 40 to 49 years which were 95.80%  
9 and 96.40% respectively. Although the severity of injury was found to be higher among workers  
10 over the age of 50 years, nonetheless most of them were able to return to work. Whereas, the  
11 younger age group, 10-19 years, stopped working more often compared to the older age groups  
12 except for the age group 60-69 years as shown in Table 1. The total direct and Indirect medical  
13 cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20).

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1 **Table 4. Estimated costs of medical, and vision recovery for industrial workers registered**  
2 **with SOCSO**

Cost Category	No,	Costs (RM)	Costs (USD)	Total (RM)	Total (USD)
<b>Direct Costs of Medical</b>				<b>1,108,098.00</b>	<b>316599.40</b>
<b>Recovery</b>					
Surgery B	64	750.00	214.20	48,000.00	13714.20
Surgery C	79	500.00	142.80	39,500.00	11285.70
Surgery D	17	188.00	53.70	3,196.00	913.10
Outpatient (mild cases)	75	40.00	11.40	3,000.00	857.10
Outpatient (moderate cases)	393	70.00	20.00	27,510.00	786.00
Outpatient (severe cases)	19	100.00	28.50	1,900.00	542.80
Medication (mild treatment)	72	50.00	14.20	17,850.00	5100.00
Medication (moderate treatment)	125	70.00	20.00	136,268.00	38933.70
Medication (severe treatment)	40	100.00	28.50	254,900.00	72828.50
<b>Ward Cost</b>	-	32.00	9.10	540,374.00	154392.50
<b>Vision Recovery</b>					
Spectacles	25	400.00	114.20	10,000.00	2857.10
Prosthesis	6	3,600.00	1028.50	21,600.00	6171.40
Spectacles + Prosthesis	1	4,000.00	1142.80	4,000.00	1142.80
Recovery references	1	-	-	-	-
<b>Indirect Costs</b>				<b>4,150,140.00</b>	<b>1185754.20</b>
Value of temporary disability				805,268.00	230076.50
Value of permanent disability				3,344,872.00	955677.70
<b>TOTAL RECOVERY COSTS</b>				<b>5,258,238.00</b>	<b>1502353.70</b>

\*1 USD=3.5 RM (Average of 2004-2008); Source of data SOCSO

### Severity of eye injury and effectiveness of vision recovery

The relationship between the severity of eye injury and the ability of the employee to return to work was analysed. Table 5 displays the relationship between the injured employee (registered with SOCSO) employment status with the severity of the eye injury they experience. It was found that most workers injured in Peninsular Malaysia suffered mild (n = 398) and moderate (n = 325) eye injuries. Of that number, 96% of them were able to return to work. In contrast, 14% of workers with severe eye injuries were unable to return to work. To prove the correlation between this data, a chi-square test was performed. The results of the chi-square test ( $\chi^2 = 24.94$ ,  $df = 2$ ,  $p < 0.001$ ) showed that there was a significant relationship between the severity of eye injury and employee work status. This indicates that, when the degree of injury of the employee's eyes worsens or the total number of days of sick leave exceeds 1 month, the chances of the workers returning to work declines.

**Table 5. Frequency of employment status based on severity of work related eye injury**

Work Status	Eye Injury Level of Severity (n)			Total
	Mild	Moderate	Severe	
Working	382	314	139	835
Stopped working	16	11	22	49
<b>Total</b>	<b>398</b>	<b>325</b>	<b>161</b>	<b>884</b>

\* $\chi^2 = 24.94$ ,  $df = 2$ ,  $p < 0.001$

## 1 DISCUSSION

2 This study showed a male preponderance of eye injuries which is congruent with the study  
3 conducted in Malaysia by Soong et al. 2008 where he found 88.1% cases occurred among  
4 males. Similarly, other studies also supported this male predominance.<sup>1,5,7,10,11,12,16-21</sup> The ethnic  
5 distribution of cases showed that Malays (42.30%) had a higher percentage of work-related eye  
6 injury followed by the Chinese, Indian and Other ethnicities. The study by Soong et al. (2008)  
7 reported a similar ethnic distribution of eye injury with the percentage of Malay, Indian,  
8 Chinese and Other ethnicities being 31.90%,12.20%, 9.70%, and 2.10% respectively.<sup>10</sup> This  
9 study found that the highest number of eye injuries occurred from impact with a moving object  
10 (excluding falling objects) (89.20%) followed by impact from a static object , impact from  
11 falling objects during operation (work), and impact from moving objects which contradicted  
12 another Malaysian study which reported 30.80% of injuries were from activities such as  
13 grinding or cutting metal (15.80%), welding (6.90%), hammering on metal (3.70%), carpentry  
14 (2.60%), and nailing (1.80%).<sup>10</sup> Moreover, injury to the surface of the eye was more common  
15 and accounted for 51.60% of eye injuries. Of the anterior segment eye injuries, corneal injury  
16 was the major cause followed by multiple injury causes. These study findings were supported  
17 by two other studies also conducted in Malaysia which reported 61.50% of eye injuries were  
18 corneal laceration and other study reporting that the common anatomical site of injury was the  
19 cornea (43.60%) followed by the conjunctiva (39.50%).<sup>5,10</sup>

20  
21 In this present study, monocular work-related injuries were more common than  
22 binocular injuries and the left eye was more affected compared to the right eye. It was also  
23 reported that about 70% of workers received treatment on the same day while the remainder  
24 mostly sought treatment within 3 days of injury. However, an earlier study conducted in  
25 Malaysia contradicted these findings where that study found that right eye injury was more

1 common, followed by the left eye and then both eyes but was in agreement with the fact that  
2 73.40% presented within 24 hours of the injury and that a further 23.90% presented between  
3 1–3 days from the day of the injury.<sup>10</sup> Furthermore, the trend of eye injury decreased from 2004  
4 to 2008 and the manufacturing industry recorded the highest number of cases of eye injuries  
5 followed by trading and public services. It was noted that Selangor state had the highest number  
6 of cases of eye injury followed by Penang. Thus far, no other such study has compared eye  
7 injuries based on industry type and by State in Malaysia previously.

8  
9 In a previous study, the average working day loss was reported as 3.4 days.<sup>22</sup> The study  
10 of Chi and colleagues (2007) reported that the duration of hospital treatment was from 4 to 7  
11 days, with the average cost of medical treatment being New Taiwan Dollar 43,609 +/- 30,660  
12 (6635.05 +/- 4664.87 or 1567.46 +/- 1102.03 USD).<sup>23</sup> Another study recorded that over US \$  
13 300 million a year was lost comprising total lost time and income, medical expenses and  
14 employee compensation.<sup>24</sup> Almost 90% of all occupational eye injuries can be prevented  
15 through the use of appropriate safety equipment. Using appropriate safety equipment can  
16 indirectly save total costs of eye injuries such as the related legal fees, the cost of repairing the  
17 damage resulting from the circumstances related to the injury in the work premises and the  
18 necessary employee training fees has been estimated at more than US \$ 934 million annually  
19 in America.<sup>25</sup> In this study it was found that the costs of medical and vision recovery was about  
20 Ringgit Malaysia 5 million (about 1.2 million USD) where the direct costs amounted to more  
21 than Ringgit Malaysia 1 million ( about 300 thousand USD ) and indirect costs were more than  
22 Ringgit Malaysia 4 million (about 1.1 million USD) . Present study provides an understanding  
23 of the economic importance of work-related eye injuries in Malaysia which has not been  
24 explored before. Both employers and employees must be aware of the relationship between  
25 visual health and productivity in the workplace. Employees who experience a significant

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3 1 decrease in their vision can contribute to increased rates of negligence in the workplace and  
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5 2 losses of working days. Negligence can make a work premise a place where workers are at high  
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7 3 risk of danger. This situation happens because of employees with a decrease in their visual  
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10 4 ability may find it difficult to adapt to their reduced visual state and this in turn can lead to  
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12 5 frustrations with their jobs or tasks. This employee than would have to deal with fatigue,  
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14 6 headaches and constant stress on a daily basis caused by their vision dysfunction. This  
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16 7 circumstance may then lead to the employee's income becoming compromised if this situation  
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18 8 persists over a period of time. If there are many workers involved, this situation can then  
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20 9 threaten the economic stability of industries and eventually countries while being likely to cause  
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23 10 a rising unemployed population. The employer also bears huge losses from this loss of  
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25 11 experienced and trained work persons who face these vision limitations.  
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35 13 In this study, it was found that about 96% of workers suffering from eye injury suffered  
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37 14 from low to moderate injury which in turn increased their indirect medical costs in comparison  
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39 15 to their direct medical costs and their chances of returning to work. Although 14% of workers  
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41 16 had suffered severe injury, still the percentage of their not returning to work was low, being  
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43 17 5.50%. There are a number of factors that can affect the severity of an employee's eye injury.  
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45 18 These factors include the quality of safety protection devices, mechanisms of accidents, types  
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47 19 of eye injuries, when treatment was started, the type of medical treatment given and so on. For  
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49 20 those with low severity injuries, the visual status of these injured workers was assisted and  
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51 21 improved through refractive error correction using glasses or contact lens. This method  
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53 22 however can only help in certain cases, depending on the effects of the injury sustained. Work-  
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55 23 related eye injuries are not only affected by refractive errors, but also includes visual field  
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57 24 problems, stereopsis and other more extensive and complicated problems. The rehabilitation is  
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59 25 not just prescribing glasses, there are multiple factors that decides the success rate of the  
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3 1 rehabilitation. The rehabilitation performed needs to be tailored to address all the problems  
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5 2 encountered by the injured worker including any loss of field of vision or eye muscle imbalance.  
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7 3 The results of the chi-square test on the data from the injured workers in this study showed that  
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9 4 the degree of severity of the eye injuries affected that injured worker's ability to return to work.  
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11 5 The greater the severity of the eye injury, the chances of that worker returning to work became  
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13 6 less. Vision rehabilitation therapy can improve an injured employee's vision to a better level. It  
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15 7 must be noted that since most of these injured workers receive an injury involving only one  
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17 8 eye, they are typically not eligible to be classified as an individual with limited vision (since  
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19 9 the uninjured eye has typically normal vision, thus not fulfilling the criteria for limited vision.  
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23 10 Adaptation to vision loss among workers usually occurs rapidly. This is because occupational  
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25 11 eye injuries usually happen to younger adult individuals and those who have the physical ability  
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27 12 to continue working. This can be seen from the findings of this study where most of the injured  
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29 13 workers return to work. This situation has the potential to create a higher risk to employees with  
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31 14 their current vision status not reaching the actual standards needed for the job they do, especially  
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33 15 when they need to handle or operate hazardous equipment. Often there is no specific assessment  
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35 16 of the safety of the employee in his duties when they return to duty after injury.  
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42 18 To further strengthen Malaysia's position within the global economic community with  
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44 19 strong and progressive economic and industrial development policies, worker safety issues in  
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46 20 the workplace should be given due attention and should address worker safety from all angles.  
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48 21 This should not only involve just accident prevention measures in workplaces but should also  
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50 22 address post-injury rehabilitation for those who are injured in their course of their work which  
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52 23 should also encompass vision recovery methods. The experience from other developed  
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54 24 countries can be studied, and wherever appropriate these experiences can implement prudently  
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56 25 in the Malaysian work environment.  
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3 1 The limitation of the study includes lack of data availability after the year 2008. The  
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5 2 outcome of the study might have the influence of the distribution of gender in workplace and  
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7 3 state-wise. Besides, other important components of vision named stereopsis, contrast  
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9 4 sensitivity, color vision, and visual field data not included in the study. However, the details of  
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11 5 vision rehabilitation are not considered for further analysis because it was a retrospective case  
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13 6 files study. Due to the retrospective observational study design, an inherent bias can be possible  
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15 7 and it can be overcome by considering a prospective study in future.  
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## 9 **CONCLUSION**

10 This study concludes that males are more affected than females and have highest percentage of  
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12 11 work-related eye injuries. It was observed that work-related eye injuries were most likely to  
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14 12 occur among Malay workers compared to the other Malaysian ethnicities. The highest number  
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16 13 of eye injuries arose from the impact of moving objects (excluding those caused by falling  
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18 14 objects) (89.20%) followed by eye surface injury (51.60%) where commonly corneal injury  
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20 15 was seen. The State of Selangor had the highest number of cases of eye injury followed by the  
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22 16 state of Penang over the study period, 2004-2008. It was found that in this period, more workers  
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24 17 suffered from eye injuries in the low category (45.00%) more followed by the moderate  
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26 18 (36.80%) and severe (18.20%) categories. About 70% workers received treatment for their eye  
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28 19 injuries on the same day as their injury occurred while the remaining mostly sought treatment  
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30 20 within 3 days of injury. Indirect medical costs were found to be higher than direct medical costs  
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32 21 and the percentage of workers returning to work after receiving treatment was 94.50%.  
33  
34 22 Awareness and vision rehabilitation program at work place need to be address for a better  
35  
36 23 prevention and rehabilitative service.

## 24 **Acknowledgement**

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2  
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4  
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9  
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13

### 14 6 **Availability of data and materials**

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16  
17 7 The data used in this study is available with the author.  
18

### 19 8 **Ethics approval and consent to participate**

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21 9 This study received approval from University Kebangsaan Malaysia Research Ethics  
22  
23 10 Committee UKM 1.5.3.5/244/SPP2/NN/187/2010.  
24

### 25 11 **Consent for publication**

26  
27  
28 12 Not applicable.  
29

### 30 13 **Competing interests**

31  
32  
33 14 The authors declare that they have no competing interests.  
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**Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO**

**Figure 2: Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008**

**Figure 3. The proportion of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

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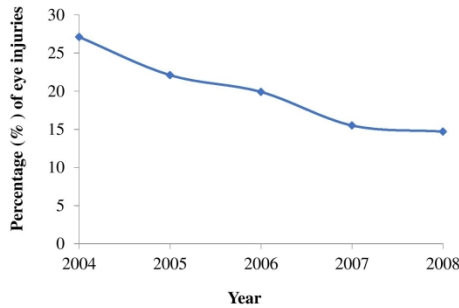
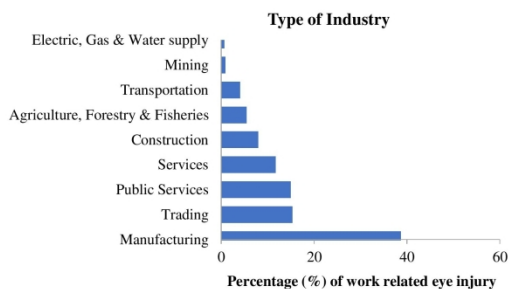


Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO

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**Figure 2:** Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008

209x297mm (300 x 300 DPI)

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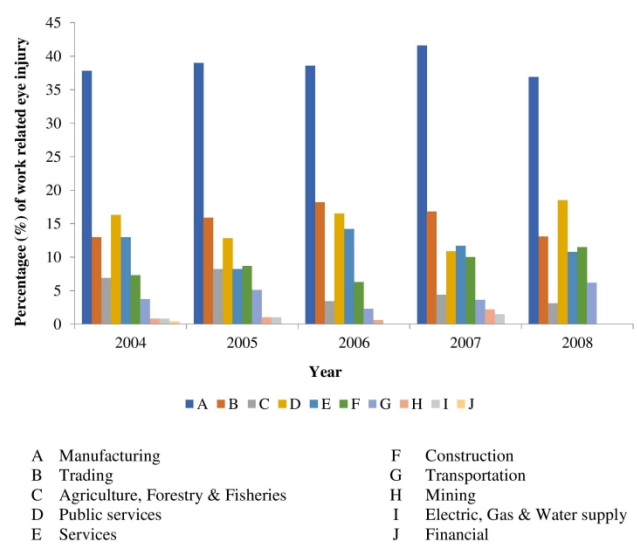


Figure 3. The trend in distribution of eye injury by industry for the period 2004 to 2008 registered with SOCSO

209x297mm (300 x 300 DPI)

# BMJ Open

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

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3 1 **Type:** Original Research  
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5 2 **Title:** Characteristics of eye injuries, medical cost and return to work status among industrial  
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32 16 Professor Dr. Rokiah Omar: Designed the manuscript construct, interpreted investigative data,  
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36 18 Nur Syamilah Anan: Examined, analysed and interpreted investigative data  
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38 19 Izmel Azim Azri: Analysed and interpreted investigative data  
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# CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS

## Abstract:

**Objective:** The aim of this study is to determine the characteristics of eye injuries, medical costs, and return to work status among industrial workers to provide better vision rehabilitative services.

**Setting:** Nationwide data from the Social Security Organization (SOCSO) of Malaysia.

**Participants:** A stratified random sample of workers registered with the SOCSO of Malaysia with documentation of eye injury.

**Primary and secondary outcome measures:** Characteristics of eye injuries and medical costs related to eye injury (primary) and return-to-work status (secondary).

**Results:** A total of 884 from 8861 case files workplace accidents involving eye injury registered with Social Security Services (SOCSO) were identified. The mean age was 35±10 years and the highest incidence of work-related eye injury occurred in the age group 30 to 39 years and among Malay ethnics. Males are affected more than females' workers. The highest cause of eye injury was the impact from a moving object excluding falling objects (89.2%) and anterior segment injuries occurred more than posterior segment injuries. The total direct and Indirect medical cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20) for 884 cases.

**Conclusion:** The majority of workers suffered from the low level of eye injury. A significant relationship was found between the severity of eye injury and employee work status. The indirect cost of medical and vision rehabilitation was higher than the direct cost. Awareness and vision rehabilitation programs at the workplace need to be addressed for better prevention and rehabilitative service.

**Key words:** Ocular Trauma, Work related injury, Industrial worker, Severity

## 1 Article Summary

### Strength:

- This study has compared eye injuries based on industry type and by states in Malaysia which were not done before too extensively.
- This study also highlighted the average medical cost of treating patients with work-related eye injuries and the return to work status among industrial workers in Malaysia which was not reported earlier.
- Moreover, it also highlighted the need for vision rehabilitation which was not addressed by the earlier studies.

### Limitation:

- The details of vision rehabilitation are not considered for further analysis because it was a retrospective case files study.

## 1 Introduction

2 The human eye has a physiologically highly precise and distinct role. To perceive images of  
3 objects clearly, it is necessary for all components of the eye to work normally. Good visual  
4 function is essential in almost all tasks in activities of daily living, especially those related to  
5 employment. Eye injury is one of the major causes of blindness that worldwide encompasses  
6 nearly half a million people, while many others experience partial loss of vision from these  
7 injuries.<sup>1</sup> Eye injury is a primary cause of unilateral vision loss in developing countries. It has  
8 been found that males are more likely to have eye injury compared to females and this is a trend  
9 that is noticed even from childhood. Moreover, eye injuries tend to be more associated with  
10 lower socioeconomic conditions.<sup>1</sup> Each year the USA reports approximately 2.4 million new  
11 eye injury cases.<sup>2</sup> Out of these, 40,000 to 60,000 patients eventually experience blindness due  
12 to eye injuries.<sup>3-4</sup> The global pattern of eye injuries shows approximately 55 million eye injuries  
13 occurring causing work day losses of more than one-day every year. Out of these injury  
14 occurrences, annually 750,000 cases will require in-patient care. Furthermore, approximately  
15 1.6 million people become blind from these eye injuries with an additional 2.3 million people  
16 develop bilateral low vision. In Pahang, Malaysia the prevalence of eye injury was 9.80%.<sup>5</sup>

17  
18 Eye injury is commonly occurring in the workplace (38.50%), road accidents (20.50%),  
19 sports (29%) and during quarrel (5%). A penetrating injury occurred in 72.50% cases whereas  
20 blunt injury accounted for 27.50% cases.<sup>6</sup> A study conducted in Brazil reported 56.70% of eye  
21 injuries occurred in the workplace followed by those occurring at home (28.30%). Surprisingly  
22 it was found that 82.90% of the victims of eye injury did not wear any eye protective devices  
23 at the time of their accidents.<sup>7</sup> A review study from Malaysia reported a higher prevalence of  
24 eye injury among males with their mean age being 35 years. The common place where eye  
25 injury was suffered among adults was in the workplace while for children it was at home.<sup>8</sup> An

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3 1 earlier study reported that work-related eye injuries in east Malaysia accounted for 36.90% of  
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5 2 the total eye injury cases reported. However, work-related eye injuries reported in Singapore  
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7 3 represented 71.40% of cases of total eye injury visiting casualty units there. Out of all the eye  
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9 4 injuries reported, 90% arose from industrial activities such as drilling, grinding, and cutting  
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11 5 metals.<sup>9</sup> A earlier prospective study conducted in Malaysia reported work-related eye injury  
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13 6 rate of 43.6% among patients attended the medical centre. The causes of eye injury involved  
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15 7 the usage of high-powered machines (30.8%), motor vehicle accidents (23.10%) and domestic  
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17 8 accidents (17.70%). However, only 2.50% used an eye-protective device (EPD) at the time of  
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19 9 injury.<sup>10</sup> Madhusudhan et al. (2014) in his study reported that eye injuries most commonly  
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21 10 involved the home (51.80%) and workplace (23.40%) in Malaysia.<sup>11</sup> Similarly, a previous study  
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23 11 by Mallika et al. (2008) among adults in Kuching, Sarawak also found that areas such as home  
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25 12 (34.30%) and industrial premises (31.80%) were the most common locations where eye injury  
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27 13 occurred.<sup>12</sup>  
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35 15 Eye injuries can cause the loss of working days among workers which causes a loss of  
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37 16 productivity and this then becomes a burden to the economy. It is important to understand the  
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39 17 implication of eye injuries and how it affects workers, family members, industries and the  
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41 18 nation. Emphasis on providing vision rehabilitation will help affected workers to continue their  
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43 19 work.<sup>13</sup> Vision rehabilitation includes the prescription of glasses, contact lenses, prisms, and  
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45 20 low vision rehabilitative services. However, return to work requires a multi-disciplinary  
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47 21 approach and can be a challenge to implement comprehensively. Little information is available  
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49 22 of the characteristics of eye injuries, their associated medical costs and return to work status  
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51 23 among industrial workers who get injured.<sup>13</sup> We postulate that comprehensive visual  
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53 24 rehabilitation services for industrial workers with eye injuries needs to be available in order that  
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55 25 productivity can be maintained. Therefore, the objective of this study is to identify the  
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1 characteristics of eye injuries, medical costs and return to work status among industrial workers  
2 in Malaysia so that better visual rehabilitation services can be recommended and provided for.

#### 4 **Methodology**

5 This was a retrospective study conducted using case records of eye injuries among industrial  
6 workers registered with the Social Security Organization (SOCSO). This research was  
7 approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee  
8 and followed the tenants of Helsinki Declaration. Permission to conduct this research was also  
9 obtained from the Medical Division of SOCSO Headquarters and the data authorised for use  
10 was those in the calendar years 2004-2008. SOCSO was chosen as the source of reference for  
11 secondary data files because SOCSO has the most comprehensive collection of work place  
12 medical records in Peninsular Malaysia. SOCSO appoints trained medical doctors as their panel  
13 doctors organisation and these doctors must completed a comprehensive 72 hour training  
14 program before being certified as an occupational health doctor and eligible to be registered  
15 with the Department of Occupational Health and Safety, Ministry of Human Resources.

17 SOCSO is a statutory body set up its own remuneration system to provide medical and  
18 financial assistance to workers whose ability to work have been affected by accident or illness.  
19 The main function of SOCSO is to provide social security protection to employees and their  
20 dependants through the Employment Injury Scheme and the Invalidity Scheme (Act 4). All  
21 workers will contribute to the scheme and the employers also have to contribute as well. The  
22 workers include private workers, contract and temporary government officers. The workers are  
23 mandatory to contribute to the SOCSO and register to the SOCSO according to the law of  
24 Malaysia. The Employment Injury Scheme provides protection to employees from occupational  
25 injuries including occupational diseases and commuting accident during travel in connection



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3 1 with employment. The Invalidity Scheme provides 24-hour protection to employees against  
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5 2 invalidity or death due to causes occurring outside working hours. SOCSO protection scheme  
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7 3 provide cash benefits to employees and their dependants in the event of unforeseen incidents,  
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9 4 in addition to providing medical treatment, physical rehabilitation or vocational training.  
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11 5 SOCSO also conducts accident prevention activities through occupational safety and health  
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13 6 awareness programmes among employees and employers. Besides, Self-Employment Social  
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15 7 Security Scheme [Act 789] provided protection under the Employment Injury Scheme to self-  
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17 8 employed taxi drivers and individuals providing similar services including Uber and Grab Car  
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19 9 drivers. Other services provided is the Employment Insurance System Act [Act 800] for the  
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21 10 purpose of protecting and helping workers who have lost their employment using two (2) main  
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23 11 components namely, Employment Insurance and Employment Services to promote active  
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25 12 labour market policies. The Employment Insurance System (EIS) is a new protection scheme  
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27 13 for workers who have lost their employment by replacing lost income, providing reskilling and  
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29 14 upskilling training to enable them to find new jobs as well as providing job-search services, so  
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31 15 that they can gain suitable employment more expediently. To qualify for such benefits, the  
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33 16 Insured Person must fulfil the contribution eligibility in accordance with the claim, that is, a  
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35 17 minimum of 12 months' contribution in a period of 24 months and such benefits shall be  
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37 18 payable beginning 1st of January 2019. However, the Insured Person must meet the eligibility  
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39 19 requirements and must be capable and ready to work as well as actively search for employment.  
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49 21 The panel of doctors are appointed by the SOCSO organization. When any injury  
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51 22 reported by the worker, they need to go and see the doctor allotted from the panel clinic or  
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53 23 hospital. The report given by the panel is then transcribed into electronic form. SOCSO also  
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55 24 helps workers' dependents in the event of their death through a pension scheme. Inclusion  
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3 1 criteria for this study included eye injury cases occurring in Peninsular Malaysia, cases being  
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5 2 eye injury related to the workplace reported between 2004 to 2008.  
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10 4 ***Patient and Public Involvement:***

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12 5 No patient Involved. Only case files were reviewed and analysed.  
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17 7 ***Sampling Technique and Methods:***

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19 8 The cases were selected through a process of stratified random sampling where every 10 cases  
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21 9 files were selected as stratum and one case file from each stratum was selected randomly. Cases  
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23 10 of workplace related eye injuries that did not occur in Peninsular Malaysia, and not reported  
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25 11 between 2004 to 2008 were excluded from this study. All case files identified for inclusion were  
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27 12 kept confidential and anonymous. The information extracted from the case files included date  
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29 13 of first consultation, age and gender, cause of the eye problem suffered, location of the eye  
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31 14 injury, level of vision, date and time of hospital admission, clinical diagnosis, eye and vision  
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33 15 recovery data, eye function data, available medical care and costs involved, recovery time and  
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35 16 number of days the subject was not able to work. The eye injury classification used for this  
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37 17 study was adopted from the standard international classification system, i.e. the Birmingham  
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39 18 Eye Injury Terminology System (BETTS) and modified to come up with the suitable SOCSO  
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41 19 classification and the classification of 21 industry types in Malaysia was based on the Malaysian  
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43 20 Standard Industry Classification (MSIC) 2008 version 1.0 used by the Department of Statistics  
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45 21 Malaysia.<sup>14</sup> The International Classification of Diseases (ICD) 11 (2018) classified visual  
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47 22 impairment into mild impairment (VA <6/12 to 6/18), moderate impairment ( VA<6/18-6/60),  
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49 23 severe impairment (VA<6/60-3/60) and blindness (VA <3/60).<sup>15</sup> The Severe impairment, and  
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51 24 blind was merged into severe impairment category for this study. The data was analysed using  
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53 25 IBM SPSS Statistics for Windows, Version 25. Descriptive tests were used to analyze the study  
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3 1 data covering mean, percentage, median and standard deviation. The relationship between the  
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5 2 severity of eye injury and the ability of the employee to return to work was analysed using Chi-  
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7 3 Square Test.  
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10 4

## 11 5 **RESULTS**

### 12 6 *Characteristics of work-related eye injury*

13 7 From 2004 to 2008, a total of 8,861 workplace accidents involving eye injuries were registered  
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15 8 with SOCSO. A total of 884 eye injury case files were randomly selected which fulfilled the  
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17 9 selection criteria for this study. A summary of information on the worker profile, severity of  
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19 10 work-related eye injury and work status based on age among industrial workers registered with  
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21 11 SOCSO is shown in Table 1.  
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31 13 Most of these workplace eye injury cases registered with SOCSO involved male  
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33 14 workers in a ratio of 14:1 compared to female workers. The average age of all employees was  
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35 15 35±10 years. The average age for male and female workers were 34±10 and 38±12 years. The  
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37 16 highest proportion of work-related eye injuries occurred in the age group of 30 to 39 years old.  
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40 17 In terms of ethnicity, Malays had the highest proportion of work-related eye injury cases.  
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**Table 1. Profile, severity of work-related eye injury and work status based on age among industrial workers registered with SOCSO 2004-2008**

Age Group	Gender (n / %)		Ethnic (n / %)				Eye Injury Level of Severity (n / %)			Work Status (n / %)	
	Male	Female	Malay	Chinese	Indian	Others	Mild	Moderate	Severe	Working	Stop Working
<b>10 – 19</b> (n = 30)	27 (90.00)	3 (10.00)	8 (26.70)	15 (50.00)	7 (23.30)	0 (0.00)	18 (60.00)	8 (26.70)	4 (13.30)	26 (86.70)	4 (13.30)
<b>20 – 29</b> (n = 263)	250 (95.10)	13 (4.90)	121 (46.00)	107 (40.70)	32 (12.20)	3 (1.10)	137 (52.10)	91 (34.60)	35 (13.30)	247 (93.90)	16 (6.10)
<b>30 – 39</b> (n = 309)	296 (95.80)	13 (4.20)	141 (45.60)	118 (38.20)	45 (14.60)	5 (1.60)	141 (45.60)	128 (41.40)	40 (12.90)	296 (95.80)	13 (4.20)
<b>40 – 49</b> (n = 196)	178 (90.80)	18 (9.20)	78 (39.80)	73 (37.20)	44 (22.40)	1 (0.50)	77 (39.30)	70 (35.70)	49 (25.00)	189 (96.40)	7 (3.60)
<b>50 – 59</b> (n = 71)	64 (90.10)	7 (9.90)	25 (35.20)	30 (42.30)	16 (22.50)	0 (0.00)	22 (31.00)	24 (33.80)	25 (35.20)	65 (91.50)	6 (8.50)
<b>60 – 69</b> (n = 15)	11 (73.30)	4 (26.70)	1 (6.70)	11 (73.30)	3 (30.00)	0 (0.00)	3 (20.00)	4 (26.70)	8 (53.20)	12 (80.00)	3 (20.00)
<b>Total</b> (n = 884)	<b>826</b> (93.00)	<b>58</b> (7.00)	<b>374</b> (42.30)	<b>354</b> (40.00)	<b>147</b> (16.60)	<b>9</b> (1.00)	<b>398</b> (45.00)	<b>325</b> (36.80)	<b>161</b> (18.20)	<b>835</b> (94.50)	<b>49</b> (5.50)

\* Row percentage referred here

1  
2  
3 1 The eye injury cases were categorized according to their causes and the characteristics  
4  
5 2 of work-related eye injury experienced by the injured workers. The causes of work-related eye  
6  
7 3 injury and the characteristics of work-related eye injury were divided into nine and eight  
8  
9 4 subtypes respectively. The highest number of eye injuries occurred from incidents that resulted  
10  
11 5 in the impact from a moving object but excluding incidents that involved a falling object  
12  
13 6 (89.20%). These moving objects include fragments or flying particles near or within the  
14  
15 7 working environment of the worker. Eye surface injury (51.60%) were the most common cause  
16  
17 8 of injury among these industrial workers. Eye surface injuries include causes such as splinters  
18  
19 9 entering the eyes, corneal abrasions, scratches and bites by non-invasive insects that lead to  
20  
21 10 injuries to the surface of the eye and adnexa. The details of the types and characteristics of  
22  
23 11 work-related eye injury among industrial workers are shown in Table 2. The characteristics of  
24  
25 12 the work-related eye injury is categorized into five categories which include the anatomy of the  
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27 13 eye, affected eye, level of severity of injury experienced, onset of treatment given and level of  
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29 14 vision of the worker with the eye injury.  
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16 About 70% of the work-related eye injuries in Peninsular Malaysia that were filed with  
17 SOCSO from 2004 to 2008 affected the anterior segment of the eye. Out of all these anterior  
18 segment injuries, corneal injury was the highest (53.40%). In this study, the left eye (47.40%)  
19 was more affected than the right eye (42.20%). The severity of work-related eye injury was  
20 categorized into three distinct levels, namely mild, moderate, and severe levels. Monocular  
21 work-related eye injuries were found more likely to occur than binocular eye injury ( $\chi^2 =$   
22  $566.69$ ,  $df = 3$ ,  $p < 0.001$ ). Majority i.e 45.00% workers in the present study suffered from mild  
23 level work-related eye injuries (Table 2). Analysis using the Chi-squared test showed a  
24 significant difference ( $\chi^2 = 99.99$ ,  $df = 2$ ,  $p < 0.001$ ) between the severity of the work-related eye  
25 injury levels. In terms of time of treatment for the injury, about 70% of workers received their

1 treatment on the same day ( $0.8 \pm 3.5$  days) as the date of their work-related eye injury while the  
2 remaining mostly sought treatment within 3 days of injury. The majority of the work-related  
3 eye injury workers had good to mild level of visual impairment on the day of their initial visual  
4 acuity assessment.

### 5 6 **Trend of work-related eye injury**

7 Figure 1 shows a decreasing trend of eye injury occurring from 2004 to 2008. The percentage  
8 of employment-related eye injuries when analyzed by industry type, the highest number of cases  
9 were in manufacturing (38.70%), followed by trading (15.30%) and public services (15.0%).  
10 On the other hand, the lowest percentage of cases were from the mining (0.90%), financial  
11 (0.60%) and electrical, gas and water industries (0.10%) as shown is in Figure 2.

12  
13 When the proportion of eye injuries was analysed by their state location of occurrence  
14 in Peninsular Malaysia, the State of Selangor (21.40%) had the highest number of cases of eye  
15 injury and state of Terengganu (0.90%) showed lowest as shown in Table 3. The work-related  
16 eye injury had an increased trend in public services from the year 2004-2008 as shown in Figure  
17 3.

**Table 2: Types and characteristics of work-related eye injury among industrial workers registered with SOCSO 2004-2008**

Characteristics	Number (n=884)	Percentage (%)		
<b>Anatomy of Eye</b>				
Cornea	472	53.40		
Multiple injury	232	26.20		
Conjunctiva	98	11.10		
Eyelid	30	3.40		
Eyebrow	20	2.30		
Crystalline lens	7	0.80		
Orbital	7	0.80		
Retina	6	0.70		
Sclera	4	0.50		
Anterior chamber	4	0.50		
Nasolacrimal gland	2	0.20		
Uvea	1	0.10		
Optic nerve	1	0.10		
<b>Affected Eye</b>				
Left eye	419	47.40		
Right eye	373	42.20		
Both eye	75	8.50		
No record	17	1.90		
<b>Eye Injury Level of Severity</b>				
Mild	530	45.00		
Moderate	236	36.80		
Severe	118	18.20		
<b>Causes</b>				
Impact from a moving object excluding falling objects	788	89.20		
Impact from a static object	33	3.70		
Impact from a falling object during work	30	3.30		
Impact from a moving object	9	1.00		
Falling from a higher place	7	0.80		
Falling from the same height or lower place	7	0.80		
Other impacts from falling object	5	0.60		
Exposure to ionizing radiation	4	0.50		
Other accidents	1	0.10		
<b>Types of Eye Injury</b>				
Eye surface injury	456	51.80		
Other injury	182	20.60		
Blow	105	11.80		
Burn	88	10.10		
Bruise	46	5.30		
Radiation effect	3	0.30		
Fracture	2	0.20		
<b>Start Treatment Day</b>				
Same day	602	68.30		
≤3 day	241	27.30		
≤7 day	26	2.90		
≤14 day	7	0.80		
≤30 day	4	0.50		
>30 day	4	0.50		
<b>Vision Acuity Level</b>	<b>Initial Assessment (n = 266)</b>		<b>Final Assessment (n=360)</b>	
	<b>RE</b>	<b>LE</b>	<b>RE</b>	<b>LE</b>
Good (6/4.5-6/6)	39.80%	38.30%	66.70%	61.70%
Mild (6/7.5-6/18)	30.80%	33.10%	21.70%	23.10%
Moderate (<6/18-6/60)	14.70%	14.70%	3.90%	6.90%
Severe (<6/60-NPL)	14.70%	13.90%	7.80%	8.30%

**Table 3: Eye injury trends according to the type of industry in each State in Peninsular Malaysia and by age group**

Eye Injury	Types of Industry										Total
	A	B	C	D	E	F	G	H	I	J	
Selangor	57	22	6	25	36	27	11	1	0		189
Pulau Pinang	91	26	1	22	9	5	5	0	0		161
Johor	59	18	9	12	29	10	9	1	1		148
Kedah	52	18	9	14	5	5	0	1	0		104
Perak	36	20	8	15	8	8	4	1	0		100
Pahang	10	10	7	15	2	3	2	1	0		50
Kuala Lumpur	8	9	0	11	4	6	2	0	0		40
Negeri Sembilan	13	4	3	9	5	0	2	0	0		36
Melaka	12	2	3	3	1	2	0	0	0		24
Kelantan	2	3	0	3	4	0	0	1	0		13
Perlis	1	2	0	2	0	5	0	0	0		11
Terengganu	1	1	3	2	0	0	1	0	0		8
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>
10 - 19	14	6	1	6	1	2	0	0	0		30
20 - 29	97	43	7	44	37	24	7	3	0		263
30 - 39	126	52	12	41	37	29	10	1	1		309
40 - 49	71	22	22	31	22	12	9	1	0		196
50 - 59	27	10	5	10	6	3	8	1	0		71
60 - 69	7	2	2	1	0	1	2	0	0		15
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>

A Manufacturing

B Trading

C Agriculture, Forestry &amp; Fisheries

D Public services

E Services

F Construction

G Transportation

H Mining

I Electric, Gas &amp; Water supply

J Financial



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3 1 **Method, cost and efficacy of recovery**  
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5 2 The manner of recovery, cost of medical expenses and the rate of injured workers returning to  
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7 3 work are shown in Table 4. The costs of treatment determined in this study refers to the  
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9 4 standardised maximum reimbursable hospital rates used by SOCSO for payment for treatment  
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11 5 of workplace injury. Whereas the types of treatment received by workers with eye injuries  
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13 6 registered in SOCSO are listed in Table 4.  
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17 7 Worker recovery from injury is divided into 2 groups. The first group depicts medical  
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19 8 recovery from injury which would include surgery (if needed), outpatient follow-up and  
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21 9 medication. The second group depicts vision recovery methods which include spectacles,  
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23 10 prostheses and recovery references. In the medical recovery group, the Type C and Type B  
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25 11 surgery treatment modalities were the most common options reported for treating eye injury (>  
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27 12 50 cases). It is also noted that the biggest number of cases were moderate types of eye injuries  
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29 13 with moderate types of treatment needed.  
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33 14 The indirect costs are derived from the value of temporary disability or the number of  
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35 15 workers' days off from work, and the value of permanent disability or workers' compensation  
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37 16 costs. This study showed that 94.50% workers returned to work after their recovery from injury.  
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39 17 However, the remaining 5.50% did not go back to work as derived from Table 5. The age wise  
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41 18 distribution of eye injury severity and occupational status showed the highest percentage of  
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43 19 return to work was for the age groups 30 to 39 years and 40 to 49 years which were 95.80%  
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45 20 and 96.40% respectively. Although the severity of injury was found to be higher among workers  
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47 21 over the age of 50 years, nonetheless most of them were able to return to work. Whereas, the  
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49 22 younger age group, 10-19 years, stopped working more often compared to the older age groups  
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51 23 except for the age group 60-69 years as shown in Table 1. The total direct and Indirect medical  
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53 24 cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20).  
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**Table 4. Estimated medical, and vision recovery cost of 884 industrial workers registered with SOCSO**

Cost Category	No,	Costs (RM)	Costs (USD*)	Total (RM)	Total (USD*)
<b>Direct Costs of Medical</b>				<b>1,108,098.00</b>	<b>316599.40</b>
<b>Recovery</b>					
Surgery B	64	750.00	214.20	48,000.00	13714.20
Surgery C	79	500.00	142.80	39,500.00	11285.70
Surgery D	17	188.00	53.70	3,196.00	913.10
Outpatient (mild cases)	75	40.00	11.40	3,000.00	857.10
Outpatient (moderate cases)	393	70.00	20.00	27,510.00	786.00
Outpatient (severe cases)	19	100.00	28.50	1,900.00	542.80
Medication (mild treatment)	72	50.00	14.20	17,850.00	5100.00
Medication (moderate treatment)	125	70.00	20.00	136,268.00	38933.70
Medication (severe treatment)	40	100.00	28.50	254,900.00	72828.50
<b>Ward Cost</b>	-	32.00	9.10	540,374.00	154392.50
<b>Vision Recovery</b>					
Spectacles	25	400.00	114.20	10,000.00	2857.10
Prosthesis	6	3,600.00	1028.50	21,600.00	6171.40
Spectacles + Prosthesis	1	4,000.00	1142.80	4,000.00	1142.80
Recovery references	1	-	-	-	-
<b>Indirect Costs</b>				<b>4,150,140.00</b>	<b>1185754.20</b>
Value of temporary disability				805,268.00	230076.50
Value of permanent disability				3,344,872.00	955677.70
<b>TOTAL RECOVERY COSTS</b>				<b>5,258,238.00</b>	<b>1502353.70</b>

\* 1USD=3.5 RM (Average of 2004-2008); Source of data SOCSO

\* Type B included Intraocular lens implant Keratoplasty: Lamellar or penetrating Retinal detachment surgery, Intraocular foreign body removal, Strabismus surgery, Repair of severe perforating injuries of the eyeball, Glaucoma surgery, Dacryocystorhinostomy, Dacryocystectomy Repair of several lachrymal passages Exenteration of orbit.

\*Type C included Cataract extraction: intracapsular and extracapsular, Repair of eyelid deformities, Extraction of dislocated / subluxated lens, Discission Paracentesis Excision of orbital or ocular tumours Iridectomy: peripheral or optical Cryopexy as prophylaxis against retinal detachment and glaucoma Evisceration, Enucleation, Ectropion or Entropion correction, Tarsorrhaphy Repair of severe laceration of eyelid and / or region around the eyes, Pterygium surgery, Excision biopsy Release of symblepharon / mucous membrane graft, Repair of lachrymal puncta or canalicular obstruction, Repair of moderate perforating injury of eyeball, Laser Coagulation

Type D included Incision and curettage of chalazion, Excision of granulomas, Removal of corneal or conjunctival foreign body Catholysis / epilation of trichiasis, Repair of minor lacerations of eyelids and / or region around the eyes, Syringing / probing of lachrymal apparatus, Repair of minor perforating injury of eyeball.

### 1 Severity of eye injury and effectiveness of vision recovery

2 The relationship between the severity of eye injury and the ability of the employee to return to  
 3 work was analysed. Table 5 displays the relationship between the injured employee (registered  
 4 with SOCSO) employment status with the severity of the eye injury they experience. It was  
 5 found that most workers injured in Peninsular Malaysia suffered mild (n = 398) and moderate  
 6 (n = 325) eye injuries. Of that number, 96% of them were able to return to work. In contrast,  
 7 14% of workers with severe eye injuries were unable to return to work. To prove the correlation  
 8 between this data, a chi-square test was performed. The results of the chi-square test ( $\chi^2 =$   
 9 24.94, df = 2, p <0.001) showed that there was a significant relationship between the severity  
 10 of eye injury and employee work status. This indicates that, when the degree of injury of the  
 11 employee's eyes worsens or the total number of days of sick leave exceeds 1 month, the chances  
 12 of the workers returning to work declines.

14 **Table 5. Frequency of employment status based on severity of work related eye injury**

Work Status	Eye Injury Level of Severity (n)			Total
	Mild	Moderate	Severe	
Working	382	314	139	835
Stopped working	16	11	22	49
<b>Total</b>	<b>398</b>	<b>325</b>	<b>161</b>	<b>884</b>

17 \* $\chi^2 = 24.94$ , df=2, p<0.001

## 1 DISCUSSION

2 This study showed a male preponderance of eye injuries which is congruent with the study  
3 conducted in Malaysia by Soong et al. 2008 where he found 88.1% cases occurred among  
4 males. Similarly, other studies also supported this male predominance.<sup>1,5,7,10,11,12,16-21</sup> The ethnic  
5 distribution of cases showed that Malays (42.30%) had a higher percentage of work-related eye  
6 injury followed by the Chinese, Indian and Other ethnicities. The study by Soong et al. (2008)  
7 reported a similar ethnic distribution of eye injury with the percentage of Malay, Indian,  
8 Chinese and Other ethnicities being 31.90%,12.20%, 9.70%, and 2.10% respectively.<sup>10</sup> This  
9 study found that the highest number of eye injuries occurred from impact with a moving object  
10 (excluding falling objects) (89.20%) followed by impact from a static object , impact from  
11 falling objects during operation (work), and impact from moving objects which contradicted  
12 another Malaysian study which reported 30.80% of injuries were from activities such as  
13 grinding or cutting metal (15.80%), welding (6.90%), hammering on metal (3.70%), carpentry  
14 (2.60%), and nailing (1.80%).<sup>10</sup> Moreover, injury to the surface of the eye was more common  
15 and accounted for 51.60% of eye injuries. Of the anterior segment eye injuries, corneal injury  
16 was the major cause followed by multiple injury causes. These study findings were supported  
17 by two other studies also conducted in Malaysia which reported 61.50% of eye injuries were  
18 corneal laceration and other study reporting that the common anatomical site of injury was the  
19 cornea (43.60%) followed by the conjunctiva (39.50%).<sup>5,10</sup>

20  
21 In this study, monocular work-related injuries were more common than binocular  
22 injuries and the left eye was more affected compared to the right eye. It was also reported that  
23 about 70% of workers received treatment on the same day while the remainder mostly sought  
24 treatment within 3 days of injury. However, an earlier study conducted in Malaysia contradicted  
25 these findings where that study found that right eye injury was more common, followed by the

1 left eye and then both eyes but was in agreement with the fact that 73.40% presented within 24  
2 hours of the injury and that a further 23.90% presented between 1–3 days from the day of the  
3 injury.<sup>10</sup> Furthermore, the trend of eye injury decreased from 2004 to 2008 and the  
4 manufacturing industry recorded the highest number of cases of eye injuries followed by trading  
5 and public services. It was noted that Selangor state had the highest number of cases of eye  
6 injury followed by Penang. Thus far, no other such study has compared eye injuries based on  
7 industry type and by State in Malaysia previously.

8  
9 In a previous study, the average working day loss was reported as 3.4 days.<sup>22</sup> The study  
10 of Chi and colleagues (2007) reported that the duration of hospital treatment was from 4 to 7  
11 days, with the average cost of medical treatment being New Taiwan Dollar 43,609 +/- 30,660  
12 (6635.05 +/- 4664.87 or 1567.46 +/- 1102.03 USD).<sup>23</sup> Another study recorded that over US \$  
13 300 million a year was lost comprising total lost time and income, medical expenses and  
14 employee compensation.<sup>24</sup> Almost 90% of all occupational eye injuries can be prevented  
15 through the use of appropriate safety equipment. Using appropriate safety equipment can  
16 indirectly save total costs of eye injuries such as the related legal fees, the cost of repairing the  
17 damage resulting from the circumstances related to the injury in the work premises and the  
18 necessary employee training fees has been estimated at more than US \$ 934 million annually  
19 in America.<sup>25</sup> In this study it was found that the costs of medical and vision recovery was about  
20 Ringgit Malaysia 5 million (about 1.2 million USD) where the direct costs amounted to more  
21 than Ringgit Malaysia 1 million ( about 300 thousand USD ) and indirect costs were more than  
22 Ringgit Malaysia 4 million (about 1.1 million USD) . Present study provides an understanding  
23 of the economic importance of work-related eye injuries in Malaysia which has not been  
24 explored before. Both employers and employees must be aware of the relationship between  
25 visual health and productivity in the workplace. Employees who experience a significant

1 decrease in their vision can contribute to increased rates of negligence in the workplace and  
2 losses of working days. Negligence can make a work premise a place where workers are at high  
3 risk of danger. This situation happens because of employees with a decrease in their visual  
4 ability may find it difficult to adapt to their reduced visual state and this in turn can lead to  
5 frustrations with their jobs or tasks. This employee than would have to deal with fatigue,  
6 headaches and constant stress on a daily basis caused by their vision dysfunction. This  
7 circumstance may then lead to the employee's income becoming compromised if this situation  
8 persists over a period of time. If there are many workers involved, this situation can then  
9 threaten the economic stability of industries and eventually countries while being likely to cause  
10 a rising unemployed population. The employer also bears huge losses from this loss of  
11 experienced and trained work persons who face these vision limitations.

12  
13 In this study, it was found that about 96% of workers suffering from eye injury suffered  
14 from low to moderate injury which in turn increased their indirect medical costs in comparison  
15 to their direct medical costs and their chances of returning to work. Although 14% of workers  
16 had suffered severe injury, still the percentage of their not returning to work was low, being  
17 5.50%. There are a number of factors that can affect the severity of an employee's eye injury.  
18 These factors include the quality of safety protection devices, mechanisms of accidents, types  
19 of eye injuries, when treatment was started, the type of medical treatment given and so on. For  
20 those with low severity injuries, the visual status of these injured workers was assisted and  
21 improved through refractive error correction using glasses or contact lens. This method  
22 however can only help in certain cases, depending on the effects of the injury sustained. Work-  
23 related eye injuries are not only affected by refractive errors, but also includes visual field  
24 problems, stereopsis and other more extensive and complicated problems. The rehabilitation is  
25 not just prescribing glasses, there are multiple factors that decides the success rate of the

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3 1 rehabilitation. The rehabilitation performed needs to be tailored to address all the problems  
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5 2 encountered by the injured worker including any loss of field of vision or eye muscle imbalance.  
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7 3 The results of the chi-square test on the data from the injured workers in this study showed that  
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9 4 the degree of severity of the eye injuries affected that injured worker's ability to return to work.  
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11 5 The greater the severity of the eye injury, the chances of that worker returning to work became  
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13 6 less. Vision rehabilitation therapy can improve an injured employee's vision to a better level. It  
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15 7 must be noted that since most of these injured workers receive an injury involving only one  
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17 8 eye, they are typically not eligible to be classified as an individual with limited vision (since  
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19 9 the uninjured eye has typically normal vision, thus not fulfilling the criteria for limited vision.  
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23 10 Adaptation to vision loss among workers usually occurs rapidly. This is because occupational  
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25 11 eye injuries usually happen to younger adult individuals and those who have the physical ability  
26  
27 12 to continue working. This can be seen from the findings of this study where most of the injured  
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29 13 workers return to work. This situation has the potential to create a higher risk to employees with  
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31 14 their current vision status not reaching the actual standards needed for the job they do, especially  
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33 15 when they need to handle or operate hazardous equipment. Often there is no specific assessment  
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35 16 of the safety of the employee in his duties when they return to duty after injury.  
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42 18 To further strengthen Malaysia's position within the global economic community with  
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44 19 strong and progressive economic and industrial development policies, worker safety issues in  
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46 20 the workplace should be given due attention and should address worker safety from all angles.  
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48 21 This should not only involve just accident prevention measures in workplaces but should also  
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50 22 address post-injury rehabilitation for those who are injured in their course of their work which  
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52 23 should also encompass vision recovery methods. The experience from other developed  
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54 24 countries can be studied, and wherever appropriate these experiences can implement prudently  
55  
56 25 in the Malaysian work environment.  
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## 7 **Availability of data and materials**

8 The data used in this study is available with the author.

## 9 **Ethics approval and consent to participate**

10 This study received approval from University Kebangsaan Malaysia Research Ethics  
11 Committee UKM 1.5.3.5/244/SPP2/NN/187/2010.

## 12 **Consent for publication**

13 Not applicable.

## 14 **Competing interests**

15 The authors declare that they have no competing interests.

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**Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO**

**Figure 2: Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008**

**Figure 3. The proportion of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

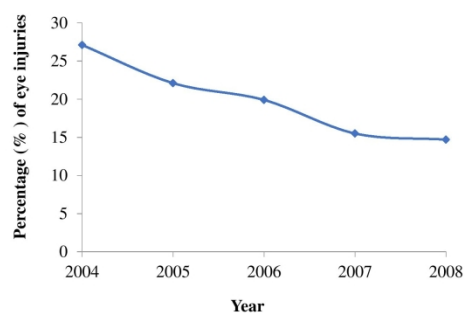
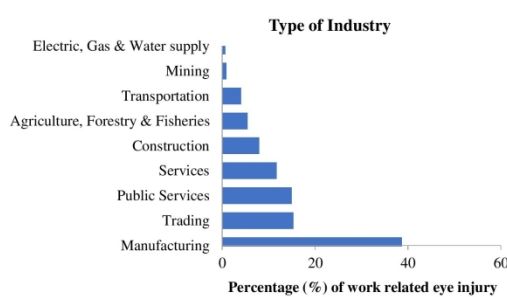


Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO

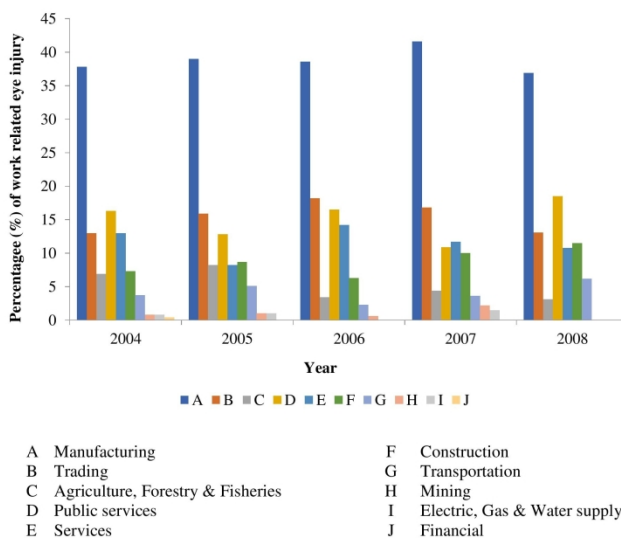
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**Figure 2:** Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008

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**Figure 3. The trend in distribution of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

209x297mm (300 x 300 DPI)

# BMJ Open

## CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO WORK STATUS AMONG INDUSTRIAL WORKERS: A RETROSPECTIVE STUDY

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34

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# CHARACTERISTICS OF EYE INJURIES, MEDICAL COST AND RETURN TO

## WORK STATUS AMONG INDUSTRIAL WORKERS: A RETROSPECTIVE STUDY

### Abstract:

**Objective:** The aim of this study is to determine the characteristics of eye injuries, medical costs, and return to work status among industrial workers to provide better vision rehabilitative services.

**Setting:** Nationwide data from the Social Security Organization (SOCSO) of Malaysia.

**Participants:** A stratified random sample of workers registered with the SOCSO of Malaysia with documentation of eye injury.

**Primary and secondary outcome measures:** Characteristics of eye injuries and medical costs related to eye injury (primary) and return-to-work status (secondary).

**Results:** A total of 884 from 8861 case files workplace accidents involving eye injury registered with Social Security Services (SOCSO) were identified. The mean age was 35±10 years and the highest incidence of work-related eye injury occurred in the age group 30 to 39 years and among Malay ethnics. Males are affected more than females' workers. The highest cause of eye injury was the impact from a moving object excluding falling objects (89.2%) and anterior segment injuries occurred more than posterior segment injuries. The total direct and Indirect medical cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20) for 884 cases.

**Conclusion:** The majority of workers suffered from the low level of eye injury. A significant relationship was found between the severity of eye injury and employee work status. The indirect cost of medical and vision rehabilitation was higher than the direct cost. Awareness and vision rehabilitation programs at the workplace need to be addressed for better prevention and rehabilitative service.

**Key words:** Ocular Trauma, Work related injury, Industrial worker, Severity

## 1 Article Summary

### **Strength:**

- This study has compared eye injuries based on industry type and by states in Malaysia which were not done before too extensively.
- This study also highlighted the average medical cost of treating patients with work-related eye injuries and the return to work status among industrial workers in Malaysia which was not reported earlier.
- Moreover, it also highlighted the need for vision rehabilitation which was not addressed by the earlier studies.

### **Limitation:**

- The details of vision rehabilitation are not considered for further analysis because it was a retrospective case files study.
- Important components of vision named stereopsis, contrast sensitivity, color vision, and visual field data not included in the study

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### Introduction

The human eye has a physiologically highly precise and distinct role. To perceive images of objects clearly, it is necessary for all components of the eye to work normally. Good visual function is essential in almost all tasks in activities of daily living, especially those related to employment. Eye injury is one of the major causes of blindness that worldwide encompasses nearly half a million people, while many others experience partial loss of vision from these injuries.<sup>1</sup> Eye injury is a primary cause of unilateral vision loss in developing countries. It has been found that males are more likely to have eye injury compared to females and this is a trend that is noticed even from childhood. Moreover, eye injuries tend to be more associated with lower socioeconomic conditions.<sup>1</sup> Each year the USA reports approximately 2.4 million new eye injury cases.<sup>2</sup> Out of these, 40,000 to 60,000 patients eventually experience blindness due to eye injuries.<sup>3-4</sup> The global pattern of eye injuries shows approximately 55 million eye injuries occurring causing work day losses of more than one-day every year. Out of these injury occurrences, annually 750,000 cases will require in-patient care. Furthermore, approximately 1.6 million people become blind from these eye injuries with an additional 2.3 million people develop bilateral low vision. In Pahang, Malaysia the prevalence of eye injury was 9.80%.<sup>5</sup>

Eye injury is commonly occurring in the workplace (38.50%), road accidents (20.50%), sports (29%) and during quarrel (5%). A penetrating injury occurred in 72.50% cases whereas blunt injury accounted for 27.50% cases.<sup>6</sup> A study conducted in Brazil reported 56.70% of eye injuries occurred in the workplace followed by those occurring at home (28.30%). Surprisingly it was found that 82.90% of the victims of eye injury did not wear any eye protective devices at the time of their accidents.<sup>7</sup> A review study from Malaysia reported a higher prevalence of

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3 1 eye injury among males with their mean age being 35 years. The common place where eye  
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5 2 injury was suffered among adults was in the workplace while for children it was at home.<sup>8</sup> An  
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7 3 earlier study reported that work-related eye injuries in east Malaysia accounted for 36.90% of  
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9 4 the total eye injury cases reported. However, work-related eye injuries reported in Singapore  
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11 5 represented 71.40% of cases of total eye injury visiting casualty units there. Out of all the eye  
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13 6 injuries reported, 90% arose from industrial activities such as drilling, grinding, and cutting  
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15 7 metals.<sup>9</sup> A earlier prospective study conducted in Malaysia reported work-related eye injury  
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17 8 rate of 43.6% among patients attended the medical centre. The causes of eye injury involved  
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19 9 the usage of high-powered machines (30.8%), motor vehicle accidents (23.10%) and domestic  
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21 10 accidents (17.70%). However, only 2.50% used an eye-protective device (EPD) at the time of  
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23 11 injury.<sup>10</sup> Madhusudhan et al. (2014) in his study reported that eye injuries most commonly  
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25 12 involved the home (51.80%) and workplace (23.40%) in Malaysia.<sup>11</sup> Similarly, a previous study  
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27 13 by Mallika et al. (2008) among adults in Kuching, Sarawak also found that areas such as home  
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29 14 (34.30%) and industrial premises (31.80%) were the most common locations where eye injury  
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31 15 occurred.<sup>12</sup>  
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40 17 Eye injuries can cause the loss of working days among workers which causes a loss of  
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42 18 productivity and this then becomes a burden to the economy. It is important to understand the  
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44 19 implication of eye injuries and how it affects workers, family members, industries and the  
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46 20 nation. Emphasis on providing vision rehabilitation will help affected workers to continue their  
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48 21 work.<sup>13</sup> Vision rehabilitation includes the prescription of glasses, contact lenses, prisms, and  
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50 22 low vision rehabilitative services. However, return to work requires a multi-disciplinary  
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52 23 approach and can be a challenge to implement comprehensively. Little information is available  
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54 24 of the characteristics of eye injuries, their associated medical costs and return to work status  
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56 25 among industrial workers who get injured.<sup>13</sup> We postulate that comprehensive visual  
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3 1 rehabilitation services for industrial workers with eye injuries needs to be available in order that  
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5 2 productivity can be maintained. Therefore, the objective of this study is to identify the  
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7 3 characteristics of eye injuries, medical costs and return to work status among industrial workers  
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9 4 in Malaysia so that better visual rehabilitation services can be recommended and provided for.  
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## 15 6 **Methodology**

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17 7 This was a retrospective study conducted using case records of eye injuries among industrial  
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19 8 workers registered with the Social Security Organization (SOCSO). This research was  
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21 9 approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee  
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23 10 and followed the tenants of Helsinki Declaration. Permission to conduct this research was also  
24  
25 11 obtained from the Medical Division of SOCSO Headquarters and the data authorised for use  
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27 12 was those in the calendar years 2004-2008. SOCSO was chosen as the source of reference for  
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29 13 secondary data files because SOCSO has the most comprehensive collection of work place  
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31 14 medical records in Peninsular Malaysia. SOCSO appoints trained medical doctors as their panel  
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33 15 doctors organisation and these doctors must completed a comprehensive 72 hour training  
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35 16 program before being certified as an occupational health doctor and eligible to be registered  
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37 17 with the Department of Occupational Health and Safety, Ministry of Human Resources.  
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45 19 SOCSO is a statutory body set up its own remuneration system to provide medical and  
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47 20 financial assistance to workers whose ability to work have been affected by accident or illness.  
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49 21 The main function of SOCSO is to provide social security protection to employees and their  
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51 22 dependants through the Employment Injury Scheme and the Invalidity Scheme (Act 4). All  
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53 23 workers will contribute to the scheme and the employers also have to contribute as well. The  
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55 24 workers include private workers, contract and temporary government officers. The workers are  
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57 25 mandatory to contribute to the SOCSO and register to the SOCSO according to the law of  
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3 1 Malaysia. The Employment Injury Scheme provides protection to employees from occupational  
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5 2 injuries including occupational diseases and commuting accident during travel in connection  
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7 3 with employment. The Invalidity Scheme provides 24-hour protection to employees against  
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9 4 invalidity or death due to causes occurring outside working hours. SOCSO protection scheme  
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11 5 provide cash benefits to employees and their dependants in the event of unforeseen incidents,  
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13 6 in addition to providing medical treatment, physical rehabilitation or vocational training.  
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15 7 SOCSO also conducts accident prevention activities through occupational safety and health  
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17 8 awareness programmes among employees and employers. Besides, Self-Employment Social  
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19 9 Security Scheme [Act 789] provided protection under the Employment Injury Scheme to self-  
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21 10 employed taxi drivers and individuals providing similar services including Uber and Grab Car  
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23 11 drivers. Other services provided is the Employment Insurance System Act [Act 800] for the  
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25 12 purpose of protecting and helping workers who have lost their employment using two (2) main  
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27 13 components namely, Employment Insurance and Employment Services to promote active  
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29 14 labour market policies. The Employment Insurance System (EIS) is a new protection scheme  
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31 15 for workers who have lost their employment by replacing lost income, providing reskilling and  
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33 16 upskilling training to enable them to find new jobs as well as providing job-search services, so  
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35 17 that they can gain suitable employment more expediently. To qualify for such benefits, the  
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37 18 Insured Person must fulfil the contribution eligibility in accordance with the claim, that is, a  
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39 19 minimum of 12 months' contribution in a period of 24 months and such benefits shall be  
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41 20 payable beginning 1st of January 2019. However, the Insured Person must meet the eligibility  
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43 21 requirements and must be capable and ready to work as well as actively search for employment.  
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54 23 The panel of doctors are appointed by the SOCSO organization. When any injury  
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56 24 reported by the worker, they need to go and see the doctor allotted from the panel clinic or  
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58 25 hospital. The report given by the panel is then transcribed into electronic form. SOCSO also  
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1 helps workers' dependents in the event of their death through a pension scheme. Inclusion  
2 criteria for this study included eye injury cases occurring in Peninsular Malaysia, cases being  
3 eye injury related to the workplace reported between 2004 to 2008.

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5 ***Patient and Public Involvement:***

6 No patient Involved. Only case files were reviewed and analysed.

7  
8 ***Sampling Technique and Methods:***

9 The cases were selected through a process of stratified random sampling where every 10 cases  
10 files were selected as stratum and one case file from each stratum was selected randomly. Cases  
11 of workplace related eye injuries that did not occur in Peninsular Malaysia, and not reported  
12 between 2004 to 2008 were excluded from this study. All case files identified for inclusion were  
13 kept confidential and anonymous. The information extracted from the case files included date  
14 of first consultation, age and gender, cause of the eye problem suffered, location of the eye  
15 injury, level of vision, date and time of hospital admission, clinical diagnosis, eye and vision  
16 recovery data, eye function data, available medical care and costs involved, recovery time and  
17 number of days the subject was not able to work. The eye injury classification used for this  
18 study was adopted from the standard international classification system, i.e. the Birmingham  
19 Eye Injury Terminology System (BETTS) and modified to come up with the suitable SOCSO  
20 classification and the classification of 21 industry types in Malaysia was based on the Malaysian  
21 Standard Industry Classification (MSIC) 2008 version 1.0 used by the Department of Statistics  
22 Malaysia.<sup>14</sup> The International Classification of Diseases (ICD) 11 (2018) classified visual  
23 impairment into mild impairment (VA <6/12 to 6/18), moderate impairment ( VA<6/18-6/60),  
24 severe impairment (VA<6/60-3/60) and blindness (VA <3/60).<sup>15</sup> The Severe impairment, and  
25 blind was merged into severe impairment category for this study. The data was analysed using

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3 1 IBM SPSS Statistics for Windows, Version 25. Descriptive tests were used to analyze the study  
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5 2 data covering mean, percentage, median and standard deviation. The relationship between the  
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7 3 severity of eye injury and the ability of the employee to return to work was analysed using Chi-  
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9 4 Square Test.  
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## 15 6 **RESULTS**

### 17 7 *Characteristics of work-related eye injury*

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20 8 From 2004 to 2008, a total of 8,861 workplace accidents involving eye injuries were registered  
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22 9 with SOCSO. A total of 884 eye injury case files were randomly selected which fulfilled the  
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24 10 selection criteria for this study. A summary of information on the worker profile, severity of  
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26 11 work-related eye injury and work status based on age among industrial workers registered with  
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28 12 SOCSO is shown in Table 1.  
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34 14 Most of these workplace eye injury cases registered with SOCSO involved male  
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36 15 workers in a ratio of 14:1 compared to female workers. The average age of all employees was  
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38 16 35±10 years. The average age for male and female workers were 34±10 and 38±12 years. The  
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40 17 highest proportion of work-related eye injuries occurred in the age group of 30 to 39 years old.  
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43 18 In terms of ethnicity, Malays had the highest proportion of work-related eye injury cases.  
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**Table 1. Profile, severity of work-related eye injury and work status based on age among industrial workers registered with SOCSO 2004-2008**

Age Group	Gender (n / %)		Ethnic (n / %)				Eye Injury Level of Severity (n / %)			Work Status (n / %)	
	Male	Female	Malay	Chinese	Indian	Others	Mild	Moderate	Severe	Working	Stop Working
<b>10 – 19</b> (n = 30)	27 (90.00)	3 (10.00)	8 (26.70)	15 (50.00)	7 (23.30)	0 (0.00)	18 (60.00)	8 (26.70)	4 (13.30)	26 (86.70)	4 (13.30)
<b>20 – 29</b> (n = 263)	250 (95.10)	13 (4.90)	121 (46.00)	107 (40.70)	32 (12.20)	3 (1.10)	137 (52.10)	91 (34.60)	35 (13.30)	247 (93.90)	16 (6.10)
<b>30 – 39</b> (n = 309)	296 (95.80)	13 (4.20)	141 (45.60)	118 (38.20)	45 (14.60)	5 (1.60)	141 (45.60)	128 (41.40)	40 (12.90)	296 (95.80)	13 (4.20)
<b>40 – 49</b> (n = 196)	178 (90.80)	18 (9.20)	78 (39.80)	73 (37.20)	44 (22.40)	1 (0.50)	77 (39.30)	70 (35.70)	49 (25.00)	189 (96.40)	7 (3.60)
<b>50 – 59</b> (n = 71)	64 (90.10)	7 (9.90)	25 (35.20)	30 (42.30)	16 (22.50)	0 (0.00)	22 (31.00)	24 (33.80)	25 (35.20)	65 (91.50)	6 (8.50)
<b>60 – 69</b> (n = 15)	11 (73.30)	4 (26.70)	1 (6.70)	11 (73.30)	3 (30.00)	0 (0.00)	3 (20.00)	4 (26.70)	8 (53.20)	12 (80.00)	3 (20.00)
<b>Total</b> (n = 884)	<b>826</b> (93.00)	<b>58</b> (7.00)	<b>374</b> (42.30)	<b>354</b> (40.00)	<b>147</b> (16.60)	<b>9</b> (1.00)	<b>398</b> (45.00)	<b>325</b> (36.80)	<b>161</b> (18.20)	<b>835</b> (94.50)	<b>49</b> (5.50)

\* Row percentage referred here

1  
2  
3 1 The eye injury cases were categorized according to their causes and the characteristics  
4  
5 2 of work-related eye injury experienced by the injured workers. The causes of work-related eye  
6  
7 3 injury and the characteristics of work-related eye injury were divided into nine and eight  
8  
9 4 subtypes respectively. The highest number of eye injuries occurred from incidents that resulted  
10  
11 5 in the impact from a moving object but excluding incidents that involved a falling object  
12  
13 6 (89.20%). These moving objects include fragments or flying particles near or within the  
14  
15 7 working environment of the worker. Eye surface injury (51.60%) were the most common cause  
16  
17 8 of injury among these industrial workers. Eye surface injuries include causes such as splinters  
18  
19 9 entering the eyes, corneal abrasions, scratches and bites by non-invasive insects that lead to  
20  
21 10 injuries to the surface of the eye and adnexa. The details of the types and characteristics of  
22  
23 11 work-related eye injury among industrial workers are shown in Table 2. The characteristics of  
24  
25 12 the work-related eye injury is categorized into five categories which include the anatomy of the  
26  
27 13 eye, affected eye, level of severity of injury experienced, onset of treatment given and level of  
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29 14 vision of the worker with the eye injury.  
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16 About 70% of the work-related eye injuries in Peninsular Malaysia that were filed with  
17 SOCSO from 2004 to 2008 affected the anterior segment of the eye. Out of all these anterior  
18 segment injuries, corneal injury was the highest (53.40%). In this study, the left eye (47.40%)  
19 was more affected than the right eye (42.20%). The severity of work-related eye injury was  
20 categorized into three distinct levels, namely mild, moderate, and severe levels. Monocular  
21 work-related eye injuries were found more likely to occur than binocular eye injury ( $\chi^2 =$   
22  $566.69$ ,  $df = 3$ ,  $p < 0.001$ ). Majority i.e 45.00% workers in the present study suffered from mild  
23 level work-related eye injuries (Table 2). Analysis using the Chi-squared test showed a  
24 significant difference ( $\chi^2 = 99.99$ ,  $df = 2$ ,  $p < 0.001$ ) between the severity of the work-related eye  
25 injury levels. In terms of time of treatment for the injury, about 70% of workers received their

1 treatment on the same day ( $0.8 \pm 3.5$  days) as the date of their work-related eye injury while the  
2 remaining mostly sought treatment within 3 days of injury. The majority of the work-related  
3 eye injury workers had good to mild level of visual impairment on the day of their initial visual  
4 acuity assessment.

### 5 6 **Trend of work-related eye injury**

7 Figure 1 shows a decreasing trend of eye injury occurring from 2004 to 2008. The percentage  
8 of employment-related eye injuries when analyzed by industry type, the highest number of cases  
9 were in manufacturing (38.70%), followed by trading (15.30%) and public services (15.0%).  
10 On the other hand, the lowest percentage of cases were from the mining (0.90%), financial  
11 (0.60%) and electrical, gas and water industries (0.10%) as shown is in Figure 2.

12  
13 When the proportion of eye injuries was analysed by their state location of occurrence  
14 in Peninsular Malaysia, the State of Selangor (21.40%) had the highest number of cases of eye  
15 injury and state of Terengganu (0.90%) showed lowest as shown in Table 3. The work-related  
16 eye injury had an increased trend in public services from the year 2004-2008 as shown in Figure  
17 3.

**Table 2: Types and characteristics of work-related eye injury among industrial workers registered with SOCSO 2004-2008**

Characteristics	Number (n=884)	Percentage (%)		
<b>Anatomy of Eye</b>				
Cornea	472	53.40		
Multiple injury	232	26.20		
Conjunctiva	98	11.10		
Eyelid	30	3.40		
Eyebrow	20	2.30		
Crystalline lens	7	0.80		
Orbital	7	0.80		
Retina	6	0.70		
Sclera	4	0.50		
Anterior chamber	4	0.50		
Nasolacrimal gland	2	0.20		
Uvea	1	0.10		
Optic nerve	1	0.10		
<b>Affected Eye</b>				
Left eye	419	47.40		
Right eye	373	42.20		
Both eye	75	8.50		
No record	17	1.90		
<b>Eye Injury Level of Severity</b>				
Mild	530	45.00		
Moderate	236	36.80		
Severe	118	18.20		
<b>Causes</b>				
Impact from a moving object excluding falling objects	788	89.20		
Impact from a static object	33	3.70		
Impact from a falling object during work	30	3.30		
Impact from a moving object	9	1.00		
Falling from a higher place	7	0.80		
Falling from the same height or lower place	7	0.80		
Other impacts from falling object	5	0.60		
Exposure to ionizing radiation	4	0.50		
Other accidents	1	0.10		
<b>Types of Eye Injury</b>				
Eye surface injury	456	51.80		
Other injury	182	20.60		
Blow	105	11.80		
Burn	88	10.10		
Bruise	46	5.30		
Radiation effect	3	0.30		
Fracture	2	0.20		
<b>Start Treatment Day</b>				
Same day	602	68.30		
≤3 day	241	27.30		
≤7 day	26	2.90		
≤14 day	7	0.80		
≤30 day	4	0.50		
>30 day	4	0.50		
<b>Vision Acuity Level</b>	<b>Initial Assessment (n = 266)</b>		<b>Final Assessment (n=360)</b>	
	<b>RE</b>	<b>LE</b>	<b>RE</b>	<b>LE</b>
Good (6/4.5-6/6)	39.80%	38.30%	66.70%	61.70%
Mild (6/7.5-6/18)	30.80%	33.10%	21.70%	23.10%
Moderate (<6/18-6/60)	14.70%	14.70%	3.90%	6.90%
Severe (<6/60-NPL)	14.70%	13.90%	7.80%	8.30%

**Table 3: Eye injury trends according to the type of industry in each State in Peninsular Malaysia and by age group**

Eye Injury	Types of Industry										Total
	A	B	C	D	E	F	G	H	I	J	
Selangor	57	22	6	25	36	27	11	1	0		189
Pulau Pinang	91	26	1	22	9	5	5	0	0		161
Johor	59	18	9	12	29	10	9	1	1		148
Kedah	52	18	9	14	5	5	0	1	0		104
Perak	36	20	8	15	8	8	4	1	0		100
Pahang	10	10	7	15	2	3	2	1	0		50
Kuala Lumpur	8	9	0	11	4	6	2	0	0		40
Negeri Sembilan	13	4	3	9	5	0	2	0	0		36
Melaka	12	2	3	3	1	2	0	0	0		24
Kelantan	2	3	0	3	4	0	0	1	0		13
Perlis	1	2	0	2	0	5	0	0	0		11
Terengganu	1	1	3	2	0	0	1	0	0		8
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>
10 - 19	14	6	1	6	1	2	0	0	0		30
20 - 29	97	43	7	44	37	24	7	3	0		263
30 - 39	126	52	12	41	37	29	10	1	1		309
40 - 49	71	22	22	31	22	12	9	1	0		196
50 - 59	27	10	5	10	6	3	8	1	0		71
60 - 69	7	2	2	1	0	1	2	0	0		15
<b>Total</b>	<b>342</b>	<b>135</b>	<b>49</b>	<b>133</b>	<b>103</b>	<b>71</b>	<b>36</b>	<b>6</b>	<b>1</b>		<b>884</b>

A Manufacturing

B Trading

C Agriculture, Forestry &amp; Fisheries

D Public services

E Services

F Construction

G Transportation

H Mining

I Electric, Gas &amp; Water supply

J Financial

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3 1 **Method, cost and efficacy of recovery**  
4

5 2 The manner of recovery, cost of medical expenses and the rate of injured workers returning to  
6  
7 3 work are shown in Table 4. The costs of treatment determined in this study refers to the  
8  
9 4 standardised maximum reimbursable hospital rates used by SOCSO for payment for treatment  
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11 5 of workplace injury. Whereas the types of treatment received by workers with eye injuries  
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13 6 registered in SOCSO are listed in Table 4.  
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16  
17 7 Worker recovery from injury is divided into 2 groups. The first group depicts medical  
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19 8 recovery from injury which would include surgery (if needed), outpatient follow-up and  
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21 9 medication. The second group depicts vision recovery methods which include spectacles,  
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23 10 prostheses and recovery references. In the medical recovery group, the Type C and Type B  
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25 11 surgery treatment modalities were the most common options reported for treating eye injury (>  
26  
27 12 50 cases). It is also noted that the biggest number of cases were moderate types of eye injuries  
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29 13 with moderate types of treatment needed.  
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33 14 The indirect costs are derived from the value of temporary disability or the number of  
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35 15 workers' days off from work, and the value of permanent disability or workers' compensation  
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37 16 costs. This study showed that 94.50% workers returned to work after their recovery from injury.  
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39 17 However, the remaining 5.50% did not go back to work as derived from Table 5. The age wise  
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41 18 distribution of eye injury severity and occupational status showed the highest percentage of  
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43 19 return to work was for the age groups 30 to 39 years and 40 to 49 years which were 95.80%  
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45 20 and 96.40% respectively. Although the severity of injury was found to be higher among workers  
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47 21 over the age of 50 years, nonetheless most of them were able to return to work. Whereas, the  
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49 22 younger age group, 10-19 years, stopped working more often compared to the older age groups  
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51 23 except for the age group 60-69 years as shown in Table 1. The total direct and Indirect medical  
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53 24 cost was RM1,108,098.00 (USD 316599.40) and RM4,150,140.00 (USD 1185754.20).  
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**Table 4. Estimated medical, and vision recovery cost of 884 industrial workers registered with SOCSO**

Cost Category	No,	Costs (RM)	Costs (USD*)	Total (RM)	Total (USD*)
<b>Direct Costs of Medical</b>				<b>1,108,098.00</b>	<b>316599.40</b>
<b>Recovery</b>					
Surgery B	64	750.00	214.20	48,000.00	13714.20
Surgery C	79	500.00	142.80	39,500.00	11285.70
Surgery D	17	188.00	53.70	3,196.00	913.10
Outpatient (mild cases)	75	40.00	11.40	3,000.00	857.10
Outpatient (moderate cases)	393	70.00	20.00	27,510.00	786.00
Outpatient (severe cases)	19	100.00	28.50	1,900.00	542.80
Medication (mild treatment)	72	50.00	14.20	17,850.00	5100.00
Medication (moderate treatment)	125	70.00	20.00	136,268.00	38933.70
Medication (severe treatment)	40	100.00	28.50	254,900.00	72828.50
<b>Ward Cost</b>	-	32.00	9.10	540,374.00	154392.50
<b>Vision Recovery</b>					
Spectacles	25	400.00	114.20	10,000.00	2857.10
Prosthesis	6	3,600.00	1028.50	21,600.00	6171.40
Spectacles + Prosthesis	1	4,000.00	1142.80	4,000.00	1142.80
Recovery references	1	-	-	-	-
<b>Indirect Costs</b>				<b>4,150,140.00</b>	<b>1185754.20</b>
Value of temporary disability				805,268.00	230076.50
Value of permanent disability				3,344,872.00	955677.70
<b>TOTAL RECOVERY COSTS</b>				<b>5,258,238.00</b>	<b>1502353.70</b>

\* 1USD=3.5 RM (Average of 2004-2008); Source of data SOCSO

\* Type B included Intraocular lens implant Keratoplasty: Lamellar or penetrating Retinal detachment surgery, Intraocular foreign body removal, Strabismus surgery, Repair of severe perforating injuries of the eyeball, Glaucoma surgery, Dacryocystorhinostomy, Dacryocystectomy Repair of several lachrymal passages Exenteration of orbit.

\*Type C included Cataract extraction: intracapsular and extracapsular, Repair of eyelid deformities, Extraction of dislocated / subluxated lens, Discission Paracentesis Excision of orbital or ocular tumours Iridectomy: peripheral or optical Cryopexy as prophylaxis against retinal detachment and glaucoma Evisceration, Enucleation, Ectropion or Entropion correction, Tarsorrhaphy Repair of severe laceration of eyelid and / or region around the eyes, Pterygium surgery, Excision biopsy Release of symblepharon / mucous membrane graft, Repair of lachrymal puncta or canalicular obstruction, Repair of moderate perforating injury of eyeball, Laser Coagulation

Type D included Incision and curettage of chalazion, Excision of granulomas, Removal of corneal or conjunctival foreign body Catholysis / epilation of trichiasis, Repair of minor lacerations of eyelids and / or region around the eyes, Syringing / probing of lachrymal apparatus, Repair of minor perforating injury of eyeball.

### 1 Severity of eye injury and effectiveness of vision recovery

2 The relationship between the severity of eye injury and the ability of the employee to return to  
 3 work was analysed. Table 5 displays the relationship between the injured employee (registered  
 4 with SOCSO) employment status with the severity of the eye injury they experience. It was  
 5 found that most workers injured in Peninsular Malaysia suffered mild (n = 398) and moderate  
 6 (n = 325) eye injuries. Of that number, 96% of them were able to return to work. In contrast,  
 7 14% of workers with severe eye injuries were unable to return to work. To prove the correlation  
 8 between this data, a chi-square test was performed. The results of the chi-square test ( $\chi^2 =$   
 9 24.94, df = 2, p <0.001) showed that there was a significant relationship between the severity  
 10 of eye injury and employee work status. This indicates that, when the degree of injury of the  
 11 employee's eyes worsens or the total number of days of sick leave exceeds 1 month, the chances  
 12 of the workers returning to work declines.

14 **Table 5. Frequency of employment status based on severity of work related eye injury**

Work Status	Eye Injury Level of Severity (n)			Total
	Mild	Moderate	Severe	
Working	382	314	139	835
Stopped working	16	11	22	49
<b>Total</b>	<b>398</b>	<b>325</b>	<b>161</b>	<b>884</b>

17 \* $X^2 = 24.94$ , df=2, p<0.001

## 1 DISCUSSION

2 This study showed a male preponderance of eye injuries which is congruent with the study  
3 conducted in Malaysia by Soong et al. 2008 where he found 88.1% cases occurred among  
4 males. Similarly, other studies also supported this male predominance.<sup>1,5,7,10,11,12,16-21</sup> The ethnic  
5 distribution of cases showed that Malays (42.30%) had a higher percentage of work-related eye  
6 injury followed by the Chinese, Indian and Other ethnicities. The study by Soong et al. (2008)  
7 reported a similar ethnic distribution of eye injury with the percentage of Malay, Indian,  
8 Chinese and Other ethnicities being 31.90%,12.20%, 9.70%, and 2.10% respectively.<sup>10</sup> This  
9 study found that the highest number of eye injuries occurred from impact with a moving object  
10 (excluding falling objects) (89.20%) followed by impact from a static object , impact from  
11 falling objects during operation (work), and impact from moving objects which contradicted  
12 another Malaysian study which reported 30.80% of injuries were from activities such as  
13 grinding or cutting metal (15.80%), welding (6.90%), hammering on metal (3.70%), carpentry  
14 (2.60%), and nailing (1.80%).<sup>10</sup> Moreover, injury to the surface of the eye was more common  
15 and accounted for 51.60% of eye injuries. Of the anterior segment eye injuries, corneal injury  
16 was the major cause followed by multiple injury causes. These study findings were supported  
17 by two other studies also conducted in Malaysia which reported 61.50% of eye injuries were  
18 corneal laceration and other study reporting that the common anatomical site of injury was the  
19 cornea (43.60%) followed by the conjunctiva (39.50%).<sup>5,10</sup>

20  
21 In this study, monocular work-related injuries were more common than binocular  
22 injuries and the left eye was more affected compared to the right eye. It was also reported that  
23 about 70% of workers received treatment on the same day while the remainder mostly sought  
24 treatment within 3 days of injury. However, an earlier study conducted in Malaysia contradicted  
25 these findings where that study found that right eye injury was more common, followed by the

1 left eye and then both eyes but was in agreement with the fact that 73.40% presented within 24  
2 hours of the injury and that a further 23.90% presented between 1–3 days from the day of the  
3 injury.<sup>10</sup> Furthermore, the trend of eye injury decreased from 2004 to 2008 and the  
4 manufacturing industry recorded the highest number of cases of eye injuries followed by trading  
5 and public services. It was noted that Selangor state had the highest number of cases of eye  
6 injury followed by Penang. Thus far, no other such study has compared eye injuries based on  
7 industry type and by State in Malaysia previously.

8  
9 In a previous study, the average working day loss was reported as 3.4 days.<sup>22</sup> The study  
10 of Chi and colleagues (2007) reported that the duration of hospital treatment was from 4 to 7  
11 days, with the average cost of medical treatment being New Taiwan Dollar 43,609 +/- 30,660  
12 (6635.05 +/- 4664.87 or 1567.46 +/- 1102.03 USD).<sup>23</sup> Another study recorded that over US \$  
13 300 million a year was lost comprising total lost time and income, medical expenses and  
14 employee compensation.<sup>24</sup> Almost 90% of all occupational eye injuries can be prevented  
15 through the use of appropriate safety equipment. Using appropriate safety equipment can  
16 indirectly save total costs of eye injuries such as the related legal fees, the cost of repairing the  
17 damage resulting from the circumstances related to the injury in the work premises and the  
18 necessary employee training fees has been estimated at more than US \$ 934 million annually  
19 in America.<sup>25</sup> In this study it was found that the costs of medical and vision recovery was about  
20 Ringgit Malaysia 5 million (about 1.2 million USD) where the direct costs amounted to more  
21 than Ringgit Malaysia 1 million ( about 300 thousand USD ) and indirect costs were more than  
22 Ringgit Malaysia 4 million (about 1.1 million USD) . Present study provides an understanding  
23 of the economic importance of work-related eye injuries in Malaysia which has not been  
24 explored before. Both employers and employees must be aware of the relationship between  
25 visual health and productivity in the workplace. Employees who experience a significant

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3 1 decrease in their vision can contribute to increased rates of negligence in the workplace and  
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5 2 losses of working days. Negligence can make a work premise a place where workers are at high  
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7 3 risk of danger. This situation happens because of employees with a decrease in their visual  
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9 4 ability may find it difficult to adapt to their reduced visual state and this in turn can lead to  
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11 5 frustrations with their jobs or tasks. This employee than would have to deal with fatigue,  
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13 6 headaches and constant stress on a daily basis caused by their vision dysfunction. This  
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15 7 circumstance may then lead to the employee's income becoming compromised if this situation  
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17 8 persists over a period of time. If there are many workers involved, this situation can then  
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19 9 threaten the economic stability of industries and eventually countries while being likely to cause  
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21 10 a rising unemployed population. The employer also bears huge losses from this loss of  
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23 11 experienced and trained work persons who face these vision limitations.  
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31 13 In this study, it was found that about 96% of workers suffering from eye injury suffered  
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33 14 from low to moderate injury which in turn increased their indirect medical costs in comparison  
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35 15 to their direct medical costs and their chances of returning to work. Although 14% of workers  
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37 16 had suffered severe injury, still the percentage of their not returning to work was low, being  
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39 17 5.50%. There are a number of factors that can affect the severity of an employee's eye injury.  
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41 18 These factors include the quality of safety protection devices, mechanisms of accidents, types  
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43 19 of eye injuries, when treatment was started, the type of medical treatment given and so on. For  
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45 20 those with low severity injuries, the visual status of these injured workers was assisted and  
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47 21 improved through refractive error correction using glasses or contact lens. This method  
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49 22 however can only help in certain cases, depending on the effects of the injury sustained. Work-  
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51 23 related eye injuries are not only affected by refractive errors, but also includes visual field  
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53 24 problems, stereopsis and other more extensive and complicated problems. The rehabilitation is  
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55 25 not just prescribing glasses, there are multiple factors that decides the success rate of the  
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3 1 rehabilitation. The rehabilitation performed needs to be tailored to address all the problems  
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5 2 encountered by the injured worker including any loss of field of vision or eye muscle imbalance.  
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7 3 The results of the chi-square test on the data from the injured workers in this study showed that  
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9 4 the degree of severity of the eye injuries affected that injured worker's ability to return to work.  
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11 5 The greater the severity of the eye injury, the chances of that worker returning to work became  
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13 6 less. Vision rehabilitation therapy can improve an injured employee's vision to a better level. It  
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15 7 must be noted that since most of these injured workers receive an injury involving only one  
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17 8 eye, they are typically not eligible to be classified as an individual with limited vision (since  
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19 9 the uninjured eye has typically normal vision, thus not fulfilling the criteria for limited vision.  
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22 10 Adaptation to vision loss among workers usually occurs rapidly. This is because occupational  
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24 11 eye injuries usually happen to younger adult individuals and those who have the physical ability  
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26 12 to continue working. This can be seen from the findings of this study where most of the injured  
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28 13 workers return to work. This situation has the potential to create a higher risk to employees with  
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30 14 their current vision status not reaching the actual standards needed for the job they do, especially  
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32 15 when they need to handle or operate hazardous equipment. Often there is no specific assessment  
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34 16 of the safety of the employee in his duties when they return to duty after injury.  
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42 18 To further strengthen Malaysia's position within the global economic community with  
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44 19 strong and progressive economic and industrial development policies, worker safety issues in  
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46 20 the workplace should be given due attention and should address worker safety from all angles.  
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48 21 This should not only involve just accident prevention measures in workplaces but should also  
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50 22 address post-injury rehabilitation for those who are injured in their course of their work which  
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52 23 should also encompass vision recovery methods. The experience from other developed  
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54 24 countries can be studied, and wherever appropriate these experiences can implement prudently  
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56 25 in the Malaysian work environment.  
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3 1 The limitation of the study includes lack of data availability after the year 2008. This  
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5 2 descriptive study was not reported relative to an underlying study base, making it difficult to  
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7 3 assess whether certain groups of workers were more likely to have eye trauma. Besides, other  
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9 4 important components of vision named stereopsis, contrast sensitivity, color vision, and visual  
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11 5 field data not included in the study. However, the details of vision rehabilitation are not  
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13 6 considered for further analysis because it was a retrospective case files study. Due to the  
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15 7 retrospective observational study design, an inherent bias can be possible and it can be  
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17 8 overcome by considering a prospective study in future.  
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## 24 10 **CONCLUSION**

25  
26 11 This study concludes that males are more affected than females and have highest percentage of  
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28 12 work-related eye injuries. It was observed that work-related eye injuries were most likely to  
29  
30 13 occur among Malay workers compared to the other Malaysian ethnicities. The highest number  
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32 14 of eye injuries arose from the impact of moving objects (excluding those caused by falling  
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34 15 objects) (89.20%) followed by eye surface injury (51.60%) where commonly corneal injury  
35  
36 16 was seen. The State of Selangor had the highest number of cases of eye injury followed by the  
37  
38 17 state of Penang over the study period, 2004-2008. It was found that in this period, more workers  
39  
40 18 suffered from eye injuries in the low category (45.00%) more followed by the moderate  
41  
42 19 (36.80%) and severe (18.20%) categories. About 70% workers received treatment for their eye  
43  
44 20 injuries on the same day as their injury occurred while the remaining mostly sought treatment  
45  
46 21 within 3 days of injury. Indirect medical costs were found to be higher than direct medical costs  
47  
48 22 and the percentage of workers returning to work after receiving treatment was 94.50%.  
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50 23 Awareness and vision rehabilitation program at work place need to be address for a better  
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52 24 prevention and rehabilitative service.  
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## 7 **Availability of data and materials**

8 The data used in this study is available with the author.

## 9 **Ethics approval and consent to participate**

10 This study received approval from University Kebangsaan Malaysia Research Ethics  
11 Committee UKM 1.5.3.5/244/SPP2/NN/187/2010.

## 12 **Consent for publication**

13 Not applicable.

## 14 **Competing interests**

15 The authors declare that they have no competing interests.

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**Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO**

**Figure 2: Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008**

**Figure 3. The proportion of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

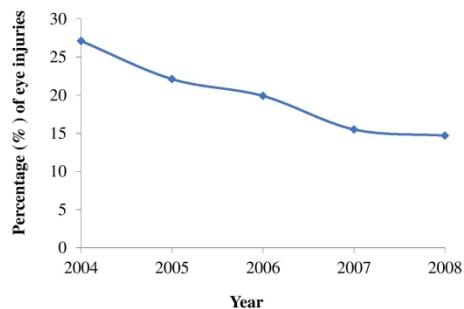
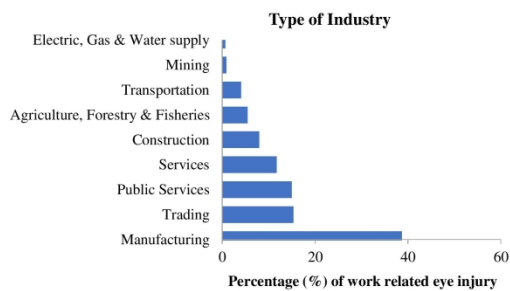


Figure 1: The changes of eye injuries in percentage from 2004 to 2008 registered with SOCSO

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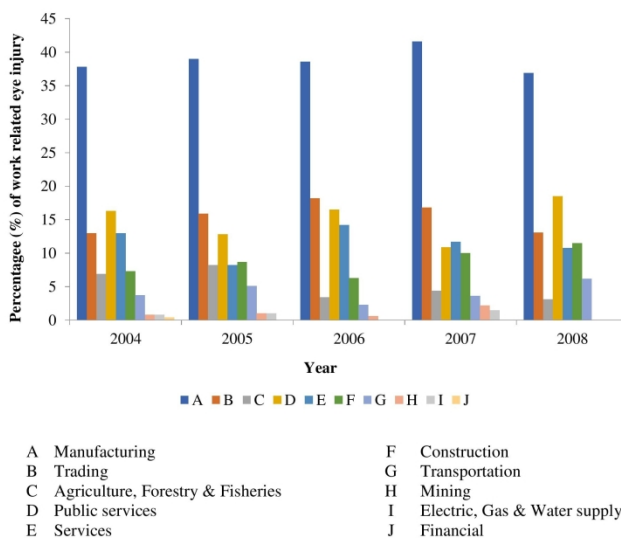
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**Figure 2:** Percentage of workers with work-related eye injury among subjects registered with SOCSO 2004-2008

209x297mm (300 x 300 DPI)



**Figure 3. The trend in distribution of eye injury by industry for the period 2004 to 2008 registered with SOCSO**

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60STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page & Line No.
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page: 3 Line: 1-2 Page: 3 Line: 3-29
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page: 5,6 Line: 1-25
Objectives	3	State specific objectives, including any prespecified hypotheses	Page: 6,7 Line: 25, 1-2
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Page: 7 Line: 5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page: 9 Line: 4-24
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page: 9 Line: 1-2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page: 9 Line:12-23
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	Page: 10 Line:7-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page: 9 Line:24-25
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page: 10 Line:1-3
		(b) Describe any methods used to examine subgroups and interactions	Page: 10 Line:1-3
		(c) Explain how missing data were addressed	-
		(d) If applicable, describe analytical methods taking account of sampling strategy	-
		(e) Describe any sensitivity analyses	-
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page: 10 Line:7-9
		(b) Give reasons for non-participation at each stage	Page: 9 Line:9-11
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical,	Page: 11

		social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	-
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page: 14,15,17 Table
		(b) Report category boundaries when continuous variables were categorized	2,3,4
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page: 18 Table 5
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Page: 19
			Line:1-25
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Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page: 23 Line: 1-8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page: 23 Line:10-24
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page: 22 Line:18-25
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page: 24 Line:4-6

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).